Value of Network Resilience 2024

Draft decision

July 2024

AUSTRALIAN ENERGY REGULATOR

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Executive summary

We commenced our review following a request from the Energy and Climate Change Ministerial Council (ECMC) to extend our current review of Value of Customer Reliability (VCR) to establish a value of customer resilience associated with long duration outages. The purpose of our Value of Network Resilience 2024 review is to establish an initial value of network resilience (VNR) that:

- is attributable to the benefit network customers receive from a resilient network, either in reduced outage probability and/or duration, where network resilience is defined as a network's ability to withstand and recover from an extreme hazard event that is likely to lead to a prolonged outage, and
- supports network investments driven by a network's ability to:
    - withstand events; for example, hardening investments (e.g. composite poles, areal bundled cables, undergrounding), network topology (i.e. supply path redundancy), design standards, and Stand Alone Power Systems (SAPs)[1]
    - recover from events; for example, standby mobile substations and generators, contingency standby crews, network automation, design standards (e.g. design for repairability) and communications with customers before and during outages.

We expect a VNR will complement the AER's guidance on network resilience[2] and provide the benefit value applied within the existing cost-benefit analysis framework. This will assist electricity networks, particularly Victorian distributors as part of their forthcoming revenue reset, assess options to invest in resilience related solutions in those parts of their networks identified as the subject of increased risk of damage as a result of extreme hazard events.

On 13 May 2024 we published an issues paper seeking stakeholder views on preliminary considerations regarding outage characteristics, unserved energy, VNR granularity and assessment criteria as well as the potential approaches we could use to develop a VNR.

We received 15 submissions[3] in response to that issues paper, with some key themes across submissions including:

- general support for the use of a relatively simple pragmatic approach for the initial VNR, recognising the timing constraints for our review and the exploration of a methodologically sound long-term approach commencing early 2025.

[1] A stand-alone power system is an electricity supply arrangement that is not physically connected to the national grid.

[2] AER, *Note on the key issues of network resilience*, April 2022.

[3] A list of submissions received is in Appendix A.

- the initial VNR should only be a short-term measure and not a foundation for a longer-term VNR.
- the AER needs to investigate more robust methodologies for the longer-term VNR and should do this in a timely manner. The AER should commit to and provide further detail on its longer-term work program.
- the AER should use insights and research from recent major outage events to inform its decision and approach to the VNR.

We also held three deliberative forums to understand the lived experiences of consumers affected by the February 2024 power outages in Victoria. Key insights and observations from the direct customer engagement, analysis and research we undertook include that:

- there were varied impacts among consumers, heavily influenced by household type, health conditions, reliance on technology, and access to alternative power sources.
- customers faced common challenges included food spoilage and replacement costs, difficulties with essential technology, and significant stress due to uncertainty and financial impacts. Customers also demonstrated that these costs and the inconveniences were lumpy in nature, with stepped increases occurring at key points during an outage.
- personal accounts from customers highlighted severe disruptions, especially for vulnerable groups dependent on medical equipment.
- customers took measures such as investing in generators and storing essential supplies in direct response to the outage, indicating a trend toward self-reliance and future preparedness.
- prolonged outages over 72 hours are rare. During the last three large-scale electricity outage events in Victoria, around 90% of customers were reconnected within 72 hours, with most of the remaining 10% of customers reconnected within seven days. [4]

Our draft decision has been informed by the customer insights obtained from our engagement with stakeholders including the deliberative forums and Victorian distribution networks, the stakeholder reference group, submissions, and our own analysis. The nature of this review and the timeline for completion constrains its scope. We have balanced considerations of timeliness and suitability in developing our proposed VNR approach.

We welcome stakeholder feedback on any component of this draft decision. We are particularly interested in views on our assessment of the options, the multiples of VCR and the tier increments we are proposing. Stakeholder views on longer term methodologies will be considered in the next stage of our VNR work commencing in 2025.

[4] Network Outage Review, *Review into the transmission and distribution businesses operational response to the 13 February 2024 storms*, Interim Report, July 2024, p. 39.

AER draft decision

On the basis of the evidence available, our proposed approach is to:

- adopt a $/kWh method for calculating unserved energy.
- align initial VNR granularity with VCR segmentation based on climate zone, remoteness, and customer type.
- focus on outages lasting between 12 hours and seven days, with a particular focus on outages lasting between 12 hours and 72 hours.[5]
- apply an upper bound to the initial VNR for residential customers, which is determined using the costs of backup generation and other non-network solutions as a reference. The upper bound for the initial VNR is $3,494 per residential customer. This approach recognises that electricity customers seek rational alternatives during prolonged outages and do not have unlimited willingness-to-pay for network resilience investments. We have not proposed to apply an upper bound to business VNR given the complexity of developing such a threshold for heterogeneous business needs.
- combine the upper bound approach with a multiple of the VCR approach. This proposal recognises that prolonged outages do have a greater impact for customers and is also representative of the lumpy nature of customers' behavioural response and the costs for customers associated with a prolonged outage. On the basis of the evidence available to us we are proposing a tiered approach as follows:

For residential customers -	For business customers -
• standard VCR applying for the first 12 hours of a prolonged outage followed by • a multiple of 2x the standard VCR applying for the period of 12-24 hours and • a multiple of 1.5x the standard VCR applying for the duration of the outage that extends beyond 24 hours.	• standard VCR applying for the first 12 hours of a prolonged outage followed by • a multiple of 1.5x the standard VCR applying for the period of 12-24 hours and • a multiple of 1x the standard VCR applying for the period of 24-72 hours and • a multiple of 0.5x the standard VCR applying for the duration of the outage that extends beyond 72 hours.

[5] We also note the consistency this seven-day period has with the Victorian Government's prolonged Power Outage Payment. One key eligibility criterion for this payment is that the electricity account holder was without power for seven days cumulatively, within a two-week period. For further information see: https://www.ausnetservices.com.au/outages/claims/prolonged-power-outage-payment

- more fully explore other approaches to estimating VNR as part of our broader VCR work program to ensure a more robust and refined approach to valuing network resilience in the longer-term.
- with stakeholders, develop a customer survey on resilience and outage impact, gathering detailed information across networks on the demographic attributes, specific challenges faced, and mitigation strategies employed by those affected by prolonged outages.

Next steps

We welcome stakeholder feedback on all aspects of our draft decision and the proposed approach to the initial VNR. We intend to work directly with the stakeholder reference group and networks to develop the customer resilience and outage impact survey that we have proposed publishing for broader consultation as part of the AER's final decision.

Table 3 Indicative timeline - VNR 2024

Milestone	Date
Issues Paper	10 May 2024
Submissions due	7 June 2024
Draft Decision	July 2024
Submissions due	19 August 2024
Final Decision	September 2024

Have your say

Written submissions on our draft decision are due **19 August 2024**.

Submissions should be sent electronically to vnr2024@aer.gov.au. Alternatively, you can mail submissions to:

Kris Funston
Executive General Manager
Australian Energy Regulator
GPO Box 3131
Canberra ACT 2601

We ask that all submissions sent in an electronic format are in Microsoft Word or other text readable document form.

We prefer that all submissions be publicly available to facilitate an informed and transparent consultative process. We will treat submissions as public documents unless otherwise requested. All non-confidential submissions will be placed on the AER's website.

We request parties wishing to subject confidential information:

- clearly identify the information that is the subject of the confidentiality claim

- provide a non-confidential version of the submission in a form suitable for publication.

For further information regarding the AER's use and disclosure of information provided to it, see the ACCC/AER Information Policy.

1 Background

This section provides context and background information relevant to our VNR project including:

- our Values of Customer Reliability (VCR) work, including the ongoing high impact low probability work program
- our guidance on the assessment of resilience investment under the NER, including a summary of how this guidance has been applied in the most recent revenue determination processes
- the Victorian Electricity Distribution Network Resilience review in response to recent storm events, the Victorian Government's response and draft proposed Rule change and the ECMC request.

1.1 VCR and other outages

As part of our ongoing work program, we produce VCR for standard outages (unplanned localised outages of up to 12 hours in duration). VCR seek to reflect the value different types of customers place on reliable electricity supply under different conditions. VCR serves an important role in ensuring customers pay no more than necessary for reliable energy by helping energy businesses identify the right level of investment to deliver reliable energy services to customers. Our VNR issues paper provides more background information on the VCR and the work we are undertaking on outages which fall outside the scope of the VCR.[6]

1.2 AER guidance note on network resilience

In April 2022, we published guidance to help networks and consumer groups understand how resilience investments are assessed under the National Electricity Rules (NER).[7] The guidance defines network resilience as a performance characteristic of a network and is the network's ability to continue to adequately provide network services and recover those services when subjected to disruptive events.[8]

The guidance notes the close relationship between resilience and reliability. While improved reliability is generally referred to as the service level outcomes from a more resilient network, other service-level outcomes like maintenance of safety and network security can also be affected.[9]

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[6] AER, *Issues paper – Value of Network Resilience 2024*, May 2024, pp. 6-7.

[7] AER, *Network Resilience – A note on key issues*, April 2022.

[8] Ibid., p. 6.

[9] Ibid.

The guidance highlights that, in an environment in which the effects of climatic change on the frequency and severity of major events are uncertain, it is important that risk allocation is optimally balanced – between ex ante (revenue proposals) and ex post funding (cost passthroughs) – to maintain service level outcomes so that it is consistent with the needs and preferences of consumers. The guidance note states our expectation that where NSPs propose resilience expenditure, they should demonstrate, within reason:

- there is a causal relationship between the proposed resilience expenditure and the expected increase in the extreme weather events.
- the proposed expenditure is required to maintain service levels and is based on the option that likely achieves the greatest net benefit of the feasible options considered.
- consumers have been fully informed of different resilience expenditure options, including the implications stemming from these options, and that they are supportive of the proposed expenditure (willingness to pay).

The guidance also highlights the related, but distinctly different, concept of community resilience. A resilient electricity network can assist in building community resilience. But many different entities, including government bodies and critical infrastructure operators (beyond electricity networks), have a role in supporting communities to withstand and recover from the effects of natural disasters.[10]

We note that there are various understandings of the term community resilience. The National Electricity Law (NEL) prescribes an electricity network service as 'a service provided by means of, or in connection with, a transmission system or distribution system.'[11] Some investments associated with building greater levels of community resilience such as the provision of portable back-up generation to energise a community hub may be captured under the definition. The purpose of this review and establishing a VNR does not at this stage require a definitive statement of whether particular types of resilience investments proposed by networks are appropriately determined to be network services. However, we do highlight that the focus for this review and a VNR is isolated to valuing network resilience.

1.3 Recent network proposals and AER decisions

Our final decisions for the Ausgrid, Essential Energy, Endeavour and TasNetworks (Dx) revenue determination processes included $322 million in expenditure forecasts related to network resilience, with the AER's resilience guidance note used as a basis for proposals and our assessment. Our VNR issues paper provides further background information on these decisions.[12]

[10] Ibid., p. 7.

[11] NEL, Part 1, section 2.

[12] AER, *Issues paper – Value of Network Resilience 2024*, May 2024, pp 9-11.

1.4 Extreme weather events, jurisdictional response and the ECMC request

There have been multiple storm events in Victoria that have triggered reviews into the resilience of its electricity distribution networks.

The Electricity Distribution Network Resilience Review was initiated in response to the 2021 storms.[13] The Victorian Government supported the vast majority of the Review's recommendations including that the relevant Victorian Government department:

- works with the AER to assess customer willingness to pay to avoid wide area, long duration outages,
- proposes a rule change to the NER capex objectives to specifically account for resilience. In supporting this recommendation, the Victorian Government noted that while current rules can, in theory, support investments in resilience, explicitly accounting for resilience in the rules would assist in future projects being favourably assessed by the AER.[14]

A further Network Outage Review has been established by the Victorian Government to investigate the response to the storms that occurred in February 2024.[15] The Review released its interim report on 4 July 2024 and this report highlighted the impacts of the outages associated with the storms on affected customers and communities. The interim report also outlined the Network Outage Review panel's initial thinking on recommendations, which addressed issues including the operational response, contingency and continuity planning (e.g., telecommunications continuity), customer communications, incentives and compensation, and improving the performance of worst performing feeders.[16]

The Review will be holding public panel meetings and receiving submissions on its interim report in July 2024. Its final report will be published in September 2024.

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[13] For more information on this review, see https://www.energy.vic.gov.au/about-energy/legislation/regulatory-reviews/electricity-distribution-network-resilience-review.

[14] State of Victoria Department of Energy, Environment and Climate Action, *Victorian Government Response to the Expert Panel's Electricity Distribution Network Resilience Review*, September 2023, p. 11.

[15] This review will cover the operational arrangements and preparedness of network service providers to respond to extreme weather events. The management of the incidents as well as the recovery process and timings will also be reviewed. In addition, there will be an investigation as to whether there were any material opportunities that could have enables a more rapid reconnection of electricity services as well as the quality of the communication with customers during the outage. For more information on this review, see https://www.energy.vic.gov.au/safety/power-outages.

[16] Network Outage Review, *Review into the transmission and distribution businesses operational response to the 13 February 2024 storms*, Interim Report, July 2024, p. 39.

2 Consultation summary

We recognise the importance of comprehensive and inclusive engagement with various stakeholders and communities as we develop our approach to valuing network resilience. Our draft decision has been informed by a number of engagement activities and these are discussed in more detail below.

Given the time constraints of this initial review we have engaged as thoroughly as possible within the available timeframe. Moving forward, we are committed to further engaging with stakeholders on our Draft Decision before making our Final Decision.

2.1.1 Issues paper

We released an issues paper in May 2024 that sought stakeholder feedback on potential approaches to valuing network resilience. We also invited stakeholders to provide their views on any of the broader themes of network resilience, particularly the outage characteristics (such as duration) on which our review should focus.

We received 15 submissions in response to our issues paper and there were some key themes that were consistent across those submissions including:

- general support for the use of a relatively simple methodology for initial VNR, recognising the timing constraints for our review.
- the initial VNR should only be a short-term measure and not a foundation for a longer-term VNR.
- the AER needs to investigate more robust methodologies for the longer-term VNR and should do this in a timely manner. The AER should commit to and provide further detail on its longer-term work program.
- the AER should use insights and research from recent major weather events to inform its decision and approach to the VNR.

Across the submissions, there was a diversity of views on the best approach. For example, many network service providers considered the VCR multiple approach was the most feasible for an initial VNR, potentially in conjunction with an upper bound. However, PIAC did not support the use of the VCR multiple or VCR extrapolation approaches but considered the use of an upper bound approach to be reasonable. For the VCR multiple approach, it suggested a factor of VCR may be more appropriate than a multiple (we understand this to mean a proportion or percentage).

2.1.2 Deliberative forums

To inform our draft decision, we conducted community consultations to gather insights from energy consumers affected by the prolonged power outages in Victoria during February 2024. The consultations aimed to capture the lived experiences of these consumers to inform the AER's regulatory decisions regarding network resilience.

The consultations were hosted by The Insight Centre and took place over three days, from June 18 to June 20, 2024. A total of 62 consumers participated in the sessions, which were designed to be inclusive and accessible, utilising two online forums and one in-person forum

held in Kallista, VIC. This hybrid approach ensured that a wide range of consumers could participate, regardless of their ability to travel, thus maximising the breadth and depth of the data collected.

The purpose of the forums was to provide us with valuable insights into the experiences and perspectives of customers, helping us develop a better understanding the costs customers incurred as a result of a prolonged electricity outage and to understand how consumers defined resilience.

An adapted Delphi method was used to reach attempted consensus on defining resilience and prolonged outages, with groups categorised by outage impact: high impact (2 to 11 days), medium to high impact (12 hours to 1 week), and low impact (up to 12 hours). Each group engaged with an identical discussion guide, tailored for the online environment, covering topics like lived experiences of outages, definitions of resilience, the difference between prolonged and standard outages, and customer expectations from electricity networks during prolonged outages.

The summary report of our consultation is provided in Appendix B.

2.1.3 Stakeholder reference group

We have established a stakeholder reference group (the VNR 2024 stakeholder reference group) comprised of experts and key stakeholders, including:

- Caroline Valente, Energy Consumers Australia (ECA)
- Craig Memery, Public Interest Advocacy Centre (PIAC)
- Garth Crawford, Energy Networks Australia
- Helen Bartley, Bartley Consulting Pty Ltd
- Mark Grenning, Energy Users Association of Australia (EUAA)

The purpose of the group is to provide additional insight and guidance throughout the engagement process. We have leveraged that insight and guidance in designing the deliberative forums and evaluating the outcomes from those forums. The work of the VNR 2024 stakeholder reference group has also informed our Draft Decision.

2.1.4 Other engagement

In addition to the above consultation, we have held meetings with individual stakeholders and peak bodies (both industry and customer focused) to discuss our review and hear their views on possible approaches and other matters related to our review.

3 Approaches to VNR – Preliminary matters

Estimating a value of resilience is challenging and there is no widely accepted best practice approach. Instead, there are a range of different methodological approaches that can be used and each approach has its own set of advantages and disadvantages.[17]

Like the VCR, the initial VNR will be a benchmark that will be used in business cases for resilience investments proposed by network businesses. As such, it is not intended to account for every circumstance or individual customer characteristic. Our determination of the initial VNR is also constrained by the timeframe for this review and we will need to work within this constraint when we develop our approach.

Our issues paper discussed some important preliminary matters we need to consider in developing an approach to VNR: outage characteristics, unserved energy, VNR granularity and assessment criteria. Stakeholders also raised additional preliminary issues in their responses to our issues paper.

In this section, we provide an overview of customer insights on the impacts of prolonged outages and discuss and outline our draft views on these preliminary matters.

3.1 AER analysis – customer impacts

To help inform our consideration of the potential approaches to an initial VNR, we have gained an understanding of customers' lived experience of prolonged outages. To do this, we:

- held three deliberative forums with electricity customers who had recent experience of power outages (see section 2 for more information)
- analysed a range of customer engagement materials provided by network businesses (e.g., deidentified survey responses from customers impacted by prolonged outages in Victoria)
- reviewed the outputs of the Victorian Electricity Distribution Network and Network Outage reviews

[17] Baik, Davis and Morgan, *Assessing the cost of large-scale power outages to residential customers*, Risk Analysis, 2018; Sanstad, Leibowicz, Zhu, Larsen and Eto, *Electric utility valuations of investments to reduce the risks of long-duration, widespread power interruptions, part I: Background*, Sustainable and Resilient Infrastructure, 2023; Baik, Hanus, Sanstad, Eto and Larsen, *A hybrid approach to estimating the economic value of enhanced power system resilience*, Lawrence Berkeley National Laboratory, 2021; Larsen, Sanstad, LaCommare and Eto, *Frontiers in the economics of widespread, long-duration power Interruptions: proceedings from an expert workshop*, Lawrence Berkeley National Laboratory, 2019; Macmillan, Wilson, Baik, Carvallo, Dubey and Holland, *Shedding light on the economic costs of long duration power outages: A review of resilience assessment methods and strategies*, Lawrence Berkeley National Laboratory, 2023.

- reviewed the analysis of the impacts the 2016 South Australian system black outage on affected businesses which was undertaken by Business SA.[18]

3.1.1 Insights from deliberative forums

The impact of the February 2024 power outages varied widely among consumers, influenced by the length of the outages and individual characteristics and circumstances. These characteristics included household composition, health conditions, work arrangements, and reliance on technology. For instance, households with children or elderly members, individuals with medical needs, and those working from home or running small businesses experienced different levels of disruption and stress.[19]

Differences in lived experiences[20]

Consumer experiences during the outages highlighted that the severity of impact was deeply personal and context-dependent. Key factors influencing these experiences included:

- Household composition: Families with children, single-person households, and elderly individuals had distinct challenges. For example, an elderly woman on a walker was stranded in her mobility chair for two days due to a power outage.
- Health and medical needs: Consumers with medical conditions requiring electricity for life support or mobility devices faced severe stress. One consumer, a single parent with a daughter on life support, described the distress caused by prolonged outages and lack of timely support from energy providers.
- Work and technology reliance: Those working from home or dependent on technology for communication and entertainment found outages particularly disruptive. One consumer was highly stressed due to the inability to charge her phone and coordinate child pick-ups and the potential danger of driving without functional traffic lights on unlit roads.
- Financial capacity and preparedness: Access to alternative power sources like generators or solar batteries, and financial means to purchase essential items during the outage, influenced the level of impact.
- Intersectionality: Many of these consumers experience a combination of these factors, leading to a compounding outage impact.

Despite the varied individual experiences, several universal impacts of prolonged outages were identified:

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[18] Business SA, *Blackout survey results – Understanding the effects of South Australia's state-wide blackout on 28 September 2016*, 2016.

[19] The Insight Centre, *Australian Energy Regulator: Consumer Engagement on the Value of Network Resilience*, June 2024, pp.21-23.

[20] The Insight Centre, *Australian Energy Regulator: Consumer Engagement on the Value of Network Resilience*, June 2024, pp.13-16.

- Food: Spoilage and replacement costs of food items.
- Technology: Critical for emergency information, work, studying, and entertainment.
- Well-being: Stress and concern triggered by uncertainty about outage length, financial impact on households and small businesses, health conditions reliant on electricity, and concerns for children in the household.

Consumer actions during outages[21]

Consumers undertook various remedial actions based on their circumstances, including traveling to places with power, using personal social networks for support, and investing in alternative power sources. The uncertainty of outage length often prompted consumers to assume a prolonged outage and act to avoid being unprepared. However, we note some people impacted by the prolonged outages indicated they were unable to take mitigation because they lacked the means to do so.

Reasonableness of outage length[22]

Consumers had varied opinions on what constitutes a reasonable outage length, influenced by their individual use characteristics and circumstances. Many disagreed with the current definition of a standard outage as up to 12 hours, finding it far greater than acceptable. They suggested that an outage length ranging from under one hour to eight hours would be more reasonable. Prolonged outages were defined by some as lasting between six to eight hours or 12 hours overnight. The tolerance for outage length decreased with the experience of longer outages, indicating that even short durations could trigger high-impact actions to minimise disruption.

Future proofing[23]

In response to the February 2024 outages, many high-impact consumers (those who experienced outages between 2 and 11 days) took steps to prepare for future outages. These included purchasing generators, torches, radios, and keeping a reserve of cash due to the failure of ATMs and EFTPOS during the outages.

Network communication[24]

Consumers expressed significant dissatisfaction with the communication from electricity networks during the outages. Many did not receive any information, while those who did found it inaccurate or conflicting. This lack of reliable communication increased stress and

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[21] The Insight Centre, *Australian Energy Regulator: Consumer Engagement on the Value of Network Resilience*, June 2024, pp.15.

[22] The Insight Centre, *Australian Energy Regulator: Consumer Engagement on the Value of Network Resilience*, June 2024, pp. 21.

[23] The Insight Centre, *Australian Energy Regulator: Consumer Engagement on the Value of Network Resilience*, June 2024, pp. 23.

[24] The Insight Centre, *Australian Energy Regulator: Consumer Engagement on the Value of Network Resilience*, June 2024, pp.24-26.

uncertainty, hampering consumers' ability to plan and manage the disruption effectively. Consumers' expectations from electricity networks during outages include robust communication before, during, and after an event, compensation for losses, infrastructure upgrades, and information guides for better preparation. Effective communication was deemed crucial for managing uncertainty and planning during outages.[25]

3.1.2 Insights from government inquiries and research undertaken by network businesses

There were some consistent themes from customer engagement undertaken by network businesses and by recent government-initiated reviews of prolonged outages in Victoria, including the following observations:

- Many residential customers incurred costs associated with food spoilage because their fridges and/or freezers were without power for too long to be able to maintain the required storage temperatures. Some customers also experienced medication spoilage as they could not store their medications within the required temperature range without electricity.
- Some residential customers who worked from home experienced lost income as they were unable to work due to the lack of power.
- Customers without connections to mains water and sewer and no back up generation could not operate the pumps needed to provide water and to operate septic tanks in a safe manner.
- Many businesses incurred stock losses and trading losses as the loss of electricity meant they could not maintain stock at the correct temperature and/or could not operate or process sales transactions electronically.

The engagement materials we reviewed indicated the above impacts were not always gradual as a prolonged outage progressed. Instead, many customers indicated they experienced key stepped increases in costs at particular points in time during an outage. For example, as food spoiled due to a lack of refrigeration.

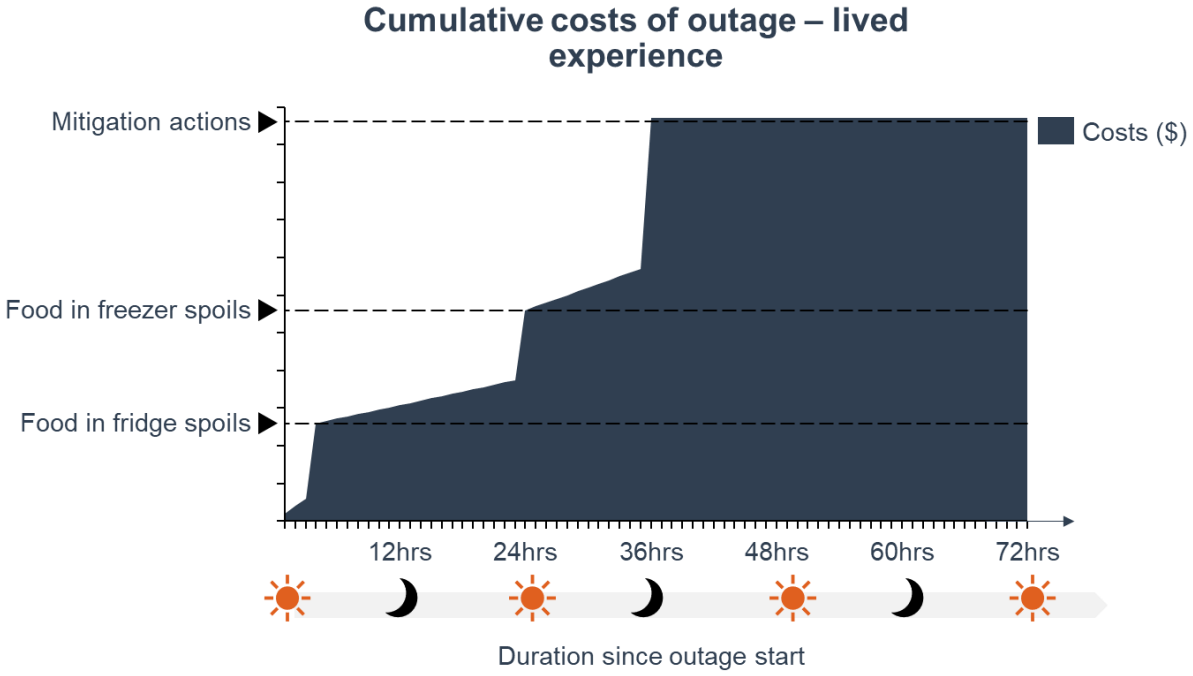
The impacts on individual customers also varied depending on their individual characteristics and level of preparedness for prolonged outages, as well as any mitigation strategies they were able to employ. For some customers, this meant the impacts of a prolonged outage were tempered over time, as they took steps to reduce the impact of the prolonged outage, where possible (e.g., by purchasing or renting a generator, accessing temporary accommodation or staying with friends or family).

[25] We note that the findings are in line with those of the Network Outage Review, *Review into the transmission and distribution businesses operational response to the 13 February 2024 storms*, Interim Report, July 2024.

3.1.3 Key overall observations

Based on the insights discussed above, it is evident that the impact of prolonged outages on customers is not constant across time. Instead, the costs incurred by customers during a prolonged outage are lumpy with stepped increases occurring at key points during an outage event. To demonstrate this, Figure 1 illustrates a hypothetical outage scenario:

Figure 1: Cumulative costs of a prolonged outage over time



For example, residential and business customers indicated that they incurred a stepped increase in costs when fridges and freezers were non-operational for a sufficient period of time for food spoilage to occur (usually between 12 – 36 hours) and when they purchased or rented generators or other mitigating actions. Another stepped increase occurred for residential customers not connected to mains water or sewer when septic tanks reached capacity and either required a pumping contractor to empty the tank or the customer to find alternative accommodation.

3.2 Additional issues raised by stakeholders

Many of the submissions we received on our issues paper commented on how we should approach the initial VNR. While stakeholders expressed a diversity of views, there were some common themes, including:

- support for the AER using a relatively simple methodology for the initial VNR, recognising the time constraints for our review.[26]
- the initial VNR should only be a short-term measure and not a foundation for a longer-term VNR.[27]
- the AER should investigate more robust methodologies for the longer-term approach in a timely manner.[28]
- The AER should commit to and provide further detail on its longer-term work program. Many stakeholders would like the longer-term work to be collaborative and also involve engagement with customers.[29]

PIAC noted it was important to distinguish and delineate between reliability, network resilience and community resilience, to reduce the risk of consumers paying twice for the same benefits or paying for benefits which could have been delivered through more efficient means. PIAC also noted that other agencies and actors have roles in disaster relief and reconstruction efforts, including the provision of crisis accommodation and back up generations and this should be taken into account when establishing the initial VNR. [30]

3.2.1 Our draft view on additional issues

We acknowledge we need to take a pragmatic approach to develop the initial VNR methodology and deliver the initial VNR within the required timeframe. We also recognise stakeholder concerns about the longer-term approach to VNR and we commit to undertaking further work on the VNR as part of our longer-term VCR/HILP work program.[31] We intend for this work to be collaborative and explore methodologically sound approaches to determining longer-term VNRs. The AER aims to commence this work in the first half of 2025 with a view to refine our VNR approach to inform the next round of regulatory determinations.

We also consider it is important to delineate between network resilience, reliability and community resilience and have defined the scope of the VNR accordingly. We will also consider this issue when we update our guidance note on network resilience.

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[26] For example, TasNetworks, *Submission on VNR issues paper* [letter], June 2024, p. 1; Ausgrid, *Submission on VNR issues paper* [letter], June 2024, p. 3.

[27] For example, Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 2; PIAC, *Submission on VNR issues paper* [letter], June 2024, p. 4.

[28] For example, Ausgrid, *Submission on VNR issues paper* [letter], June 2024, p. 2.

[29] For example, Ausgrid, Submission on VNR issues paper [letter], June 2024, p. 4.

[30] PIAC, *Submission on VNR issues paper* [letter], June 2024, pp. 5-6.

[31] For example, Ausgrid, *Submission on VNR issues paper* [letter], June 2024, pp.2-3; AusNet, *Submission on VNR issues paper* [letter], June 2024, pp.1, 5-6; Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 2; SA Power Networks, *Submission on VNR issues paper* [letter], June 2024, p. 1; ENGIE, *Submission on VNR issues paper* [letter], June 2024, p. 1; Transgrid, *Submission on VNR issues paper* [letter], June 2024, p. 5; Essential Energy, *Submission on VNR issues paper* [letter], June 2024, p. 3; Jemena, *Submission on VNR issues paper* [letter], June 2024, p. 5; Energy Networks Australia, *Submission on VNR issues paper* [letter], June 2024, p. 1.

3.3 National Electricity Objective

We must have regard to the National Electricity Objective (NEO) when we develop the initial VNRs.

The NEO

To promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:

a. price, quality, safety, reliability and security of supply of electricity; and

b. the reliability, safety and security of the national electricity system; and

c. the achievement of targets set by a participating jurisdiction—

i. for reducing Australia's greenhouse gas emissions; or

ii. that are likely to contribute to reducing Australia's greenhouse gas emissions.

In developing our approach to the initial VNR, we have applied the NEO. The NEO promotes efficient investment in, and efficient operation and use of, electricity services for the long-term interests of consumers of electricity, taking into consideration price, quality, safety, security, reliability and emission reductions. We have particularly focussed on the price and reliability elements of the NEO in this work because the initial VNRs seek to reflect the value different types of customers place on a resilience, which is a subset of reliability, under different conditions.

We consider the initial VNR will promote the long-term interests of electricity customers by enabling businesses, regulators and other stakeholders to make informed decisions about the efficiency of proposed investments in electricity services. This is because the initial VNR will be a reasonable reflection of customer reliability preferences. These values will help decision-makers to balance resilience and affordability when making decisions about investment.

3.4 Outage characteristics

The issues paper noted within the scope of VNR, there was a large range of potential outages we could consider when placing a value on network resilience, with each outage having its own individual dimensions and effects.

To enable us to develop an appropriate value of network resilience, we have sought stakeholder views on the outage scenarios that are of most concern to stakeholders (e.g., outage location, duration, timing, size of area impacted, etc.).

We have also used our engagement with customers (via the deliberative forums) and information provided by network businesses regarding their customer engagement to develop a better understanding of their lived experience and perspectives on prolonged outages and used this to inform our consideration of outage scenarios.

3.4.1 Stakeholder views on outage characteristics

Outage duration

We received several submissions in which stakeholders provided views on the outage duration of most importance in the VNR context. There were differing views across these submissions about the duration of outages that should be the focus of the initial VNR including:

- 12 hours to 2 days (SA Power Networks)
- 24 hours (Energy Queensland)
- 2 – 3 days (ENGIE)
- 12 hours to 7 days (Transgrid)
- All outages over 12 hours (CPU). [32]

3.4.2 Insights from deliberative forums and network engagement

The customer engagement undertaken by the AER for this review and by network businesses also provides some useful insights on the duration of outages that should be the focus of the initial VNR.

According to the interim report prepared by the Victorian Network Outage Review, during the last three large-scale electricity outage events in Victoria, around 90% of customers were reconnected within 72 hours and most of the remaining 10% of customers were reconnected within 7 days.[33] The interim report also noted that customers began to accrue costs around 48 hours into a prolonged outage because food begins to spoil and needs to be replaced, and because customers require access to essential goods and services.[34]

Reviewing the deidentified data from AusNet's survey of customers affected by the 2021 Victorian storms, most customers surveyed experienced outages of between 12 hours and 48 hours. Surveyed customers also indicated that food spoilage and stock spoilage was a key impact associated with the outages and that it generally occurred within 12 to 36 hours of the outage commencing.

Insights from our deliberative forum reveal that consumers have varied perceptions of standard and prolonged outages, influenced by individual circumstances. Due to increased technology reliance and remote work, what is considered a long outage has decreased.

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[32] SA Power Networks, *Submission on VNR issues paper* [letter], June 2024, pp. 1-2; Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 3; ENGIE, *Submission on VNR issues paper* [letter], June 2024, p. 2; Transgrid, *Submission on VNR issues paper* [letter], June 2024, p. 4; CPU, *Submission on VNR issues paper* [letter], June 2024, p. 2.

[33] Network Outage Review, *Review into the transmission and distribution businesses operational response to the 13 February 2024 storms*, Interim Report, July 2024, p. 39.

[34] Ibid, p. 45.

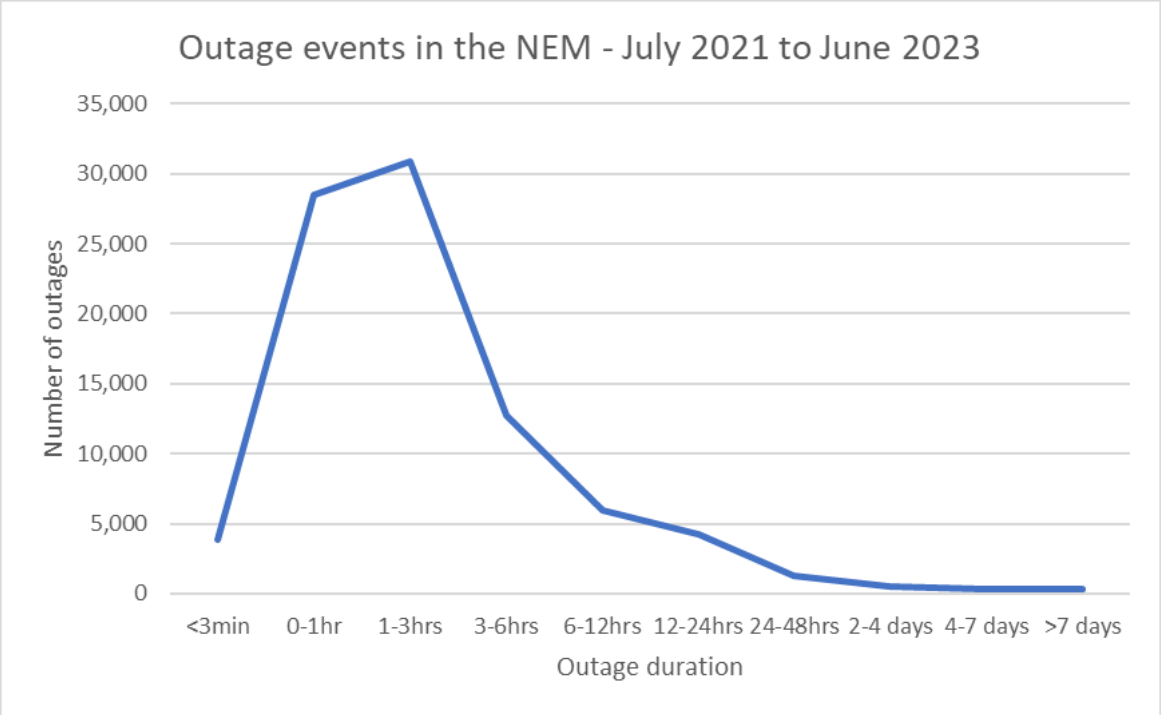
Outage acceptability also depends on timing and context, with those working from home or heavily reliant on electricity having lower tolerance levels. Many consumers disagreed with a 12-hour standard outage, viewing it as excessively long. Reasonable outage lengths range from under one hour to 12 hours, but even short outages can be highly impactful. Generally, a prolonged outage is defined as lasting six to eight hours or 12 hours overnight. Those who frequently experience outages tend to view shorter durations as prolonged, prompting them to activate action plans to minimise disruption.[35]

3.4.3 Our draft decision on outage characteristics

We have considered stakeholder views and the customer insights we obtained from our deliberative forums in deciding on the outage characteristics we will focus on when establishing initial VNRs. We have also undertaken our own analysis of the outages which occurred within the NEM between 1 July 2021 and 30 June 2023.

Our analysis of outage data (Figure 2) highlights that the prolonged outages exceeding 72 hours are far less common than prolonged outages between 12 hours and 72 hours.

Figure 2: Outage events in the NEM – July 2021 to June 2023



Source: Distribution network business' responses to the AER's Category Analysis Regulatory Information Notice (RIN) (October 2023).

[35] The Insight Centre, *Australian Energy Regulator: Consumer Engagement on the Value of Network Resilience*, June 2024, pp.21-23.

Our draft decision is to focus on outage durations between 12 hours and 7 days, with a particular focus on outage durations between 12 hours and 72 hours. This is because these outage durations were generally identified by stakeholders as being the most important in the VNR context. In addition, our analysis of outage data also indicates that this outage duration range is likely to capture most prolonged outages experienced by customers.

3.5 Unserved energy

When we survey customers as part of our VCR work, we derive the willingness-to-pay for each survey respondent, which represents the values they place on avoiding outages of different durations and with different attributes (summer, winter, weekend, weekday etc). Different customers will have different values depending on a range of factors, including their own electricity consumption characteristics, their location (climate zone/remoteness) and the specific attributes of the outage (duration, time of day, time of year).

Given that a customer's level of consumption can affect their willingness-to pay,[36] when we calculate the VCR, we use unserved energy estimates to normalise the willingness-to-pay estimates by expressing them in $/kWh.[37]Though we do note that it is unlikely that customers are considering their specific consumption load in terms of kilowatts of energy and more with regard to the utility that energy provides them, namely, a hot shower or airconditioned comfort when completing the survey.

Network businesses generally use these $/kWh VCR to build up their own network specific VCR (for example, based on a particular feeder's customer mix and climate zone/s) for use in the cost-benefit analyses they prepare to support network expenditure proposals. It is important to note that the network businesses apply their own forecasts of load and probability of outage in combination with the VCR to obtain a value for reduction in outages experienced by customers as a result of the proposed investment.

In its submission, AusNet suggested we may need to consider taking a different approach for prolonged outages and express values for these outages in a different unit of measurement (e.g., $ per day) in order to derive more meaningful values.[38] This is because the unserved energy component associated with the outage grows at a much faster rate than the dollar value of the outage, potentially leading to a low $/kWh event though customers may have a high willingness-to-pay to avoid these types of outages.

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[36] Gorman, *The quest to quantify the value of lost load: A critical review of the economics of power outages*, The Electricity Journal, 2022, p. 2.

[37] The 2019 VCR methodology is available at available on our website. This methodology is currently being reviewed and information on that review is also available on our website.

[38] In its submission to our VCR 2024 review, AusNet noted that the high value its customers placed on avoiding prolonged outages was diluted by the large volumes of unserved energy associated with prolonged outages and it suggested that revisions to the method used may be necessary to derive more meaningful values for prolonged outages. See AusNet, *Submission on the AER draft determination on the VCR methodology*, April 2024, p. 5.

In our issues paper, we sought stakeholder views on the use of unserved energy to derive a $/kWh VNR.

3.5.1 Stakeholder views on unserved energy

Multiple stakeholders considered that the approach to unserved energy in the VCR methodology, while useful, may not capture fully the broader community impacts of prolonged outages and/or the value consumers place on avoiding prolonged outages.[39]

CPU acknowledged that a $/kWh value could be useful but considered it may disadvantage smaller communities due to their lower consumption rates. Consequently, it considered that the $/kWh value was a useful baseline but should be supplemented with other considerations (e.g., criticality of affected services, customer demographics and regional economic factors).[40]

AusNet saw merit in quantifying the use associated with resilience using the non-deferable load (e.g. the essential electricity the customer cannot consume during the outage) rather than the total amount of unserved energy. However, it considered this approach would add complexity to development of VNRs and business case development and was a less meaningful concept when considering power outages over long periods of time – i.e. multiple days. AusNet noted the approach would require the AER to make decisions on which loads could and could not be deferred, which may be difficult given loads vary significantly between customers and may also vary substantially over the course of a prolonged outage. AusNet was of the view this complexity could be avoided by ensuring the chosen methodology, or combination of methodologies was capable of reflecting all the activities customers may wish to do over the outage period whilst also producing robust and intuitive VNRs.[41]

3.5.2 Our draft view on unserved energy

We acknowledge stakeholder concerns about applying the methodology used to derive $/kWh VCR to any initial VNRs. In particular, the impact that the use of unserved energy estimates associated with a prolonged outages may have on any $/kWh initial VNRs.

We have considered some different approaches to unserved energy that we could use if required, including expressing the initial VNR in $ per day or using an adjusted, lower estimate of unserved energy that includes only usage that is considered essential. In respect of the $/day approach, we consider it would be unlikely to be appropriate for an initial VNR for business customers, given the heterogeneity of businesses' electricity consumption.

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[39] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 4; CPU, *Submission on VNR issues paper* [letter], June 2024, pp. 2-3; Essential Energy, *Submission on VNR issues paper* [letter], June 2024, p. 5.

[40] CPU, *Submission on VNR issues paper* [letter], June 2024, p. 5.

[41] AusNet, *Submission on VNR issues paper* [letter], June 2024, p. 3.

Using an adjusted unserved energy estimate that only includes essential load would introduce additional complexity into the initial VNR calculation. It may also be challenging to establish the appropriate split between essential and non-essential load for business customers, given the diversity of business activities and the heterogeneity of business customers' electricity consumption. We also note that some of the potential approaches to establishing an initial VNR will not require an estimate of unserved energy for prolonged outages (e.g., multiple of VCR).

Given the above and the time available for our review, we consider any alternative approaches to deriving $/kWh values should be considered as part of our longer-term VNR work.

3.6 VNR granularity

The issues paper sought stakeholder views on how granular the VNR values needed to be and the reasons for requiring that level of granularity.

3.6.1 Stakeholder views on granularity

Network business stakeholders generally considered that the initial VNRs should be developed at a feeder level as this would enable more targeted investment towards network resilience.[42] However, SA Power Networks considered the granularity of the initial VNRs could be limited to customer type and climate zones, rather than feeders as this is consistent with VCR modelling and resilience-based outages typically impacting multiple feeders. It viewed $/kWh and granularity to climate zones and customer type as suitable for the initial VNRs.[43]

ENGIE considered localisation of the VNR was important to reflect the different impacts that consumers in different communities experience from prolonged outages, but that the granularity of the initial VNR should be dependent on how substantially those values differ between locations.[44]

AusNet believed feeder level VNR would be best theoretically. However, given the time constraints for the review, the trade-off between simplicity and accuracy, and the purpose of VNRs, it considered network-specific values would be most suitable. It considered this approach would simplify the calculation and ensure that resilience investments, which would be paid for by all customers, proportionally reflected the tolerance for risk and appetite for investment of all customers on the network.[45]

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[42] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p.4; Essential Energy, *Submission on VNR issues paper* [letter], June 2024, p. 5

[43] SA Power Networks, *Submission on VNR issues paper* [letter], June 2024, p 1, 3.

[44] ENGIE, *Submission on VNR issues paper* [letter], June 2024, p. 2.

[45] AusNet, *Submission on VNR issues paper* [letter], June 2024, p. 2.

3.6.2 Our draft decision on granularity

We note some stakeholders expressed a preference for VNR that is specific to their network service area or to individual feeders. We consider it will not be possible to deliver an initial VNR at the feeder level given the time constraints for our review. Even if it were possible, we note it may be challenging and very resource intensive due the large number of feeders we may need to develop bespoke VNR for and the methodological difficulties in achieving this level of granularity. For example, some potential methodologies (e.g. modelling) may be less accurate at this granularity level, while for others (e.g. survey-based methods) it may be more difficult to achieve a sufficient sample and statistically significant results.

We also note it is not clear whether a customer's VNR is likely to be driven by the feeder on which they are located or whether, like VCR, other attributes are more meaningful drivers of VNR (e.g., climate zone / remoteness and preparedness for resilience events). We consider it would preferable if any segmentation of the VNR aligned with the key drivers of VNR values, with network businesses able to build up a VNR that reflects the customer characteristics of a given feeder. We note this approach would align with the approach networks currently use for the VCR.

Given the VNR and VCR are likely to be used in conjunction with each other,[46] we consider it would be preferable if the VNR has a similar level of granularity and geographic alignment with the VCR, where possible.

Our draft decision is to develop:

- separate VNR for residential customers and business customers.
- VNR with a similar level of granularity to the VCR in respect of geographic segmentation (climate zone and remoteness), where possible.

3.7 Criteria for assessing potential approaches

The issues paper identified four criteria which we considered might help us assess the potential approaches to determining a VNR and identify the most appropriate option/s. These were:

- established within the required timeframe
- suitability of methodology
- ability to localise the value calculation
- impact on network expenditure proposals.

[46] This is because a cost benefit analysis may be built up of forecast standard outages (up to 12 hours in duration) and prolonged outages (over 12 hours in duration).

3.7.1 Stakeholder views on assessment criteria

Stakeholders expressed a range of views on the proposed assessment criteria in their submissions, including the following:

- Endeavour Energy did not support the criteria and proposed its own alternative criteria focused on power interruption duration, scalability, ease of use, and scope of outputs.[47]
- SA Power Networks generally supported the criteria but had concerns about the impact on network expenditure criterion.[48]
- Energy Queensland and Essential Energy supported the criteria but proposed the inclusion of additional criteria focused on the additional cost burden associated with prolonged outages[49] and also environmental impact and critical infrastructure.[50]
- CPU was concerned about the impact on network expenditure criterion and suggested the criterion should be replaced with one focused on whether the VNR supports the value consumers and stakeholders place on resilience, and the outcomes that can be achieved for those consumers.[51]
- Transgrid considered the criteria would benefit from more explicit consideration of simplicity, longevity and robustness, to inform approach choices. It was also concerned about the inclusion of the impact on network expenditure criterion.[52]
- Jemena and Energy Networks Australia noted there appeared to be a mismatch between the intent of the review (that is, to determine an initial VNR within the review timeframe) and the reference to longevity in the rationale for the suitability of methodology criterion. Both suggested the AER should develop two sets of assessment criteria: one for the initial VNR and another for the longer-term VNR. Jemena and Energy Networks Australia also had concerns about the inclusion of the impact on network expenditure criterion.[53]
- Energy Networks Australia also suggested the proposed criteria would benefit from more explicit consideration of simplicity, transparency and robustness to inform approach choices, and the inclusion of a new criterion focused on transparency and robustness.[54]

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[47] Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 3.

[48] SA Power Networks, *Submission on VNR issues paper* [letter], June 2024, p. 2.

[49] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 4; Essential Energy, *Submission on VNR issues paper* [letter], June 2024, p. 6.

[50] Essential Energy, Submission on VNR issues paper [letter], June 2024, p. 6.

[51] CPU, *Submission on VNR issues paper* [letter], June 2024, p. 3.

[52] Transgrid, *Submission on VNR issues paper* [letter], June 2024, pp. 3-4.

[53] Jemena, *Submission on VNR issues paper* [letter], June 2024, pp. 1-2; Energy Networks Australia, *Submission on VNR issues paper* [letter], June 2024, pp. 1-2.

[54] Energy Networks Australia, *Submission on VNR issues paper* [letter], June 2024, p. 1.

3.7.2 Our draft decision on assessment criteria

The assessment criteria are intended to help us assess the potential approaches for establishing an initial VNR and we may not use the same criteria for our longer-term VNR work.

We have considered the stakeholder views on the proposed assessment criteria and consider most of the suggested changes are already captured in the existing criteria. For example, the suitability of methodology criterion captures whether the proposed approach is appropriate for establishing the value customers place on network resilience (that is, avoiding prolonged outages) and whether the proposed approach is robust. However, we have refined the explanation for each criterion to clarify its scope.

We consider we need to be cognisant of how the VNR will be used in investment proposal cost-benefit analyses and the flow through impacts this may have on network expenditure. Not doing so would mean not having regard to important context (in addition to being inconsistent with the NEO) and the interests of electricity consumers. However, given this context is similarly explored as part of the other assessment criteria, we have removed the network expenditure criterion as a separate criterion from our draft assessment criteria.

Our draft decision is to use the assessment criteria set out in Table 4 to assess the potential approaches to determining VNR. We consider these assessment criteria will help us determine a fit for purpose approach to determining an initial VNR with the required timeframe.

Table 4: Assessment criteria

	Criterion	Explanation
1	Established within the required timeframe	The initial VNRs need to be finalised in time to be used in Victorian DNSP revenue determination process commencing early 2025. We will need to select a methodology which can establish initial VNRs within this timeframe.
2	Suitability of methodology	The initial VNR methodology needs to be appropriate for establishing the value customers place on network resilience.
3	Ability to localise the value calculation	The extent to which values can be localised varies across methodologies. We will need to select a methodology that can produce initial VNRs at an appropriate level of granularity.

4 Assessment of options

Our issues paper explored the following six potential approaches for determining the initial VNR:

- Using the costs of backup generation and other non-network solutions as an upper bound.
- Using a multiple of the VCR for standard outages (that is, outages of duration of 12 hours or less).
- Extrapolating the VCR for standard outages beyond 12 hours.
- Conducting follow-up surveys to actual prolonged and/or widespread outages.
- Using modelling to estimate a value.
- Exploring other cost data.

We sought stakeholder views on these approaches and any other approaches stakeholders considered might be appropriate.[55] We also noted that the preferred approach for VNR could involve using a combination of potential approaches.

Our assessment of the potential options has been informed by the issues raised in submissions, the insights from our customer engagement, our review of international literature on valuing prolonged outages, outage information and customer engagement already undertaken by distribution networks, and our own analysis. We have used the assessment criteria set out in section 3.7.2 to frame our assessment of the identified options.

4.1 Option 1 – Using rational alternatives as a limit

This approach applies an upper bound to any value of resilience. Where an outage is prolonged, we assume a rational, hypothetical consumer is likely to seek out alternatives to fulfil their energy needs. This could be through meeting those needs directly with the purchase of self-generation equipment, or procuring those services that a lack of energy has made unavailable such as booking temporary accommodation.

This is similar to the theory applied as part of our VCR methodology for standard outages (12 hours or less), where we place a cap on the open-ended question in our residential survey about willingness to pay to avoid the baseline scenario.

For standard outage VCR, the residential cap is set at the approximate cost of a back-up power system which can supply a household for one hour.[56] The cap was included in our

[55] A list of the questions included in the Issues Paper is in Appendix C.

[56] AER, *AER Statement of methodology for determining values of customer reliability*, September 2020.

2019 VCR methodology, as we considered the cost of a reasonable alternative could be regarded as the maximum value one would pay for grid-provided electricity. If grid-provided electricity cost more than this, it would be reasonable to expect the alternative to be favoured instead.

4.1.1 Stakeholder views on option 1

Stakeholders generally considered placing an upper bound on the initial VNRs would be reasonable[57] and that this option should be used in conjunction with another option[58].

Energy Queensland[59] considered an upper bound was a practical assumption of any modelling of VNR due to the socio-economic aspect of customers connected to a network. However, it was concerned placing an upper bound on the VNRs may 'restrict viable network investment'. Energy Queensland was also concerned option 1 assumed that rational alternatives were available, and the customer can afford those alternatives.

CPU noted customer feedback in the Victorian EDNR Review highlighted 'the burden of resilience falls more heavily on customers', indicating this should be a responsibility appropriately balanced between individuals and businesses that had chosen to invest in their own backup generation and electricity networks. It considered this was informative for option 1 and highlighted the challenges in using rational alternatives.

Some stakeholders also expressed views on which rational alternatives would be most appropriate, with self-generation the preferred alternative.[60] SA Power Networks considered using alternative accommodation was unlikely to be suitable as it may not capture the extent of a customer's willingness-to-pay to avoid outages.[61]

While AusNet was of the view self-generation may be the most suitable economic substitute for network electricity, it highlighted several considerations we should be cognisant of if we used option 1. These considerations related to the granularity of the upper bound; customer challenges with generators; and the circumstances of people living in apartments. AusNet also suggested the upper bound for business customers should be based on the customers' monthly electricity bills.[62]

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[57] See, for example, PIAC, *Submission on VNR issues paper* [letter], June 2024, p. 6; Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 3; and Transgrid, *Submission on VNR issues paper* [letter], June 2024, p. 5.

[58] Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 3; Ausgrid, *Submission on VNR issues paper* [letter], June 2024, p. 3; Transgrid, *Submission on VNR issues paper* [letter], June 2024, p. 5.

[59] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 6.

[60] SA Power Networks, *Submission on VNR issues paper* [letter], June 2024, p. 3; AusNet, *Submission on VNR issues paper* [letter], June 2024, p. 4.

[61] SA Power Networks, *Submission on VNR issues paper* [letter], June 2024, p. 3.

[62] AusNet, *Submission on VNR issues paper* [letter], June 2024, p. 4.

In terms of the costs that should be included in the upper bound calculation, Energy Queensland considered that the self-generation upper bound would need to include the capital purchase of generation, and the cost incurred by a customer to monitor and refuel the generation for the prolonged period. It also considered other costs such as that should be considered included the normal usage that self-generation would not cover (e.g., heating/cooling), replacement groceries and/or takeaway meals and, for business customers, business income losses.[63]

PIAC noted it should not be assumed that consumers would procure rational alternative services directly and exclusively from the market and there should be a recognition that some rational alternatives may be provided by other agencies and actors during disaster relief and reconstruction efforts. As such, PIAC considered any calculation of an upper bound should reflect that these costs are often already socialised.[64]In this regard, we note the recent Victorian Government announcement regarding its Energy Resilience Solutions program, which funds solar panels, batteries and back-up generators in towns across Victoria identified as being high-risk of outages due to ongoing extreme weather. Practically, these community buildings will provide a space for residents to cook meals, charge devices and access information.[65]

4.1.2 Our draft assessment of option 1

Adopting this approach would result in an upper bound to the initial VNR, based on the costs of alternatives to fulfill electricity needs. We consider an upper bound would be consistent with the behaviour of a rational, hypothetical electricity consumer in response to a prolonged outage. That is, this consumer would likely take steps at some point during a prolonged outage to mitigate the impacts by seeking out alternatives to fulfill their electricity needs.[66]

We note there is evidence to support this assumed behaviour. For example, following severe storms in 2021, AusNet conducted follow up research with impacted customers to understand the value the customers placed on resilience. The research found after the June 2021 storms, 36% of the customers surveyed bought a generator and a further 9% bought one after the October 2021 storms.[67]

Applying an upper bound to the VNR also recognises electricity consumers do not have an unlimited willingness to pay for network resilience and strikes a balance between network

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[63] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 7.

[64] PIAC, *Submission on VNR issues paper* [letter], June 2024, p. 6.

[65] Victorian Department of Energy, Environment and Climate Action, Strengthening energy resilience during extreme weather, 29 May 2024, see: https://www.energy.vic.gov.au/about-energy/news/news-stories/strengthening-energy-resilience-during-extreme-weather

[66] Bental and Ravid, *A simple method for evaluating the marginal cost of unsupplied energy*, the Bell Journal of Economics, 1982; Gorman, *The quest to quantify the value of lost load: a critical review of the economics of power outages*, the Electricity Journal, 2022.

[67] AusNet, *Willingness to pay for resilience – debrief and discussion*, 17 November 2022, p. 13.

resilience and affordability, thereby helping to promote an efficient level of resilience investment.[68]

We acknowledge stakeholder concerns about the availability of rational alternatives, the ability or willingness of some customers to pay for those alternatives, and the potential for the costs of rational alternatives to socialised. However, we note the purpose of option 1 is to place an upper bound on VNR, not an upper bound on each individual customer's willingness to pay. This means there will be customers who's individual VNR, if calculated, may be lower than the upper bound, and customers who may choose to source rational alternatives from other agencies and actors.

We also consider it would be difficult to assess the extent to which the cost of rational alternatives may already be socialised across the NEM and determine an appropriate reduction in the upper bound. We are of the view that is unlikely that any such assessment could be completed within the timeframe for this review.

Given the above, we consider this approach is a suitable methodology for determining an initial VNR (criteria 2). However, as we are uncertain as to which point in the continuum of a prolonged outage this value comes into effect other than at the end as an upper bound, we consider this option should be adopted in conjunction with another option(s). This option also satisfies the timing and localisation criteria (criteria 1 and 3), as it can be delivered within the required project timelines and is flexible enough to provide some scope for localisation. The application of this approach is discussed in Section 5.

4.2 Option 2 – Using a multiple of the VCR for standard outages

This approach would involve using a multiple of VCR for standard outages. This approach assumes prolonged outages place additional burdens on customers, and this justifies an additional 'resilience' premium.

An example of applying this in a theoretical context is AEMO's review of possible management options for frequency containment in South Australia. In this review, AEMO did a sensitivity analysis using a multiple of the VCR for standard outages (a multiple of 2x) to estimate unserved energy costs. Its rationale for using the multiple of VCR was to account for 'the escalated inconvenience and costs to customers from long duration outages'.[69]

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[68] Gorman (in article cited above, p. 9) notes that mitigation investments in back up generation represent an important backstop technology which provides a non-infinite cost alternative to mitigating electricity outages.

[69] AEMO, *Separation leading to under-frequency in South Australia*, May 2023, p. 8. AEMO's analysis considered specified scenarios involving the non-credible separation of South Australia from the rest of the National Electricity Market (NEM) power system at five specific separation points. The sensitivity analysis using the multiple of the standard outage VCR produced higher estimated benefits (in terms of the reduction in unserved energy) than the estimates calculated using the standard outage VCR. For example, the option involving constraint on Heywood imports (with no minimum synchronous unit requirement) had an estimated annual net

4.2.1 Stakeholder views on option 2

Multiple stakeholders considered option 2 would be an appropriate approach to determine the initial VNRs[70] and their reasons included:

- this option recognises the additional burden prolonged outages place on customers[71]
- this approach is simple and can be applied to existing models where the VCR has been used [72]
- network businesses have been using the VCR for several years in assessing network expenditure so option 2 can be understood and applied more quickly by network businesses which require the initial VNR for their regulatory proposals.[73]

However, PIAC did not support option 2 and considered the use of a VCR multiple would risk exacerbating the imperfections it considers are present in the VCR. PIAC also considered the use of a VCR multiple was based on the flawed assumption that burdens increase in step with the duration of the outage. PIAC acknowledged prolonged outages can impose additional costs, but was of the view beyond certain tipping points the costs tended to decrease as an outage continued. Given that, PIAC suggested approximating a VNR using a factor of the VCR would be equally, if not more appropriate to using a multiple.[74]

Erne Energy considered the notion that the VNR may result in a higher value than the current VCR was likely to be erroneous and cited earlier work by the United Kingdom's Electricity North-West which identified that consumers impacted by prolonged outages which affected the entire community, placed a lower value on reliability as an outage progressed.[75]

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benefit of between ($5 million) and $18 million using the standard outage VCR. Using the multiple VCR, the estimated annual net benefit was between $1 million and $47 million.

[70] Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024; SA Power Networks, *Submission on VNR issues paper* [letter], June 2024; Energy Queensland, *Submission on VNR issues paper* [letter], June 2024; ENGIE, *Submission on VNR issues paper* [letter], June 2024; Essential Energy, *Submission on VNR issues paper* [letter], June 2024, AusNet, *Submission on VNR issues paper* [letter], June 2024.

[71] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 8; Ausgrid, *Submission on VNR issues paper* [letter], June 2024, p. 4; SA Power Networks, *Submission on VNR issues paper* [letter], June 2024, p. 2.

[72] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 8; Transgrid, *Submission on VNR issues paper* [letter], June 2024, p. 5; Ausgrid, *Submission on VNR issues paper* [letter], June 2024, pp. 3-4.

[73] Ausgrid, *Submission on VNR issues paper* [letter], June 2024, pp. 3-4.

[74] PIAC, *Submission on VNR issues paper* [letter], June 2024, pp. 4, 6-7.

[75] Erne Energy, *Submission on VNR issues paper* [letter], June 2024, p. 2.

In terms of the level of the multiplier, Endeavour Energy considered that a multiplier of no lower than 2 should apply.[76] Ausgrid submitted, based on feedback from its ongoing stakeholder collaborations on resilience and its customer engagement for its 2024-29 regulatory proposal, the multiplier should be significantly greater than one. Ausgrid also considered that if the AER were to run robust deliberative engagement, the VNR would likely reflect an equivalent multiplier of greater than two times the VCR.[77]

AusNet stated that its Quantifying Customer Values research corroborated AEMO's assumption that customers valued avoiding a prolonged outage about twice as much as they valued avoiding a standard outage.[78]

Transgrid noted that a tiered-multiple approach may be appropriate, whereby an initial multiple is applied beyond the initial 12-hour window, followed by other time bracketed multiples depending on the length of outage considered.[79]

SA Power Networks suggested customer consultation and using data from previous VCR surveys may help inform any decision on the appropriate multiple to be used, while Ausgrid encouraged the AER, in addition to factoring in customer values, to also assess broader and downstream economic and social impacts.[80]

4.2.2 Our draft assessment of option 2

Recent outages in Victoria and the engagement we have undertaken with consumers as part of this review have highlighted that prolonged outages can place additional burdens on customers, including food spoilage, inability to operate sewage or septic tank systems, inability to work, and other inconveniences.[81] For example, a number of participants in our deliberative forums advised they could not work during the outage and lost income as a result.[82]

Customer surveys and engagement undertaken by AusNet following severe storms in June and October 2021 also highlighted the financial impacts of prolonged outages on affected customers. According to information provided by AusNet, the median financial impact on customers ranged from $150 to $2,900, depending on location.[83]

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[76] Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 3-4.

[77] Ausgrid, *Submission on VNR issues paper* [letter], June 2024, p. 4.

[78] AusNet, *Submission on VNR issues paper* [letter], June 2024, p. 5.

[79] Transgrid, *Submission on VNR issues paper* [letter], June 2024, p. 5.

[80] SA Power Networks, *Submission on VNR issues paper* [letter], June 2024, p. 2.

[81] Electricity Distribution Network Resilience Review Expert Panel, *Electricity Distribution Network Resilience Review*, final recommendations report, May 2022, pp. 5–6.

[82] The Insight Centre, *Australian Energy Regulator: Consumer Engagement on the Value of Network Resilience*, June 2024.

[83] AusNet, *Willingness to pay for resilience – debrief and discussion*, 17 November 2022, p. 14. Information on AusNet's research is available here.

Given the evidence available to us indicates prolonged outages have more significant impacts on many consumers in terms of costs and inconvenience (see section 3.1 for more detail), we consider it is appropriate to adopt an approach to determining an initial VNR, such as option 2, which recognises these additional impacts (criteria 2). However, we also note that while AusNet's customer research highlights the additional costs that may be incurred during a prolonged outage, its calculated values of customer reliability for these outages decrease as the outage length increases. This is consistent with some of the findings in the international research on this issue and as we noted in section 3.5, is a result of the use of unserved energy in the methodology used to calculate values of customer reliability.

Adopting option 2 in conjunction with option 1 would recognise these additional costs while also acknowledging that the costs are unlikely to increase at the same rate indefinitely. This approach also accepts that customers will likely adapt their behaviour as a prolonged outage continues, and that there are limits on consumers' willingness-to-pay for network investments to reduce the length and/or occurrence of prolonged outages (criteria 2).

While it may be difficult to determine an appropriate multiple with confidence, we consider we are able, in collaboration with stakeholders, to develop a reasonable multiple within the required timeframe for this project (criteria 1). Given option 2 is relatively simple and network service providers are familiar with using the VCR in capital expenditure assessments, we consider the Victorian DNSPs should be well-placed to incorporate any initial VNR calculated using this option into their upcoming regulatory proposals.

In considering the appropriate multiple, we will have regard to the information we have available (e.g., customer research and insights from our deliberative forums) and feedback from stakeholders.

As discussed in Section 3.6, the timeframe for determining the initial VNR places a constraint on the level of granularity we can achieve with the initial VNR. However, as option 2 would leverage the VCR for standard outages (outages lasting 12 hours or less), we can localise the initial VNR at a similar level to the VCR. We consider this level of localisation should be sufficient for the intended uses of the initial VNR (criteria 3). The application of this approach is discussed in Section 5.

4.3 Option 3 – Extrapolating the VCR for standard outages beyond 12 hours

This approach would involve extrapolating the VCR for standard outages beyond 12 hours, by using knowledge about how the VCR change as outage duration increases. In addition to our VCR for standard outages, it may be possible to use information on 24 and 48 hour outages from our direct cost survey of very large business customers (we currently ask survey respondents about these outages, but do not produce VCR for them) to inform any extrapolation.

4.3.1 Stakeholder views on option 3

There were a range of stakeholder views on option 3, including:

- it could be an appropriate approach and should be considered further.[84] However, it does not factor in the additional burden customers are likely to experience with prolonged outages[85]
- using information from the VCR direct cost survey to inform the extrapolation may not be appropriate given residential and business customers had different considerations and priorities informing their preferences and responses to prolonged outages.[86]

PIAC was not supportive of the use of option 3 as it considered this option would risk exacerbating the imperfections it considers are present in the VCR. PIAC also considered this option assumed that costs for prolonged outages increased in a manner comparable to those for shorter duration outages and did not agree with that assumption.[87]

4.3.2 Our draft assessment of option 3

As this approach would leverage information we have from our VCR work, and at a level of localisation that is sufficient for the intended use of the VNR (criteria 3).

In terms of the suitability of this approach (criteria 2), we note there are limitations to using extrapolation. For example, the observed trends in a data set may not hold for data points that are outside that data set. This is particularly so if the data points being extrapolated are a long way from original data set.

The original data set for the VCR covers outages up to 12 hours, with. As we noted in Section 3, the outage duration range we have identified as being most important in the context of the initial VNR is outages between 12 hours and 3 days. This means we would need to extrapolate the VCR to outage durations of at least 3 days and possibly longer.

We do have access to additional information collected as part of the VCR survey regarding the impacts of longer duration outages (24 hours and 2 days) on businesses which consume very large amounts of energy, which could potentially be used to inform any extrapolation. However, we share stakeholder concerns about the appropriateness of using this information to draw conclusions about how residential and smaller business customers may value network resilience.

Based on our engagement with consumers and the insights network businesses have shared with us regarding their customers' views and experiences of prolonged outages, it appears

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[84] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, pp. 8-9; Transgrid, *Submission on VNR issues paper* [letter], June 2024, p. 5. Energy Networks Australia, *Submission on VNR issues paper* [letter], June 2024, p. 2, Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 2, ENGIE, *Submission on VNR issues paper* [letter], June 2024, p. 1; Essential Energy, *Submission on VNR issues paper* [letter], June 2024, p. 6.

[85] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, pp. 8-9.

[86] PIAC, *Submission on VNR issues paper* [letter], June 2024, p. 7; Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 9.

[87] PIAC, *Submission on VNR issues paper* [letter], June 2024, p. 7.

there are differences between standard outages and prolonged outages of over one day and these may flow through to the value customers place on avoiding prolonged outages. Given the relationship between the VCR and outage duration may hold in some forms of extrapolation, we consider we would need to undertake further work before being able to draw a conclusion about the appropriateness of extrapolating the VCR (criteria 2). We consider it is unlikely that we would be able to undertake this additional work in time for this option to be used to determine an initial VNR within the required timeframe (criteria 1).

4.4 Option 4 – Conducting follow-up surveys to actual prolonged and/or widespread outages

This approach would involve conducting follow-up surveys of customers after actual prolonged outages. Customers affected by prolonged outages would be identified and surveyed about the costs they incurred and/or their willingness-to-pay to avoid similar outages in the future.

4.4.1 Stakeholder views on option 4

Endeavour Energy was of the view that survey-based methods were well suited to the VCR but costly and less accurate (particularly outside of direct customer impacts) for widespread and long duration outages. [88]

Energy Queensland considered option 4 had merit but, if adopted, should be used in conjunction with other approaches. It also questioned whether this approach could be implemented within the required timeframe given it was 'highly improbable that a natural disaster event would occur outside of the typical storm season'.[89]

AusNet believed option 4 was the most robust method of calculating direct costs but it was likely to represent the lower bound of VNRs because it did not include the wider socio-economic costs and emotional cost of a prolonged outage. It encouraged the AER to consider how these additional, indirect costs might be quantified.[90]

PIAC considered option might provide valuable insights and supported the AER investigating this approach further. It also considered that this option, if adopted, should be combined with a complementary approach to overcome the limitations it considered were associated with a respondent's subjective assessment of costs incurred as a result of the electricity outage and the natural disaster more broadly. PIAC also noted the viability of option 4 could impacted by the infrequent nature of prolonged outages and that reliance on survey data from actual outages may not reflect local circumstances or the evolving relationship between consumers and the energy system.[91]

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[88] Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 2.

[89] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, pp. 9-10.

[90] AusNet, *Submission on VNR issues paper* [letter], June 2024, pp. 5-6.

[91] PIAC, *Submission on VNR issues paper* [letter], June 2024, p. 7.

4.4.2 Our draft assessment of option 4

Some DNSPs have undertaken similar surveys of their affected customers following prolonged outages on their networks and we have considered how we can leverage this work if we use this approach. While those surveys have assisted in our consideration of the initial VNR, we consider we would need to undertake further surveys if we were to use this option.

To do this, we would need to be able to identify and survey a sufficient number of affected customers and then analyse this information to develop the initial VNR. Our draft view is that we are unlikely to be able to do this within the required timeframe for the initial VNR (criteria 1).

We are also aware that it can be difficult for respondents to these surveys to distinguish between the costs they have incurred as a result of the electricity outage event and the costs they have incurred as a result of the hazard event. As a result, some respondents allocating costs incorrectly between these two causes and this may present a challenge to using surveys in this context (criteria 2). To address this issue, we consider any surveys would, at a minimum, need to be designed carefully and undergo cognitive testing prior to use, as occurs with our VCR surveys.

We also note this approach would be dependent on outages occurring and it is possible there may not be recent outages for some networks, which may make it difficult for us to develop initial VNR for those networks (criteria 2). While some studies focusing on prolonged outages have found that willingness-to-pay does not change significantly between customers with experience of prolonged outages and those without,[92] we are uncertain about the extent to which results from one network business' customers could be generalised and applied to other network business' customers.

For example, some experience more frequent hazard events and customers in these areas may have higher levels of preparedness as a result and are therefore better placed to manage the impacts of a prolonged outage. We consider it is unlikely that generalising the results of a survey from these customers to customers in a different network service area where hazard events are materially less frequent will be appropriate. This is because customers who have a higher level of preparedness (e.g., those who own self-generation) may be less willing to pay for network-level resilience measures.

Given the above, we consider this option is unlikely to be suitable for use as the primary methodology for determining the initial VNR. However, our draft view is that it is likely to be a useful as a sense check on our decision on the appropriate level of the VNR and we propose to use the data from similar surveys for this task.

[92] Macmillan, Wilson, Baik, Carvallo, Dubey and Holland, *Shedding light on the economic costs of long-duration power outages: A review of resilience assessment methods and strategies*, Energy Research & Social Science, April 2023 p. 4.

We also consider this option is well-suited to our longer-term work program to develop a more refined approach to valuing network resilience. In particular, it may be useful to inform the parameters of any model developed to estimate VNR. Consequently, we intend to explore this option further with stakeholders in the future as part of that work program.

4.5 Option 5 – Using modelling to estimate a value

This approach would involve using a model to estimate the economic outcomes of a specific prolonged outage(s). There are different models that could be used, including input-output (IO) models or CGE models.

IO models are production-function-based approaches and are the simplest macroeconomic models used to estimate indirect economic effects of an outage. IO models use coefficient matrices to capture interdependencies across sectors of the economy. When used to study outages, IO models assume that sectors of the economy become inoperable, preventing their input to other sectors downstream in the supply chain. Using these techniques, the ripple effects of the outage can be simulated, and direct / indirect losses can be computed and compared. IO models do not capture adaptive behaviour, leading to them typically overestimating indirect economic losses.[93] The model used for the AER's residential 2019 Widespread and Long Duration Outage (WALDO) VCR relied on input-output tables.[94]

4.5.1 Stakeholder views on option 5

Stakeholders were generally supportive of the use of modelling to establish the VNR because it would include social and other indirect costs.[95] However, stakeholders considered it would be challenging to select a suitable model and calibrate it in time to determine the initial VNR within the required timeframe.[96] Some stakeholders raised concerns about modelling, including the complexity of models, the potential for values to be case study dependent, and the setting of an unserved energy upper limit.[97]

AusNet considered there were merits in using option 5 to establish a country-wide value of climate resilience, it did not consider this approach fit-for-purpose to calculate the initial VNR. This was because it considered there were challenges in:

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[93] Macmillan, Wilson, Baik, Carvallo, Dubey and Holland, *Shedding light on the economic costs of long duration power outages: A review of resilience assessment methods and strategies*, Lawrence Berkeley National Laboratory, 2023, pp.4-5.

[94] For information on the WALDO model, see https://www.aer.gov.au/industry/registers/resources/reviews/values-customer-reliability-2019.

[95] Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 2; Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 11; Jemena, *Submission on VNR issues paper* [letter], June 2024, p. 2; PIAC, *Submission on VNR issues paper* [letter], June 2024, p.7

[96] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, pp. 10-11; PIAC, *Submission on VNR issues paper* [letter], June 2024, p. 7.

[97] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 11; Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 2.

- identifying the appropriate data sources
- disaggregating the costs incurred by consumers from those incurred by taxpayers and the wider community
- disaggregating the costs associated with the outage from those associated with the hazard event that caused the outage.[98]

Multiple stakeholders also considered this option would need to be paired with customer surveys or other customer research to refine the model's inputs regarding consumer cost impacts.[99]

4.5.2 Our draft assessment of option 5

We have previously explored modelling as an option for longer duration outages during our 2019 VCR review, where we explored the 2019 WALDO VCR model. Over the last 12 months, we have also met with a number of researchers and universities with an interest in this area to discuss how we might approach valuing high impact, low probability outages. We have also met with academics and researchers from the Lawrence Berkeley National Laboratory (Berkeley Lab) who specialise in estimating the economic impacts of electricity outages.

Based on those discussions and our literature review, we are aware that option 5 is an approach being investigated internationally. For example, Berkeley Lab is currently developing a Power Outage Economics Tool (POET), which will estimate the economic impacts of widespread and long duration (over 24 hours) outages. POET is a regional economic model that incorporates survey information on customer preparedness for widespread and long duration outages and information about the regional economy.

Using an IO or CGE model would be more complex than the other approaches we have identified and potentially require multiple input parameter assumptions. We understand that there are existing models that we could potentially use to undertake this work. However, these models may need to be calibrated and this may require input from energy modellers and NSPs. Based on our experience developing the 2019 WALDO VCR model, our draft view is that we will not be able to identify, calibrate and consult properly on a CGE or IO model, and calculate VNR using that model, within the required timeframes for this review (criteria 1).

Based on our literature review and discussions with academics and researchers, there is not a single, individual model that is considered best practice for valuing resilience. Instead,

[98] AusNet, *Submission on VNR issues paper* [letter], June 2024, p. 5.

[99] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, pp. 10-11; PIAC *Submission on VNR issues paper* [letter], June 2024, p. 7.

there are differing views on the suitability of different types of models for this task and each type of model has its own unique set of advantages and disadvantages.[100]

CGE models can be used to estimate economic effects of a 'shock', such as an electricity outage, including any indirect economic effects. CGE models use a framework of demand and supply equations for various markets in equilibrium. The effects of outages are simulated by changing the relative prices and quantities of goods and services. CGE models can account for behavioural effects, such as price changes and substitution among inputs.

Because of this flexibility, CGE models provide more accurate estimates of long-run losses from extreme events that IO models. However, CGE models may understate costs because they assume a frictionless economy and perfectly rational behaviour, which may not be realistic during these types of events and electricity outages. CGE models lead to typically lower (and arguably more accurate) estimates of economic losses than IO models. They are one of the most complex and resource intensive modelling approaches.[101]

We consider using a model to estimate VNR may produce more accurate estimates for widespread outages and some durations of prolonged outages and would enable the inclusion of indirect economic losses. Therefore, our draft view is that this option would be a suitable methodology for estimating an initial VNR (criteria 2), although we note some models may be less accurate for shorter durations of prolonged outages and as such may not be optimal for the outage durations we are focusing on when valuing network resilience (e.g., CGE models).

We note that there may also be limits on the level to which values can be localised (criteria 3), with some models only providing estimates localised to a specific Statistical Area Level (e.g., Statistical Area Level 3 or SA3). This may affect the appropriateness of this option if highly granular initial VNR were required.

Given the above, we consider it is unlikely we can use option 5 to establish initial VNRs within the required timeframe. However, we are of the view this option is suited to our longer-term work program to develop a more refined approach to valuing network resilience.

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[100] Larsen, Sanstad,. Hamachi LaCommare, and Eto, *Frontiers in the economics of widespread. Long-duration power interruptions: proceedings from an expert workshop*, Berkeley National Laboratory, 2019; Gorman; *The quest to quantify the value of lost load: a critical review of the economics of power outages*, the Electricity Journal, 2022; Sanstad, Zhu, Leibowicz, Larsen and Eto, *Case studies of the economic impacts of power interruptions and damage to electricity system infrastructure from extreme events*, Berkeley National Laboratory, 2020; Baik, Hanus, Sanstad, Eto and Larsen, *A hybrid approach to estimating the economic value of enhanced power system resilience*, Berkeley National Laboratory, 2021; Macmillan, Wilson, Baik, Carvallo, Dubey and Holland, *Shedding light on the economic costs of long-duration power outages – A review of resilience assessment methods and strategies*, Lawrence Berkeley National Laboratory, 2023.

[101] Macmillan, Wilson, Baik, Carvallo, Dubey and Holland, *Shedding light on the economic costs of long duration power outages: A review of resilience assessment methods and strategies*, Lawrence Berkeley National Laboratory, 2023, pp.5-6.

4.6 Option 6 – Exploring other cost data

This approach would involve obtaining and analysing cost data that may provide insights on the costs associated with a prolonged outage. The types of cost data used in this analysis would be dependent on the scope of data available. It is possible data sets may not be available for all locations affected by prolonged outages and the available data may not provide comprehensive insights.

4.6.1 Stakeholder views on option 6

Stakeholder views on option 6 were limited. Energy Queensland did not support this approach as it considered it was the least mature in its development and could not be implemented within the required timeframe for establishing an initial VNR. However, Energy Queensland noted that this option could be used to validate the assumptions underpinning other approaches.[102]

PIAC supported exploring other cost data in principle but considered a narrow focus on the economic costs of natural disasters risked establishing an initial VNR that was overly coloured by socioeconomic discrepancies across property values and insurance levels.[103]

4.6.2 Our draft assessment of option 6

To use this option, we would need to undertake further work to identify suitable data sources and determine whether we could obtain the data for our analysis. We consider that we would want to use high frequency and localised data on economic activity to ascertain the impact of an outage event.

Potential sources of cost data could include information from state or territory governments about the costs they incur when a prolonged outage event occurs and/or other data sources. For example, the Australian Taxation Office's Single Touch Payroll datasets and the Australian Bureau of Statistics' integrated datasets could potentially provide useful insights on the impacts of a prolonged outage event.[104] We note research on this type of cost data could be undertaken over time in response to events, using the actual observed response of energy customers to update and refine the VNR methodology.

Our draft view is that it would be challenging to identify, obtain and analyse the required data model and undertake calibration within the timeframes for this review. We therefore consider this option is unlikely to satisfy the timing criteria (criteria 1) and may be better suited to our longer-term work program to develop a more refined approach to valuing network resilience. Without having fully explored the data available, it is also difficult to ascertain whether this

[102] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, pp. 11-12.

[103] PIAC, *Submission on VNR issues paper* [letter], June 2024, p.7.

[104] For an overview of some potential data sources, see Gruen, *The rise of big data and integrated data assets*, EY Conference, 2024.

methodology would be suitable (criteria 2). However, we consider that the nature of these types of datasets means we would likely be able to localise the VNR calculation (criteria 3).

4.7 Overall assessment and draft decision on options

Our assessment of the six options we identified is summarised in Table 5.

Table 5: Summary of our assessment of the potential options for use in initial VNR approach

Option	Established within the required timeframe	Suitability of methodology	Ability to localise the value calculation	Overall
1. Rational alternatives as upper bound	✓	✓	✓	✓
2. Multiple of VCR	✓	✓	✓	✓
3. Extrapolation of VCR	~	~	✓	~
4. Follow-up surveys	~	~	✓	~
5. Modelling	✗	✓	~	✗
6. Other cost data	✗	~	✓	✗

Key: ✓ Yes ~ Maybe / uncertain ✗ No

We acknowledge stakeholder views on the various potential approaches and note that our draft decision on the proposed approach for establishing initial VNRs is a pragmatic one, reflecting the time constraints for this review. We balanced considerations of timeliness and suitability in developing our proposed VNR approach, acknowledging that it is not possible to explore and implement some potentially 'first best' approaches within the required timeframe for establishing the initial VNRs.

Our overall assessment is that options 5 (modelling) and 6 (other cost data) cannot be delivered within the required timeframe for our review and therefore cannot form part of our proposed approach to establishing initial VNRs. However, these options are best explored with stakeholders as part of our longer-term VNR work program.

Of the four remaining options, option 1 (using rational alternatives as a limit) and option 2 (multiple of VCR) satisfied all 3 assessment criteria, while there was some uncertainty about whether options 3 (extrapolation) and 4 (follow-up surveys) satisfied the timeframe and suitability criterion.

On balance, we consider option 1 (using rational alternatives as a limit) as an upper bound to the initial VNR is appropriate as it recognises electricity consumers do not have an unlimited willingness-to-pay for network resilience investment and will also seek out rational alternatives during prolonged outages. We also consider this option helps strike a balance between network resilience and affordability, thereby helping to promote an efficient level of resilience investment. However, given the challenges in establishing an upper bound for business, we do not propose to apply an upper bound to the initial VNR for business (see section 5).

As discussed above, an upper bound is best adopted in conjunction with another option and we propose to combine this with a multiple of VCR approach because there is strong stakeholder support for this approach and some uncertainty about whether extrapolation and follow-up survey approaches were suitable and/or timely.

5 Proposed approach to determining the VNR

Our draft decision is that an approach adopting an upper bound in conjunction with a multiple of VCR is the most appropriate for determining the initial VNR. This approach will involve:

- using multiples of the VCR for standard outages to determine the initial VNRs
- applying an upper bound to the residential initial VNR, which will be determined using the costs of backup generation and other non-network solutions as a reference.

This approach acknowledges the need to connect the theoretical framework with practical application, ensuring that our decision reflects both the logical rationale (as demonstrated in 3.1.3) and constraints we face. In this section, we will outline the practicalities of adopting this approach, including calculating the upper bound and the appropriate VCR multiple.

5.1 VCR multiple

To use this approach, we will need to determine a reasonable multiple to apply to the standard outage VCR that reflects the additional inconvenience and costs associated with prolonged outages. As demonstrated by Figure 1, the stepped increases in costs and the variability of customer experiences necessitate a tiered multiple approach, ensuring that the multiples applied are both reasonable and reflective of customer experiences.

In using a multiple of the VCR to measure the cost and inconvenience of prolonged outages we note that the VCR is defined as customers' willingness to pay to avoid prolonged outages (a measure of the cost and inconvenience caused to customers by outages) divided by the amount of unserved energy due to an interruption. It is possible for the VCR to fall as the duration of outages increases even if the cost to customers is increasing. This would happen if unserved energy increased more than in proportion to the duration of outages. These considerations are relevant to the choice of VCR multiple to measure the cost of outages of varying duration.

5.1.1 Stakeholder views on the level of the VCR multiple

Endeavour Energy and Ausgrid considered that a multiplier of no less than two should be used if the VCR multiple was adopted to establish the initial VNRs. This view was based on the insights from their engagement with their customers on resilience and their regulatory proposals.[105]

While PIAC did not specify a particular multiple, it acknowledged that prolonged outages can impose additional costs such as food spoilage or the inability to operate sewage or septic

[105] Endeavour Energy, *Submission on VNR issues paper* [letter], June 2024, p. 4; Ausgrid, *Submission on VNR issues paper* [letter], June 2024, p. 4.

tank systems. However, beyond certain tipping points costs tend to decrease as an outage continued.[106]

5.1.2 Our draft decision on how to apply the VCR multiple

As we discussed in Section 3.1, the insights we have obtained from our customer engagement and the customer engagement undertaken by network businesses and government-initiated inquiries into recent outage events indicate that customers do experience additional inconvenience and costs when these outages occur.

The customer engagement has also highlighted that these costs are not insignificant for many residential and business customers, ranging from food spoilage and stock losses, income or trading losses, through to the costs of renting / purchasing and operating a generator.

It is also clear that these costs do not increase at a constant rate over the course of a prolonged outage event. The costs are instead lumpy and increase at different rates at different points in an outage event. This is because stepped increases occur at key points in time (for example, when food spoilage occurs) and after those increases, a customer may not incur some costs a second time (e.g., food spoilage as it is unlikely customers will replace perishable food items until the power is restored) or may take steps to mitigate the impacts of the prolonged outage (e.g., purchase a generator, or find an alternative location to work from home if possible). This is best graphically represented per Figure 1: Cumulative costs of a prolonged outage over time in section 3 above.

We also note that Ausgrid and Essential Energy advised that in their customer engagement they have undertaken on resilience and their recent regulatory proposals, customers have indicated that they place a higher value on avoiding prolonged outages in comparison to standard outages.[107]

Given the above, we consider it is reasonable to assume that:

- the costs incurred by customers are likely to be higher as an outage event extends beyond 12 hours and customers experience the stepped increases in costs associated with longer duration outages (e.g., food spoilage or stock losses)
- once customers have incurred the key fixed costs associated with a prolonged outage (e.g., food spoilage) and/or taken steps to mitigate the outage impacts (e.g., generator purchase or hire), their costs will increase at a slower rate as the outage continues
- given the insights from network business customer engagement on resilience and prolonged outages, many customers place a higher value on avoiding prolonged outages compared to standard outages.

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[106] PIAC, *Submission on VNR issues paper* [letter], June 2024, pp. 6-7.

[107] Ausgrid, *Submission on VNR issues paper* [letter], June 2024, p. 4; Essential Energy, *Submission on VNR issues paper* [letter], June 2024, p. 4.

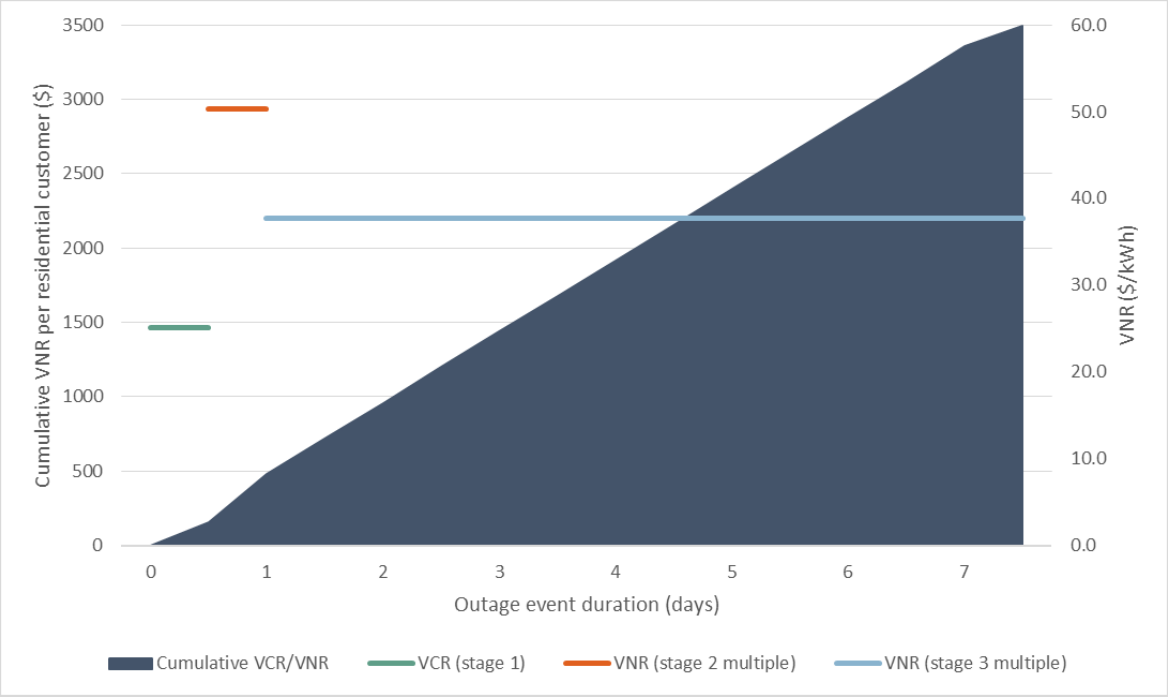
Consequently, we propose to apply a tiered multiple approach, similar to that suggested by Transgrid,[108] with different tiers for residential and business customers. While this approach will initially require the use of the 2023 VCR, we expect network businesses to use the updated 2024 VCR when they are published in December 2024.

For residential customers, this proposed approach would apply:

- the standard VCR (as built up by the network business from the segmented residential VCR) for the first 12 hours of a prolonged outage
- a multiple of 2x the standard VCR (the VCR used for the first 12 hours) for the period of 12-24 hours
- a multiple of 1.5x the standard VCR (the VCR used for the first 12 hours) for the duration of the outage that extends beyond 24 hours, until the upper bound is reached.

For a residential customer, this approach would result in the upper bound being reached in 7 days (see Figure 3 below).

Figure 3: Residential customer tiered multiple approach with upper bound



Note: Analysis based on average Victorian residential customer annual consumption and the Victorian residential VCR (for outages up to 12 hours). This analysis is for illustrative purposes and assumes that a customer's consumption is constant on an hourly basis and that a customer's unserved energy is equal to the energy they would have consumed in the absence of the prolonged outage.

[108] Transgrid, *Submission on VNR issues paper* [letter], June 2024, p. 4; Essential Energy, *Submission on VNR issues paper* [letter], June 2024, p. 5.

For business customers, our proposed approach would apply:

- the standard VCR (as built up by the network business from the segmented residential VCR) for the first 12 hours of a prolonged outage
- a multiple of 1.5x the standard VCR (the VCR used for the first 12 hours) for the period of 12-24 hours
- a multiple of 1.0x the standard VCR (the VCR used for the first 12 hours) for the period of 24-72 hours (1-3 days)
- a multiple of 0.5x the standard VCR (the VCR used for the first 12 hours) for the duration of the outage that extends beyond 72 hours (over 3 days).

As discussed further below in section 5.2.2 there is difficulty in establishing an appropriate upper bound applicable for business. The above business tiers have been developed with a view to recognising business customers will take steps, at some point in time, to mitigate the impacts of a prolonged outage. Given the diverse nature of individual businesses and the heterogeneity of their electricity consumption, we have taken a cautious approach in setting the multiple tiers for business.

As we have discussed throughout this draft decision, the required timing for the initial VNR has constrained the potential methodological options for determining the initial VNR. On balance, we consider our proposed approaches for the residential initial VNR and the business initial VNR reflect customers' lived experience of outages and the value they place on avoiding these outages, as well as the likely timing of key stepped increases in outage impacts.

We acknowledge that there are other possible formulations to the tiered multiple approach. We welcome stakeholder views on any other formulations that may be appropriate along with any evidence that supports that alternative formulation. For example, the period in which the highest multiple applies could be extended from 12-24 hours to 12-48 hours. We are also interested in alternative views and evidence on the VCR multiples that should be chosen.

5.2 Costs of back up generation and other non-network solutions

In determining the upper bounds to initial VNRs, we will need to consider which non-network solutions to use to calculate the costs.

5.2.1 Stakeholder views on the preferred non-network solutions and approach to calculating the upper bounds

Some stakeholders also expressed views on which rational alternatives would be most appropriate, with self-generation the preferred alternative.[109] SA Power Networks considered using alternative accommodation was unlikely to be suitable as it may not capture the extent of a customer's willingness to pay to avoid outages.[110]

While AusNet was of the view self-generation may be the most suitable economic substitute for network electricity, it noted we should consider the granularity of upper bound, customer challenges with generators, and the circumstances of people living in apartments. AusNet also suggested the upper bound for business customers should be based on the customers' monthly electricity bills.[111]

Regarding upper bound cost calculation, Energy Queensland considered that these should include the capital purchase of generation, and the cost incurred by a customer to monitor and refuel the generation for the prolonged period. It also considered other costs that should be included the value of normal usage that self-generation would not cover (e.g., heating/cooling), replacement groceries and/or takeaway meals and, for business customers, business income losses.[112]

PIAC noted it should not be assumed that consumers would procure rational alternative services directly and exclusively from the market and there should be a recognition that some rational alternatives may be provided by other agencies and actors during disaster relief and reconstruction efforts.[113] As such, PIAC considered any calculation of an upper bound should reflect that these costs are often already socialised.[114]

5.2.2 Our draft decision on non-network solutions

The least-cost of backup self-generation (plus fuel costs depending on duration of forecast outage) is likely the most objective and easily applied upper bound for residential customers. This is because we can reasonably estimate the generator and fuel costs for an average customer using average household electricity consumption, outage duration and some information about least cost generation options.

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[109] SA Power Networks, *Submission on VNR issues paper* [letter], June 2024, p. 3; AusNet, *Submission on VNR issues paper* [letter], June 2024, p. 4.

[110] SA Power Networks, *Submission on VNR issues paper* [letter], June 2024, p. 3.

[111] AusNet, *Submission on VNR issues paper* [letter], June 2024, p. 4.

[112] Energy Queensland, *Submission on VNR issues paper* [letter], June 2024, p. 7.

[113] For example, the Victorian Government's Energy Resilience Solutions program funds solar panels, batteries and back-up generators in 24 towns identified as beings at high risk of electricity outages. See the Victorian Government's media release for more information.

[114] PIAC, *Submission on VNR issues paper* [letter], June 2024, p. 6.

However, there are considerable practical challenges in using this upper bound for business customers, as there is much greater variation in electricity consumption.[115] This heterogeneity makes it very difficult to determine the appropriate specifications of the least cost self-generation solution to use in our upper bound VNR calculation. We incurred similar challenges in our 2019 VCR self-generation willingness-to-pay cap and in that instance, we applied a different cap to business customer surveys, and this was set at the value of their last electricity bill.

While temporary accommodation could be useful as an indication of cost for residential customers, it is likely to be more difficult to determine an objective value of temporary accommodation. This is because the cost and availability of temporary accommodation may vary depending on circumstances of a given prolonged outage (e.g., time of year, location, number of customers impacted). For example, in smaller-remote areas, temporary accommodation may not be available in the immediate area and determining what an appropriate alternative looks like could be difficult. We also note that temporary accommodation is unlikely to be considered applicable in the context of a small business given the higher friction costs of sourcing alternative shop fronts or workspaces.

Given the practical challenges in using least-cost self-generation or temporary accommodation solutions to set an upper bound for the business initial VNR, we have considered alternatives, such as using monthly bill amounts. However, given there will also be considerable heterogeneity in business electricity bill amounts, we consider there will be similar practical challenges in setting an upper bound for business using these alternatives.

We also note that, while varying across different business contexts, businesses may have less flexibility in the short term than residential customers to source an appropriate generator or seek an alternative operating location. This means they are likely to continue to incur non-insignificant costs throughout a prolonged outage. There is also a lack of supporting customer insight evidence that businesses seek alternative generation options during a prolonged outage. Given these challenges we propose not to apply an upper bound for business customers but to use multiples of the VCR to account for their mitigation efforts during prolonged outages. In Section 3.1.3 where we discuss the lumpiness and step-ups in costs associated with prolonged outages, provide further context for our proposed approach.

Although we consider business customers will have upper bounds to their willingness to pay and may employ strategies to mitigate the impacts of a prolonged outage at certain price points, we cannot easily infer which strategies are likely to be used and when. Consequently, we consider it is not possible to infer a reasonable upper bound for the initial VNRs for business customers.

[115] There are also material variations in the VCR for different types of businesses. For example, the 2023 VCR for agriculture businesses is $44.40/kWh, while the VCR for industrial businesses is $74.79/kWh. For very large businesses (businesses using >10MVA peak demand), the VCR for services businesses is $12.36/kWh, while the VCR for industrial businesses is $138.34/kWh.

That said, we consider our approach to the business initial VNR should recognise that business customers:

- do not have an unlimited willingness-to-pay for network resilience and the initial VNR needs to recognise that and strike a balance between network resilience and affordability
- are likely to take steps to mitigate the impact of prolonged outages on their business (e.g., by purchasing or renting a generator). This view is based on the insights from customer engagement undertaken by the AER and network businesses and insights from the South Australian system black outage in 2016.[116]

Given the above, our draft decision is to:

- use the least cost self-generation option to determine the upper bound for the initial VNR for residential customers.
- not apply an upper bound to the initial VNR for business customers and instead propose to apply multiples of the VCR which recognise business customers also take steps, at some point in time, to mitigate the impacts of a prolonged outage.

Our proposed approach to calculating the residential upper bound for the initial VNR is set out below.

Residential self-generation upper bound

To determine the residential self-generation upper bound, we assumed the rational, hypothetical customer:

- will, given the need to refuel and the costs associated with generation, ration their usage and not consume their usual household load during the prolonged outage
- will want a generator that is capable of operating multiple household appliances but will stagger their household load and not seek to start and/or run every appliance at the same time.

We then undertook research on the starting and running wattages for common household appliances and reviewed a number of generator sizing guides published by generator retailers and manufacturers.[117] Based on that information and our above assumptions, we considered that a generator size of between 5,000 to 6,500 watts would be appropriate for the residential customer upper bound.

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[116] Business SA, *Blackout survey results – Understanding the effects of South Australia's state-wide blackout on 28 September 2016*, 2016.

[117] Queensland Government Electrical Safety Office, *Powering appliances with generators* [webpage] (accessed 14 June 2024); Powerlite, *What generator size do I need?* [webpage] (accessed 14 June 2024); Westinghouse, Portable generators [webpage] (accessed 14 June 2024); CD Power, Generator sizing guide [webpage] (accessed 14 June 2024).

We then undertook some market research on the price and operating specifications of the generators within this size range. We assumed the hypothetical customer would seek to balance cost and running time in selecting a generator make and model. On that basis, we selected a midrange model with the following specifications:

- Maximum load of 5,500W and running load of 5,000W
- Fuel tank size of 20L
- Price (as quoted by an Australian-based online retailer) of $1,699.

We assumed customers would likely want to operate a range of household appliances and some of these may require the generator to be hardwired, with a changeover switch installed. We therefore included costs associated with enabling the generator to be plugged directly into household circuits. Given the cost differential between manual and automatic changeover switches, we assumed the hypothetical customer would install a manual changeover switch. In calculating the upper bound, we also included operating and maintenance costs.[118] Based on these assumptions and specifications, we estimated a draft upper bound for the residential initial VNR of $3,494 per residential customer.

In setting the residential self-generation upper bound, we also considered an alternative self-generation option utilising battery storage and solar PV. However, this option was a considerably more expensive resilience measure compared to the generator option. Customer engagement insights also indicated this alternative option was not a 'lived experience' option considered by those that have experienced prolonged outages. Consequently, we propose to use the generator option upper bound we have set out above.

5.3 Development of a survey on resilience and outage impact

Based on recent consumer forums, discussions with stakeholders and observations, it is proposed that we develop a comprehensive survey to collect data on the resilience and experiences of individuals affected by prolonged power outages. This initiative aims to gather detailed information on the demographic attributes, specific challenges faced, and mitigation strategies employed by those affected. Understanding these aspects is crucial for framing the human impact of future investment decisions and allows the AER to better understand the lived experiences of those affected. This data will help characterise the resilience needs of different areas, particularly those prone to prolonged outages, ensuring that future investments and strategies are effectively targeted.

The survey will focus on the following key areas:

[118] See Appendix D for detailed information on the upper bound calculation.

- Impact of Outages: Documenting the duration and frequency of outages experienced, specific challenges faced during outages, costs incurred, and any health or safety issues encountered.
- Mitigation Strategies: Recording the use of generators, battery storage, associated costs incurred, accessing alternative accommodation or other methods to cope with outages.
- Demographic Attributes: Collecting data on age, household composition (including the presence of children or elderly individuals), income and other relevant factors.

The survey will use both qualitative and quantitative methods, including rating scales (e.g., 1 to 10 for impact severity) and open-ended questions to capture detailed lived experiences.

We will work with stakeholders to develop the survey, including the timeframes within which the surveys are conducted. To address any privacy concerns and for efficiency purposes we propose that network service providers seek the survey responses from their customers and submit deidentified responses to the AER. We also propose that the AER develops a resilience and outage impact database using these survey inputs, potentially making it publicly accessible. This database will serve to support future research, inform policy development aimed at enhancing resilience, provide data to refine and calibrate any potential resilience models (see Section 4 Assessment of Options for further detail) or inform or contextualise alternate approaches in the longer-term VNR work.

Glossary

Term	Definition
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
Capex	Capital expenditure
CBA	Cost-benefit analysis
CGE	Computable general equilibrium
DNSP or distributor	Distribution network service provider
ECMC	Energy and Climate Change Ministerial Council
HILP	High impact, low probability
IO	Input-output
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
NSPs	Network service providers
Opex	Operating expenditure
SAPN	SA Power Networks
SAPs	Stand Alone Power System
STPIS	Service Target Performance Incentive Scheme
VCR	Value of customer resilience
VNR	Value of network resilience
WALDO	Widespread and long duration outages

Appendix A: List of submissions received on VNR issues paper

Number	Submitter	Date received
1	TasNetworks	7-Jun-24
2	Endeavour Energy	7-Jun-24
3	Hydro Tasmania	7-Jun-24
4	SA Power Networks	7-Jun-24
5	Ergon Energy and Energex	7-Jun-24
6	ENGIE	7-Jun-24
7	CitiPower, Powercor and United Energy	7-Jun-24
8	Transgrid	7-Jun-24
9	Erne Energy	10-Jun-24
10	Essential Energy	10-Jun-24
11	Jemena	11-Jun-24
12	Energy Networks Australia	11-Jun-24
13	Ausgrid	11-Jun-24
14	AusNet	11-Jun-24
15	PIAC	11-Jun-24

Appendix B: Summary report for the AER deliberative forums

THE INSIGHT CENTRE

Australian Energy Regulator

Consumer engagement on the Value of Network Resilience

27 June 2024

Report content

THE INSIGHT CENTRE

Executive summary

Introduction

The Australian Energy Regulator (AER) is conducting a review of the Value of Customer Resilience (VCR) which includes potential approaches to establishing a Value of Network Resilience (VNR). To support this work, The Insight Centre conducted a series of consumer consultations as one of the many evidence sources used to provide deep context in forming a value of network resilience.

This report contains findings from consultations with consumers impacted by the February 2024 Victoria power outages, one of the largest outage events in the state's history. The report is designed to provide:

1) insights into consumer lived experience of power outages, including how consumers define resilience across individual, community, and network levels; consumer views on standard and prolonged outages; and consumer expectations from networks during power outage events; and

2) a review of pilot engagement methods used, including synchronous 'live' discussions (in-person and online via Zoom) and asynchronous online discussion boards, and guidance for the AER on best practice consumer engagement for future consultations and consumer research.

THE INSIGHT CENTRE

Summary of findings: consumer lived experience

The February 2024 Victoria power outages were high stress events impacting the wellbeing of many consumers. In their own words, two consumers described their lived experiences of these outages as follows:

"My fences came down, our whole estate was out for four days and I've got a daughter with high medical and disabilities and she's registered for life support. I had the energy provider ring up three times and say they'd be on within two days. And I asked them, how about a generator, get us on urgently for life support. Oh, nothing was done… One of my neighbours, she's elderly on a walker and, and has one of those mobility electric chairs, and she was stuck in that for two days because it's one of the ones that lifts and she couldn't get out of it because it couldn't go down and her mobile phone was flat." [1]

"I was very stressed because I could not charge my phone to contact my friend about taking and picking her kids up from school the next day…there was no way of contacting her. I was super stressed that night because I was afraid the stop lights would not be working and it would be dangerous on the roads. I could have driven to my husband's warehouse as he had electricity, but I had to wait until daylight because it was dangerous on the roads with no stop lights." [2]

[1] *Woman, 50-59, single parent, 4-day power outage.*
[2] *Woman, 60-69, partner with adult kids out of home, 2-day power outage.*

Summary of findings: consumer lived experience

The consumers we spoke to in this study had experienced a broad range of power outage lengths, from those who had experienced relatively short outages (of less than a day) through to those who had experienced long outage periods of five days or more.

Despite these differences in outage length experience, **it was often not only outage length but rather consumer energy use characteristics and individual circumstances that heightened or reduced outage impact and tolerance, and were the drivers of differences in consumer ability and opportunity to act.**

Given the diversity of factors that impacted consumer deliberations, it is unsurprising that what they considered an acceptable outage length varied. The sentiment can best be summarised as “Well, it depends…”.

The characteristics that framed these conversations were:

1. Household makeup: children/family/single person/elderly or special needs
2. Additional energy use: high medical care needs/work from home/small business owner
3. Degree of reliance on technology within the household or business
4. Financial capacity to take action to help cope with outages
5. Preparedness with alternative power sources (e.g. generators, battery storage systems, solar lights)

And the conditions surrounding the outage event itself included:

1. Day versus night/Winter versus summer/Temperature extremes of cold or heat versus more moderate temperatures/Weekday versus weekend
2. Unplanned versus planned outages
3. Disruption due to significant event versus more localised event

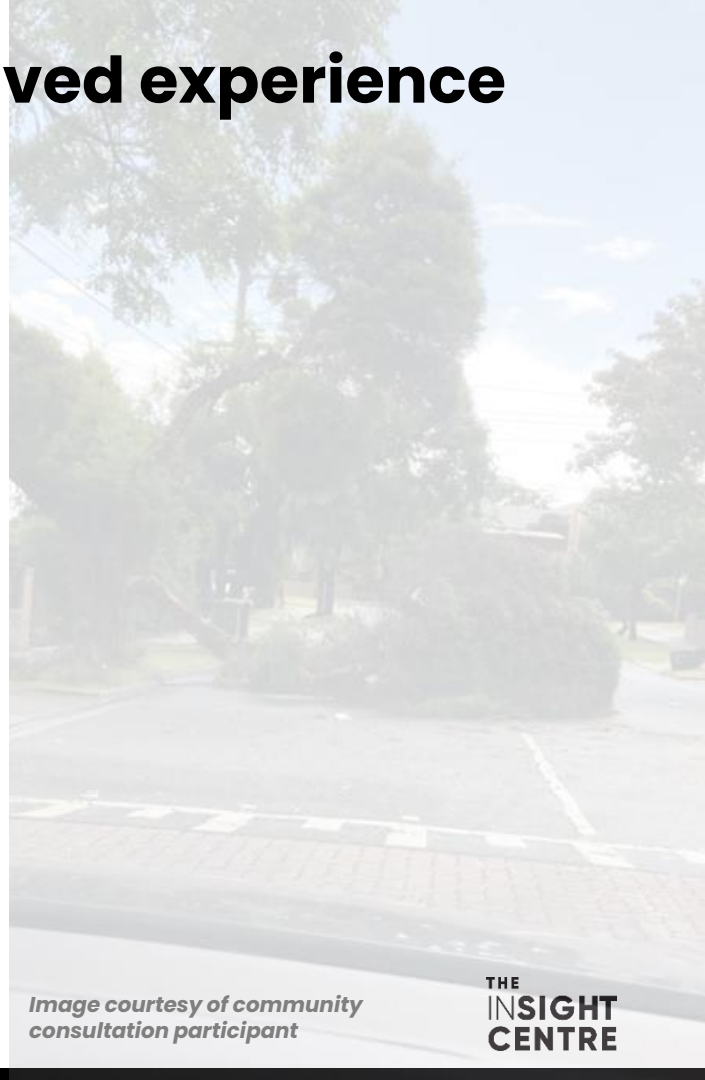


Image courtesy of community consultation participant

Summary of findings: consumer lived experience

The following definitions synthesise participant discussions about what resilience means to them at an individual, community and network level.

Individual resilience: *The capacity of an individual household or business to have a plan to minimise disruption and know how to respond during an outage.*

Individual resilience focused on self-reliance, highlighting the need to plan and manage the high stress environment of an outage. To be resilient, consumers focused on solutions to address food spoilage, continue access to technology and contact with loved ones, manage medical devices, and minimise disruption to paid work or business operations.

Community resilience: *The capacity of the community to deliver what people in the area need, to protect the most vulnerable and quickly return to normal functioning.*

Community resilience focused on accessing necessities that everyone would need to successfully navigate the impact of an outage (including shelter, food, petrol, charging stations), and on the support needs for those who couldn't look after themselves and needed greater assistance.

Network resilience: *The capacity of a network to be prepared, to withstand and quickly recover from power outages, and to promptly and accurately communicate with consumers during an outage.*

Network resilience was often discussed in terms of reliability, in that consumers saw resilience and reliability as intertwined. However, a resilient network was also often couched in terms of its capacity to prepare for and quickly recover from an outage event, rather than preventing an outage event from occurring.

Robust network communication is the priority consumer expectation from networks during an outage event.

Consumers require network communication before, during and after an event to aid in their planning, manage their uncertainty, and learn about what networks are doing to prepare for the next outage.

Despite consumer expectations of a resilient network, no participants suggested increased consumer contributions were required to support network resilience.

Most consumers did not know what investments are being made and/or what actions could be taken to improve network resilience. Due to this absence in communication, there is an assumption that nothing can be done to make the network more resilient and so the most sensible action for many consumers is to invest in their own individual resilience as much as financially possible.

Guidance on consumer engagement

	Insights	Recommendations
1	**The most adversely impacted consumers are most likely to value engaging in-person.** Online consultation methods offer the best value for money and are more productive in terms of data generation alongside time investment. However, in-person consultations are a valuable opportunity to bring consumers from the most adversely effected communities together to build a sense of care and trust with the organisation conducting consultations.	We recommend prioritising the most adversely impacted consumer groups for in-person consultations.
2	**Building meaningful consensus is more equitable and more effective via asynchronous online engagement.** Synchronous 'live' discussions (in-person and on Zoom) are less effective for meaningful consensus building within reasonable time frames. Asynchronous methods also ensure equal participation and minimise group think bias.	We recommend the use of online discussion boards as an effective additional asynchronous approach when iterative consensus building is required.
3	**Live online sessions (e.g. via Zoom) combined with online discussion boards maximise accessibility and cost effectiveness.** This dual approach allows for the development of a live group dynamic as well as maximum and equal individual engagement opportunity. It includes participants unable to travel, allows participation across geographic regions, engages the maximum number of participants, and requires a reasonable time commitment.	We recommend a combination of synchronous live online engagement with online discussion boards where consumer accessibility, reach, and cost effectiveness are priorities.
4	**A comprehensive consumer engagement program on complex regulatory issues requires a mixed methods approach.** The inclusion of qualitative research will ensure consumers understand the issues they are being asked to engage on, provide critical context and lived experience case-studies, and help to validate and triangulate quantitative findings.	We recommend qualitative consultation alongside any consumer surveys on complex regulatory issues.
5	**Qualitative research can also support the development of robust quantitative survey instruments** by testing survey questions and wording to ensure that a range of consumers understand what questions mean and what they are being asked.	We recommend in-depth interviews with target groups of consumers to pre-test survey instruments when consumer are being asked to engage on potentially complex questions.

Consultation background

Context and objectives

The Australian Energy Regulator (AER) is conducting a review of the Value of Customer Resilience (VCR), which includes potential approaches to establishing an initial Value of Network Resilience (VNR) as part of its broader effort to assess the value of preparing for high-impact, low-probability events, such as extended power outages caused by extreme weather.

This project is one of the many data sources used to provide deep context for the AER in the work of forming a value of network resilience.

To support this work, The Insight Centre conducted a series of consultations with community engagement specialists (via a reference group) and consumers. These consultations enabled stakeholder and consumer input on approaches to valuing network resilience (as outlined in the AER's May 2024 Issues Paper) as well as on broader themes of network resilience and the lived experience of power outages.

This qualitative report focuses on consultations with consumers impacted by the February 2024 Victoria power outages.

The consumer consultations had two overarching aims:

1. **To understand consumer outage lived experiences**, including their views on resilience across individual, community, and network levels; their views on standard and prolonged outages; and their expectations from electricity networks.

2. **To test two different approaches to consumer engagement**, including i) in-person consultation and ii) online consultation. The testing of approaches focuses on similarities, differences, strengths and weaknesses between the methodologies, and provides guidance on best practice consumer engagement for future consultations and consumer research.

THE INSIGHT CENTRE

Methodology

To meet the AER's objective of speaking with customers with lived experience of recent prolonged outages, community consultations focused on energy consumers impacted by the February 2024 Victoria power outages.

The Insight Centre hosted three consultation groups with a total of 62 consumers. Consultation groups were held from 18 to 20 June 2024, and each consultation session lasted between 2.5 and 3 hours. Participants received compensation for their time and contribution to this project.

An online and in-person approach was used to:

1. include consumers who may be unable to travel to attend in-person consultations
2. ensure accessibility of the information presented
3. include consumers from across Victoria
4. engage with a maximum number of consumers for data breadth and depth in a short time period and
5. test the effectiveness of different consultation modes to advise the AER on approaches for ongoing consultation.

The consumer engagement approach initially considered the use of deliberative forums, however given time limitations (see p.12 for details) a consultation approach was selected. To retain consensus building elements, an adapted Delphi method was used to understand how consumers defined resilience and prolonged outages. The Delphi process aims to arrive at a group decision or opinion through an iterative method of discussion and consensus building.

The three consumer groups were recruited based on the length of their outage experience during the February 2024 Victoria power outages:

1. **High impact consumers** (experienced outages between 2 and 11 days in duration), n=20. 3-hour in-person consultation held in Clematis, VIC.
2. **Medium to high impact consumers** (experienced outages between 12 hours and up to 1 week in duration), n=18. 2.5-hour consultation conducted online using a live Zoom session (1-hour), and a two-day online discussion board (1.5-hours).
3. **Low impact consumers** (experienced outages of up to 12 hours in duration), n=24. 2.5-hour consultation conducted online using a live Zoom session (1-hour), and a two-day online discussion board (1.5-hours).

Each consultation used an identical discussion guide and activities (topics and questions). The structure of the in-person discussion guide was adapted for the online environment, with all discussion topics and questions included.

For an overview of the discussion guide structure and participant demographics, please see the Appendix (pp. 32-34).

THE INSIGHT CENTRE

Methodology

Reference group

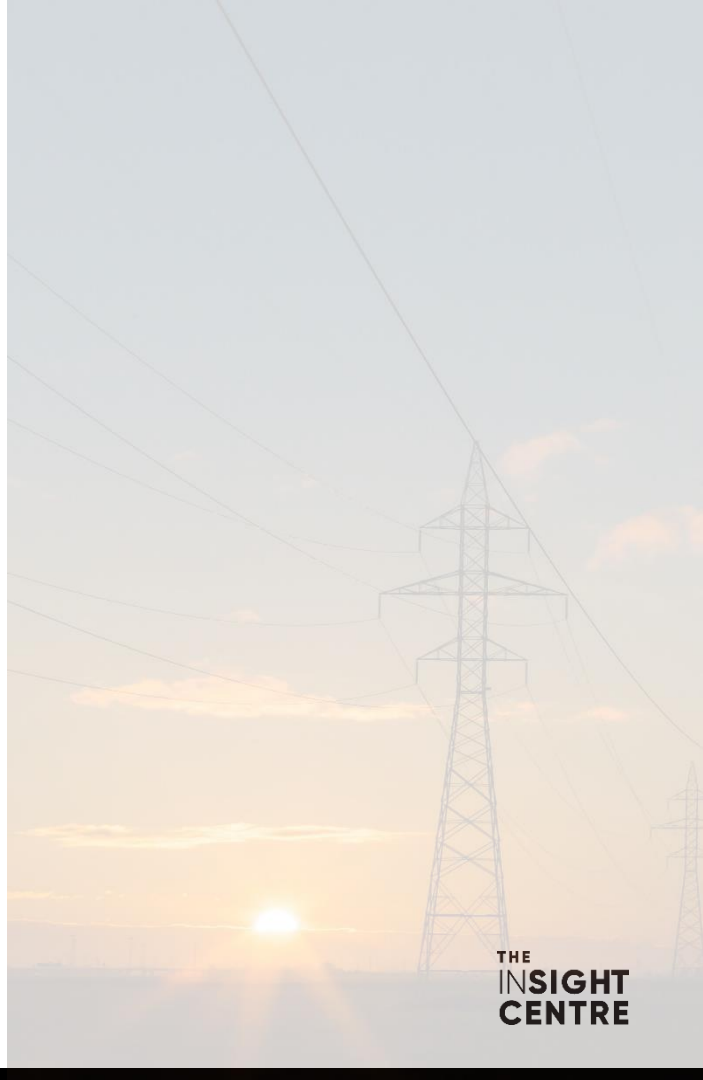
In May 2024, as part of project scoping for AER's consumer engagement, the AER convened a reference group of consumer engagement specialists to seek preliminary feedback on the project. Project endorsement was not sought from the reference group.

The reference group members provided preliminary input on what they considered best practice approaches to consumer consultations and provided feedback on the overarching structure of the discussion guide.

The AER and members of the reference group were invited to attend the community consultations as observers, with observers present across all three in-person and online consultations.

Project limitations

1. Timeframe: stakeholder and community consultations were conducted during a limited 4-week timeframe from May to June 2024, with the first stakeholder reference group held on May 17, and the final community consultation held on June 20. This timeframe was in place to meet the submission deadline set out in the AER's May 2024 Issues Paper.
2. Given the timeframe, there were limitations on the depth of information that could be shared with consumers to give them a robust understanding of complex material related to VNR and VCR, meaning that some consumer views may have been based on incorrect assumptions.
3. Geographic targeting: due to the limited timeframe available for consultation, the project focused on those consumers impacted by the Victorian power outages of February 2024. Discussions were focused on planned and unplanned standard and prolonged outages and the February event.
4. Given the geographic focus, the research findings should not be extrapolated to other states.



February 2024 outages:

Consumer lived experience

Impact of power outages

The February 2024 power outages were high stress events impacting the wellbeing of many consumers. The overall impact of the outage events varied based on outage length and individual consumer characteristics and circumstances.

Impacts of outages reported by consumers typically reflected the context of their energy use characteristics, including household type (children/single person/elderly), health conditions and medical needs, if the consumer works from home or is a small business owner, and their degree of reliance on technology and electricity within the household or business.

The **severity of impact also varied by individual circumstances, with any one type of impact affecting people differently** (e.g. an inability to cook at home was an inconvenience for some, but a stressful financial situation for others; and some had a higher outage tolerance due to access to a generator or solar power and battery). This suggests that impact types cannot be equally applied across all consumers (i.e. one size does not fit all), and that **individual circumstances can heighten or reduce outage impact**.

Universal power outage impacts	
	**Food:** spoilage costs and replacement costs
	**Technology:** access critical for emergency information and use for working from home, studying or entertainment
	**Wellbeing:** stress and concern triggered by uncertainty of outage length (lack of communication); financial impact (on households, SMEs, work-from-home); health conditions reliant on electricity access; and children in the household etc

"I couldn't use my computer to do work and also couldn't nearly use my phone as it had low charge...I lost a lot of food which I just had stocked so it cost a lot of money. I was very stressed as I don't like the heat or high weather temperature and got very exhausted. I had no idea when the power would be back on, I also didn't know if it would be hours or days. I didn't know whether I should go stay somewhere else."
Man, 30-39, lives alone. Low impact consumer group, 6-hour power outage.

"I was working from home the first day the power outage occurred. It affected my work as I was unable to connect to the internet due to both electricity and cellular access being down. As the power was still out the second day, I was forced to go into the city and work from the office. Furthermore, food in the fridge and freezer had to be thrown out. It was stressful knowing that I was unable to contact anyone at work to update them of my situation in case anyone was looking for me or had work for me."
Woman, 18-29, family household. Medium-high impact consumer group, 1-day power outage.

"We were still just kind of sitting around waiting to get power back for days and you don't know when it's coming back and we don't have family here so we couldn't go and, you know, decamp to mum's house for a couple of days. We kind of just had to sit in it and, we have food allergies in our house and food issues. Which mean that while we have gas cooking, some of us just can't live on pasta for a week or, which meant that a lot of take-out. We lost thousands in the deep freeze. You know, after even with me not closing or not opening anything, we just, you know, we lost it all."
Woman, 40-49, family household. High impact consumer group, 6-day power outage.

Consumer actions

Consumers engaged in several remedial actions during the February 2024 power outages, which varied based on individual circumstances (e.g. ability and safety to travel, access to personal social networks, work from home status, available finances).

Consumer timeframes to take action included immediate knowledge of the outage, learning about the length of outage, or when reaching a point of uncertainty about how long the outage would last. For those in the last group, their uncertainty resulted in an assumption of a prolonged outage and consumers acted to avoid becoming 'stuck' without adequate preparation.

Future proofing

- As a result of the February 2024 outages, high impact consumers took several precautions against future outages.
- These included investing in generators; purchasing jerry cans for petrol (due to the closure of petrol stations during the outage); purchasing more torches and radios (including with windup mechanisms); and keeping a reserve of cash in the home (due to the failure of ATMs and EFTPOS during the outage).

Primary drivers for action	
	**Uncertainty of outage length** (lack of information from networks)
	**Technology** (access to entertainment, study, or work from home)
	**Necessity** (access to food, light, electricity)
	**Need to work** (travelling to office or other location with power; purchasing generator)

Primary actions taken	
	**Alternative accommodation** (friends, family, hotels)
	**Escape from heat** (going to quick service restaurants/ cafes or shopping centres; taking a drive to cool down with AC)
	**Technology and communication access** (charging devices at other locations; traveling to be able to work)
	**Personal networks** (communicating with friends, family, neighbours; information seeking via social media)
	**Purchase and use of generators, power banks, candles, torches**
	**Purchase of take-away food**

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Network communication

Consumers in this study were asked to reflect on the communication from their networks during the February 2024 outages. Overall, **network communication was characterised as absent, confusing and conflicting.**

Many consumers did not receive any information from their network during the outages. These consumers included life support customers (i.e. customers who live in households in which a person is dependent on life support equipment), despite their attempts to contact their network for information and solutions.

For consumers who did receive information, most found the information inaccurate or contradictory (e.g. reporting that power was restored when it wasn't; inaccurate estimates over or understating the length of the outage).

While a **lack of communication increased feelings of stress and/or uncertainty** for consumers across the spectrum of outage lengths, network communication was further compromised as many consumers were left without charged devices or access to telecommunication networks due to the outage.

Some consumers who were able to access network websites found that incorrect information was also shared online. High impact consumers reported incorrect information on outages in their area, and difficulty accessing up-to-date information due to poor website user experience (UX).

"There was absolutely no warning or communication until after the outage. We received a text message advising of the outage but without any details or timeframes approximately 2 hours after the power went out. Then we received another text message later in the day advising that there may not be any power for the next 7 days… Lack of information really impacted our planning."
Woman, 40-49, family household. Low impact consumer group, 5-hour power outage.

"I received information after the fact and even then it changed and was not accurate. So, I couldn't make contingency plans. The Information kept changing and was very erratic."
Man, 50-59, lives alone. Medium-high impact consumer group, 2-day power outage.

"I thought the communication from the network was poor and confusing. Despite being on the life support list for essential equipment, when I tried to call asking about a backup generator, I had trouble communicating with foreign workers. No real solutions were provided which is why I had to source my own power."
Man, 30-39, partner. Medium-high impact consumer group, 2.5-day power outage.

"And the communication was zero. Like, I'd been ringing up to find out when it was gonna be fixed. Couldn't get any, any response. On a couple of occasions that I did ring, they said that it was fixed, and I said, well, 'I wouldn't be ringing if it was fixed', you know. And we had live wires, and we were a bit reluctant to drive in and out of the driveway because the wires were on the ground. So, I didn't know whether it was safe enough or not. I had no one to ask."
Woman, 50-59, family household. High impact consumer group, 2-day power outage.

Consumer views on resilience

Individual resilience

Individual resilience during power outages primarily focused on self-reliance, preparedness, problem solving skills, and access to personal networks.

Importantly, many of these elements of individual resilience rely on financial investment and social capital, meaning that some vulnerable consumers may be left without.

Definitions of individual resilience during power outages	
	**Self-reliance:** access to solar power, solar battery, or generator at home/workplace
	**Preparedness:** having a plan, resources and emergency kit in place; ability to contact neighbours and family if phone network fails; communication from electricity networks prior to event to support individual planning
	**Problem solving skills:** emotional stability, being prepared for the worst-case scenario; adaptability and being able to bounce back from hardship
	**Personal networks:** a network of family/friends who can assist during outage

Consultation approach: *Consumers were asked to share what would make them resilient as individuals during a power outage. These contributions to individual resilience were synthesised to create a list of definitions for use in a consensus exercise, in which consumers were asked to select the definitions they most agreed with and would prioritise.*

"Individually I think of resilience in terms of being able to adapt, being able to rely on yourself, being able to recover from adverse events, bouncing back after hardship etc. I live alone so this helped me try problem solve the issue but I also utilised my support network like my family and also kept informed by news and googling. I made myself more resilient for next time by buying a power bank for my phone and making sure I put my comp on charger every night. I also resolved to make decisions more quickly next outage and to just book a hotel straight away if I needed. I also bought a battery-operated fan."
Man, 30-39, lives alone. Low impact consumer group, 6-hour power outage.

"It's highly important to be prepared for any situation prior to any incident happening. Therefore having power banks, matches, torches, generators etc. will help when nature strikes. Also speaking to friends ahead of time and knowing where you can go would be helpful and would lead to a better outcome and aid resilience."
Woman, 50-59, partner. Medium-high impact consumer group, 16-hour power outage.

"Problem solving skills seem like the most important aspect of this for me because if you have problem solving skills you will be able to adapt and work through different solutions yourself. A lot of your stress is relieved if you can resolved the issue in a timely manner. For me personally, living with a disability, I find a good network of friends and family is very important for assisting me to do things. I can't always just rely on an energy provider to support me when thousands of people face the same issue."
Man, 30-39, partner. Medium-high impact consumer group, 2.5-day power outage.

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Community resilience

Community resilience during power outages primarily focused on community support and assistance, including community members coming together to support each other and checking in on those most vulnerable, access to resources, and backup power sources.

When resources such as petrol and food boxes are being distributed among community members, some consumers noted the importance of these resources being available equally to all due to experiences of long lines and shortages during the February 2024 power outages.

Definitions of community resilience during power outages	
	**Community support:** door knocking to check welfare of individuals; meals for people unable to cook; services to attend at the homes of the elderly
	**Access to resources:** information on where to go to get support; safe places with cooling/heating, access to showers, power, food, water and shelter; power banks sold at cost or given to the vulnerable; free ice distributed to the community
	**Backup power resources:** Back-up generators at community centres and other area locations for community access; back-up generators for traffic lights and main thoroughfares

Consultation approach: *Consumers were asked to share what would make communities resilient during a power outage. These contributions to community resilience were synthesised to create a list of definitions for use in a consensus exercise, in which consumers were asked to select the definitions they most agreed with and would prioritise.*

"If the outage is prolonged an access to food and shelter might be necessary for the individuals who might be socially disadvantaged."
Woman, 40-49, family household. Low impact consumer group, 8-hour power outage.

"It would be great to have a community centre with all the resources available during power cut offs so that people can have a place to go to with lights and other facilities."
Man, 30-39, partner. Low impact consumer group, <12-hour power outage.

"You need power for traffic lights, I was on the road when the outage happened, I was dropping my friends' children at her home, I drove back home thinking the storm had subsided, it did subside but the mess on the roads was stressful, there were no stop lights working, there were ambulances, fire brigades, sirens, drivers did not give way to the ambulances, it was scary and dangerous. Community support and assistance is imperative, free ice to the community is so important to keep your food from the fridge so you can eat it, especially your frozen meats, I had to throw out so much meat, get ice, I was scared to get out because the roads were chaos with no stop lights."
Woman, 60-69, partner. Medium-high impact consumer group, 2-day power outage.

"The queue [for petrol] went for hours, and by the time I got there it was gone… And they did that with our food boxes as well. They did like a couple of hours during work time, and nobody could get them… it just wasn't accessible to everyone."
Woman, 40-49, single parent. High impact consumer group, 8-day power outage.

Network resilience

Electricity is viewed as an essential service, with an expectation that it is always available. **Consumer definitions of network resilience integrated network reliability**, suggesting that consumers do not view resilience and reliability as distinct network features.

Definitions of network resilience focused on withstanding power outage triggers, preparation for outage events and swift recovery, and prompt and accurate communication with consumers.

Definitions of network resilience during power outages	
	**Network endurance:** a network that can withstand and quickly recover from power outages
	**Preparation:** networks to be prepared for outage events, including capacity to resolve issue quickly and efficiently with fast response times. This includes having back-up systems in place for communities (generator, batteries)
	**Consumer communication:** Providing prompt, clear and accurate communication to consumers, including reasons for outage, information on what is being done, what customers can expect, and time to recovery

Consultation approach: *Consumers were asked to share what would make electricity networks resilient during a power outage. These contributions to network resilience were synthesised to create a list of definitions for use in a consensus exercise, in which consumers were asked to select the definitions they most agreed with and would prioritise.*

"I believe a resilient network has a contingency plan in place and maintains transparency at all times - they're also built strong (i.e. robust infrastructure), and in the event of an unlikely outage in this case, they're well prepared and able to provide a back-up system. A resilient network is prepared at all times, and through such careful preparation, is built to survive (not to break). Of course, outages happen, but being resilient, means also being prepared to survive through the worst of times and to come out okay on the other side."
Woman, 30-39, lives alone. Low impact consumer group, 6-hour power outage.

"Having lots of communication is the key to great resilience as it is keeping everyone in the loop of why the outage is happening, how and when it might finish and what will happen next after the outage (especially if it's an outage that lasts for many days)."
Woman, 50-59, family household. Low impact consumer group, 3-hour power outage.

"[Networks should] prioritise facilities in most need, provide generators or have a backup source of power to avoid the outage in the first place, and to provide correct/accurate information especially ETA which they currently are very poor at."
Man, 30-39, share house. Medium-high impact consumer group, 18-hour power outage.

"As a service that provides what is now a basic necessity, networks need to be responsible of the power they hold. They need to have some forethought and planning on what to do when things get hairy. Clear communication to assure the public (keeping in mind that not everyone had cellular connection) that something is being done."
Woman, 30-39, partner. Medium-high impact consumer group, 2-day power outage.

Standard vs prolonged power outages

Differences in impact

Impacts from standard versus prolonged outages were influenced by the length of the standard outage itself, with impact differences also affected by individual consumer circumstances (e.g. a three-hour outage can be tolerated by some but have a negative impact on a consumer working from home). This suggests that **consumers have different tipping points for tolerance** and the definition of a standard outage does not broadly equate to a less impactful experience.

Many issues experienced during standard outages were similar to those experienced during prolonged outages, with the **main difference often being that the length of outage** (when communicated) **meant a difference in preparation** (for example, moving food to avoid spoilage; seeking alternative accommodation).

Standard outage impact

- Consumers reported many similar impacts to prolonged outages though for a shorter amount of time, with main disruptions being their ability to work, impact on day-to-day activities, keeping self and children entertained, loss of communication and internet access, and concerns about food loss.
- Impacts of standard outages are affected by the conditions surrounding the event itself (including day of the week - workday/weekend; time of the day - day/night; time of the year - winter/summer), and if the event is planned or unplanned.

Planned: consumers reported better network communication and therefore a heightened ability to prepare

Unplanned: feelings of stress are experienced by many consumers from a lack of information and communication (including not knowing how long the outage will last, and therefore being unsure of how best to plan and act)

"It totally depends whether it's a workday or weekend, if it's day or evening or night, it can affect my work, can affect my sleep."
Man, 30-39, partner. Low impact consumer group, <12-hour power outage.

"Our primary concern is always food spoilage so every time there is an outage we hope that it is short so that we don't have to throw away food."
Man, 40-49, family household. Low impact consumer group, 2-3-hour power outage.

"I am concerned that an outage of up to 12hrs is considered standard. I thought we lived in a 1st world country. [Standard outages impact my] ability to work, shop, study, have a communication channel into the world, mobile phone, cooking, keeping items cold."
Woman, 50-59, family household. Low impact consumer group, <12-hour power outage.

"We lose internet and phone connectivity, and our water pump. So even short-term over a few hours would make us leave our property. If we have warning, it's not a problem generally. Outages during the week also affect our work… So, without power during the week/working hours we can't work from home anymore."
Man, 30-39, family household. Medium-high impact consumer group, 2.5-day power outage.

"A planned one, right, so, you know that that's going to happen, you get a message about [the outage]…you can prepare for it. You can ask a friend, 'have you got this message? Can I come over?'"
Man, 40-49, family household. High impact consumer group, 2-day power outage.

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Defining power outages

Consumers differed in terms of what they considered standard and prolonged outages, and this was impacted by their individual use characteristics and circumstances. Overall, the **consumer defined length of a prolonged outage has decreased due to a higher reliance on technology and increase in people working from home.**

How consumers view an acceptable outage length was also impacted by the conditions surrounding the event itself (day of the week; time of day; time of year), with consumers who work from home, own their business, or are otherwise reliant on electricity having a lower tolerance overall.

Standard outages	Prolonged outages
• When presented with a definition of a standard and a prolonged outage, **many consumers disagreed that a 12-hour outage should be considered standard.** • A 12-hour outage was viewed as far greater than what many consumers considered acceptable. • When asked which outage length consumers would find reasonable or not highly impactful, acceptability was discussed in the context of consumers' individual circumstances with reasonable outages ranging from under one hour and up to 12 hours. For many consumers, high impact is felt even at short outage durations, indicating consumer reliance and low tolerance.	• When asked to define a prolonged outage, the comparison to a standard eight-hour workday definition was viewed by some as a more acceptable definition. • Across low, medium and high impact consumers, **the definition of a prolonged outage was between six to eight hours, or 12 hours overnight**. • As experience of outage length increased, consumer definitions of what constitutes a prolonged outage length often decreased, with many of the most impacted consumers reporting lower time periods as already triggering action plans to minimise disruption.

Definition presented to consumers: *The current definition of a standard outage is up to 12 hours in duration, while a prolonged outage is anything above 12 hours.*
Consultation approach: *Consumers were asked to share what they believed was a suitable prolonged outage length. These contributions were synthesised to create a list of prolonged outage length definitions for use in a consensus exercise, in which consumers were asked to select the most suitable timeframe of a prolonged outage.*

Consumer network expectations

Communication needs

Unplanned prolonged outages are a high stress environment where consumers are seeking more accurate and timely information to help them plan their strategy to cope with disruption. Overall, many consumers were highly critical of communication before, during and after a prolonged outage event.

Consumers need prompt, accurate and regular communication from networks about what happened, actions being taken, and timeframes to restore power. Underpinning consumer discussions about communication during an outage event is their need to manage uncertainty, both for prolonged and unplanned standard outages.

Network resilience and network communication

- During the consultation, despite consumers' expectations of a resilient network, no participants suggested increased consumer contributions were required to support network resilience.
- Some consumers expressed a disinterest in making further financial contributions to the network because they believe they are already paying a high price which should be sufficient to cover network investment.
- They also lack information about what investments are being made and what actions could be taken to strengthen the network and wonder why they aren't being given this information. In this information void, they assume that there is nothing that can be done to improve the network (apart from the mention of undergrounding electricity wires), or that networks can't or won't make the network more resilient.
- In the absence of effective communication, many consumers to believe they better "go it alone" and invest in improving their own individual household or small business resilience where financially possible.

"Communication allows you to make informed decisions."
Woman, 50-59, partner. Medium-high impact consumer group, 17-hour power outage.

"I want clear communication from the network, I want communication where to go to be safe, what to do, and how to charge phones etc. We need a better network that can withstand and quickly recover from power outages, it is too dangerous for the community to leave it the way it is. The day of the storm in February 2024, the communication was misleading, no one knew anything which was frustrating and stressful, the electricity networks need to be transparent and take ownership of the issue, I felt like there was no one in charge on the day of the storms, when I listened to the radio, there was so much misinformation regarding when the power would come back on."
Woman, 60-69, partner. Medium-high impact consumer group, 2-day power outage.

"The public already pay for the service; further costs shouldn't be on them."
Woman, 40-49, share house. Low impact consumer group, 4-hour power outage.

"We're already paying enough for the service as it is, we shouldn't have to pay more… Clearly networks aren't resilient enough, privatised companies should pay executives less and invest in the company more… When I pay the exorbitant fees for electricity I expect in this modern world of technology a degree of assurance for supply."
Man, 40-49, share house. Medium-high impact consumer group, 12-hour power outage.

Expectations of networks

When asked about expectations from networks during prolonged outages, consumers' **priority need is robust network communication**.

Communication is needed before, during and after an outage event to aid in consumer planning, manage uncertainty, and learn about what networks are doing to prepare for the next outage event. In post-event communication, key information needs include what the network learned, what specific upgrades to the network are being made, what is being done to make the system resilient, and what simple things consumers can do to better prepare for outages in the future. High impact consumers reported being particularly surprised that they had not received any follow-up communication from their network after the February 2024 Victoria power outages.

Consumer network expectations	
	**Communication:** prompt, robust and accurate information, before, during and after outage event
	**Compensation:** clarity and ease to receive compensation for loss of service, damage, food spoilage, medication loss, work/wages/business losses. Some consumers suggested a wraparound or regulatory approach to provide information on what can be claimed and for how much
	**Infrastructure:** upgrades and infrastructure investment to prevent against future prolonged outages
	**Information guides:** information guides about simple things consumers should and should not do during an outage, and in preparation for an outage

"Information is needed [by] the public as to how residents can prepare for such incidents."
Woman, 40-49, share house. Low impact consumer group, 4-hour power outage.

"I would expect some form of reliable communication to update customers as well as infrastructure investments immediately following [the outage event] to reduce the impact of such an event later on."
Woman, 18-29, family household. Medium-high impact consumer group, 1-day power outage.

"[I expect] clear and accurate information sent in time relevant period. That the network has been investing in infrastructure and maintenance. Automatic compensation with credit on bill, no need to apply or fill out any forms."
Woman, 50-59, partner. Medium-high impact consumer group, 20-hour power outage.

"We've had no communication [after the February 2024 outages]. 'So, we've rectified this, or we've worked towards this or we're looking at fixing this', or even feedback. I mean, they can send a bill in the mail, why can't they send feedback on customer issues? So, it doesn't make you happy, it doesn't give you hope... But also, my husband, he's a tradesman and he needs electricity to do his work and he had work piling up and couldn't, didn't know, you can't plan, you know, so the communication could be improved."
Woman, 50-59, family household. High impact consumer group, 2-day power outage.

"I think with the communication they could have also made a better effort to explain what we could do. Like, you know, a guide on how long frozen food lasts in the freezer."
Man, 30-39, share house. High impact consumer group, 6-day power outage.

Review of pilot engagement methods

Purpose

The AER is seeking to understand the most effective ways to engage with energy consumers. To do this, as part of the consumer engagement on the Value of Network Resilience project, we trialled in-person and online approaches to consumer engagement using a range of synchronous and asynchronous methods. These methods include:

1. Synchronous live consultation in-person
2. Synchronous live consultation online using Zoom
3. Asynchronous consultation online using discussion boards

The testing of consumer consultation approaches answers the following questions:

1. Which engagement methods are most effective and most accessible?
2. Which methods maximise depth of engagement with consumers?
3. Which methods are most inclusive for participants to take part, and do not require significant amounts of time to travel/engage in extended consultation?
4. Which methods are appropriate for capturing the voices of differently impacted consumers?

Consultation approach in detail

In-person consultation approach	Online consultation approach
• **Number of consultations:** 1 • **Number of participants:** 20 • **Participant profile:** High impact consumers (experienced outages between 2 and 11 days in duration) • **Length of consultation:** 3-hours • **Method:** Synchronous consultation (live in-person). • **Approach:** The consumer consultation was conducted in-person on 20 June 2024, and held at the Paradise Valley Hotel in Clematis, Victoria. Clematis is a township in the Dandenong Ranges - one of the most impacted regions of the February 2024 Victoria power outages.	• **Number of consultations:** 2 • **Number of participants:** 42 • **Participant profile:** Group 1 - low impact consumers (experienced outages of up to 12 hours in duration); Group 2 – medium-high impact consumers (experienced outages between 12 hours and up to 1 week in duration) • **Length of consultation:** 2.5-hours, split over 2 days. • **Method:** Synchronous (live on Zoom) and asynchronous (online discussion boards) hybrid consultation approach. • **Approach:** Consumer consultations were held over 2 days on 18-19 June 2024. 1-hour Zoom sessions were used to share information about the project and for participants to get to know one-another and share their lived experiences of the February 2024 outages. Online discussion boards opened immediately following the Zoom sessions and were open for 2 days. Each day, participants completed around 45-minutes of questions and discussion.

Consensus building using the Delphi method
1. The Delphi method is a process used to arrive at a group opinion or decision by engaging participants in an iterative method of discussion and consensus building. 2. Consensus exercises focused on understanding consumer definitions of resilience (at the individual, community, and network levels), and how consumers define a prolonged outage **3. In-person approach:** participants shared their individual definitions during the live consultation. Responses were synthesised live and presented back to participants to understand which definitions they prioritised. **4. Online approach:** participants shared their individual definitions in the online discussion boards on Day 1. These responses were synthesised overnight and presented back to participants on Day 2 to understand which definitions they prioritised. Definitions were presented using a multi-select question where participants were able to select their top 3 definitions for each question. To understand why participants prioritised their selections, following each voting selection participants were immediately presented with a follow-up open ended question.

Strengths and limitations of pilot methods

	In-person consultation approach	Online consultation approach
Participant voice	• In-person consultations limit the time participants have to speak and can inadvertently privilege the loudest voices. • Introverted participants may not feel confident to share their views on all topics.	• Online discussion boards allow for higher participant numbers; more content and more complex stimuli presented to participants; responses to all questions from all participants; and more opportunity for participants to engage in discussion with each other.
Data depth and breadth	• In-person consultations allow flexibility to explore new insights and themes that emerge organically from participants. This helps to capture rich and authentic qualitative data.	• Like in-person consultations, a live Zoom approach allows for flexibility to explore new insights and themes that emerge organically. • Online discussion boards maximise participant engagement and yield more than twice the data produced by one synchronous (in-person or Zoom) consultation.
Accessibility	• In-person consultations limit who can take part due to geographic accessibility, travel requirements, and scheduling.	• Online consultations (Zoom and online discussion boards) include participants unable to travel to attend in-person sessions and those from across geographic regions. • Asynchronous online discussion boards allow participants to take part at a time best suited to them.
Bias and group think	• In-person consultations can result in group think, thereby biasing data.	• To minimise group think bias, online discussion boards prevent participants from seeing others' responses before they have responded to all questions themselves.

Strengths and limitations of pilot methods

	In-person consultation approach	Online consultation approach
Building consensus	• Large in-person consultations are less effective for meaningful consensus building within an acceptable time frame, which also impacts opportunity for an iterative process.	• Online discussion boards allow each participant to engage fully in consensus exercises, with opportunity to conduct multiple iterations of a consensus exercise.
Human interaction	• In-person consultations provide stronger relationship and rapport building between participants and with moderators. • This builds a sense of trust and care with the organisation facilitating the consultations and can help to create a sense of community between participants.	• Online discussion boards lack human interaction as participants do not see each other during discussions. • To facilitate relationship and rapport building, a live Zoom session as the first consultation step allows participants to meet before continuing the conversation in an online discussion board.
Value for money	• In-person consultations require significant investment for venue booking, catering, AV equipment, extra staff, travel and accommodation costs for facilitators. • These costs increase for consultations in regional areas.	• Online consultations (Zoom and online discussion boards) are significantly more cost effective and cover a wide geographic reach without extra costs. • Online discussion boards can also accommodate large participant numbers without significant cost increases.

Appendix

Community consultation structure

Introduction	Lived experience	Views on resilience	Views on prolonged vs standard outages	Network expectations	Conclusion
• Overview of consultation; consultation background and purpose • Participant introduction • Consent to record session	• Impact of outages • Actions taken during outages • Network communication during outages	• Individual resilience • Community resilience • Network resilience • Consensus exercises on resilience definitions	• Differences in impact between standard and prolonged outages • Defining prolonged outages • Consensus exercise on prolonged outage definition	• Expectations of service from networks • Unreasonable service outage length	• Thank you to participants and close of consultation

Participant demographics

Consultation group	Participants	VIC Locations
Group 1: High impact consumers	20	Belgrave 3160; Carnegie 3163; Cockatoo, 3781; Ferntree Gully, 3156; Glen Waverly 3150; Heathmont 3135; Kallista 3791; Mt Waverley 3149; Murrumbeena 3163; Noble Park 3174; Rowville 3178; Scoresby 3179; Selby, 3159; Tecoma, 3160; Wantirna 3152; Wantirna South 3152; Wheelers Hill 3150
Group 2: Medium to high impact consumers	18	Ashburton, 3147; Bayswater, 3153; Belgrave South 3160; Boronia 3155; Chadstone 3148; Craigieburn 3064; Dandenong North 3175; Dingley Village 3172; Ferntree Gully 3156; Greensborough 3088; Hawthorn 3122; Heathmont 3135; Mount Waverley 3149; Murrumbeena 3163; Rowville 3178; Scoresby 3179; Vermont 3133
Group 3: Low impact consumers	24	Altona Meadows 3028; Beaumaris 3193; Berwick 3806; Boronia 3155; Brighton 3186; Carnegie 3163; Clyde North 3978; Croydon 3136; Dandenong North 3175; Elwood 3184; Hawthorn 3122; Kilsyth 3137; Lyndhurst 3975; Lysterfield; Mount Waverley 3149; Richmond 3121; Riddells Creek 3431; Ringwood 3134; Seabrook 3028; St Kilda 3182; Wonga Park 3115
	Total	62

Demographics	%
Gender	
Women	48
Men	52
Age	
18-29	6
30-39	21
40-49	32
50-59	19
60-69	15
70+	6
Diversity	
Culturally and Linguistically Diverse	47
Work type	
Business owner/self employed	13
Full time	47
Part time or casual	23
Home duties	5
Student	3
Retired/Not in work	10
Household	
Family/partner	76
Live alone	11
Share house	13

Thank You

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Appendix C: Summary of Issues Paper questions

Topic	Question
Questions on potential approaches, outage scenarios and assessment criteria	**Questions on outage scenarios, unserved energy and criteria for assessing potential approaches** 3.1.1 What outage length do you consider is the most important for us to focus on? (e.g., 1 day, 2-3 days, 7 days etc.)? Please explain why you consider this outage length is the most important. 3.1.2 How granular do you think the values need to be (e.g., specific feeders, etc)? Please explain why you consider this level of localisation is important. 3.1.3 Do you have any views on the use of unserved energy to derive a $/kWh value for network resilience? 3.1.4 What are your views on the assessment criteria we have developed for considering the potential methodological options? 3.1.5 Are there any additional assessment criteria we should include? Please explain why. **Questions on potential approaches** 3.2.1 Are there any additional potential approaches, other than those listed above, that we should consider? Why? 3.2.2 Do you have a preferred approach to valuing network resilience? If so, why do you prefer that approach? **3.2.3 Do you have any views on how we might use a combination of approaches?**
Potential Approaches	**Questions on Option 1 - Using rational alternatives as an upper bound** 3.3.1 Do you think we should include an upper bound on the costs consumers may be willing to pay to avoid prolonged outages? Please provide reasons for your view. 3.3.2 Can you see any potential challenges in calculating an upper bound on the costs consumers may be willing to pay to avoid prolonged outages? 3.3.3 If we do include an upper bound, do you have a view on the least-cost backup self-generation solutions we should explore? 3.3.4 If we do include an upper bound, do you have a view on which approach (least-cost backup self-generation or temporary accommodation costs) is preferred? Should we explore a combination of these approaches? **Questions on Option 2 - Using a multiple of the VCR for standard**

Topic	Question
	outages 3.4.1 Is this approach appropriate for outages greater than 12 hours? Please explain why. 3.4.2 Can you see any potential advantages in using this approach? 3.4.3 Can you see any potential challenges in using this approach? 3.3.4 Do you have any views on whether this approach could be implemented, and values produced within the required timeframe? **Questions on Option 3 - Extrapolating the VCR for standard outages beyond 12 hours** 3.5.1 Do you believe this approach is appropriate to value consumer resilience for outages greater than 12 hours? Please explain why. 3.5.2 Can you see any potential advantages in using this approach? 3.5.3 Can you see any potential challenges in using this approach? 3.5.4 Do you have any views on whether this approach could be implemented and values produced within the required timeframe? **Questions on Option 4 - Conducting follow-up surveys to actual prolonged outages** 3.6.1 Do you believe this approach is appropriate to value consumer resilience for outages greater than 12 hours? Please explain why. 3.6.2 Can you see any potential advantages in using this approach? 3.6.3 Can you see any potential challenges in using this approach? 3.6.4 Do you have any views on whether this approach could be implemented and values produced within the required timeframe? 3.6.5 Do you have any views on whether residential and/or business survey outcomes from one outage event or network could be used as a proxy for other outage events or networks? **Questions on Option 5 - Using modelling to estimate a value** 3.7.1 Do you believe this approach is appropriate to VNR for outages greater than 12 hours? Please explain why. 3.7.2 Do you have any views on which model(s), if any, may be appropriate for estimating a VNR? 3.7.3 Can you see any potential advantages in using this approach? 3.7.4 Can you see any potential challenges in using this approach? 3.7.5 Do you have any views on whether this approach could be implemented and values produced within the required timeframe?

Topic	Question
	Questions on Option 6 - Exploring other cost data 3.8.1 Do you believe this approach is appropriate to value network resilience for outages greater than 12 hours? Please explain why. 3.8.2 Can you see any potential advantages in using this approach? 3.8.3 Can you see any potential challenges in using this approach? 3.8.4 Are there any data sources that you think would be useful for this type of analysis? Do you know who may be able to supply the data you have identified? 3.8.5 Do you have any views on whether this approach could be implemented and values produced within the required timeframe?

Appendix D: Overview of key inputs to upper bound calculation

The following table provides an overview of the estimated upper bound for residential, including the selected generator, brand, cost, starting wattage, running load:

	Selected Generator	Cost ($)	Starting Wattage (W)	Running Load (W)
Residential	5500W Petrol Inverter Generator	1699	5500	5000

Other Inputs

The following tables outline various other key inputs, including capital costs, running costs, maintenance, and other financial assumptions.

Capital cost	
Manual change over switch ($)	150
Change over switch installation ($)	500

Running Costs	
SAE 10W-30 oil - Cost per litre ($)	7.5
Fuel - Cost per litre ($)	2
Carbon per L of diesel used (Kg)	2.67
Hours of operation per year (i.e. outage length)	24
Hours of operation per oil change	25
Oil required each oil change (litres)	0.75

Maintenance	
Servicing cost ($)	100
Service frequency (every X years)	2

Other financial assumptions	
Discount rate	7.0%

Inflation	3.0%
Effective Life (years)	10

Emissions cost[119] – AER interim values of emissions reduction

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Emissions cost ($ per tonne of carbon)	70	75	80	84	89	95	105	114	124	135	146

[119] This assumption, as detailed in the appendix, is likely to be mitigated when considering the emissions associated with the electricity generation due to the reduced lost load resulting from the network investment. This generation could come from a hardened network option, such as coal generation (at least for now), or a responsive non-network option, such as a portable generator.