Widespread and Long Duration Outages - Values of Customer Reliability

Final Conclusions

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AUSTRALIAN ENERGY REGULATOR

Inquiries about this publication should be addressed to:

Australian Energy Regulator
GPO Box 520
Melbourne Vic 3001

Tel: 1300 585165

Email: AERInquiry@aer.gov.au
AER Reference: PRJ1003080

Amendment Record

Version	Date	Pages

Contents

Shortened forms

Shortened form	Extended form
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
CBD	central business district
COAG	Council of Australian Governments
the Committee	the VCR Consultative Committee
CPI	Consumer Price Index
DER	distributed energy resources
ECA	Energy Consumers Australia
ESB	Energy Security Board
GWh	gigawatt hour
HILP	high impact low probability
IASR	Inputs, Assumptions and Scenarios Report
kWh	kilowatt hour
NEL	National Electricity Law
NEM	National Electricity Market
NEO	National Electricity Objective
NER	National Electricity Rules
NSP	network service provider
the Subcommittee	the HILP Subcommittee
USE	unserved energy
VCR	values of customer reliability
WALDO	widespread and long duration outages
WTA	willingness to accept
WTP	willingness to pay
$/kWh	dollars per kilowatt hour

1 Executive Summary

The Australian Energy Regulator (AER) is the independent regulator for Australia's national energy markets. We are guided in our role by the national electricity, gas, and energy retail objectives set out in in the National Electricity Law (NEL), the National Gas Law (NGL) and the National Energy Retail Law (NERL). These objectives focus on promoting the efficient investment, operation and use of energy services for the long-term interests of consumers.

In response to a Rule Change proposal from the Council of Australian Governments (COAG) Energy Council, the Australian Energy Market Commission (AEMC) amended the NER to give the AER the responsibility of determining the values different customers place on having a reliable electricity supply.[1] This is referred to as the value of customer reliability (VCR).

VCRs seek to reflect the value different types of customers place on reliable electricity under different conditions. As such, VCRs are useful inputs in regulatory and network investment decision-making to factor in competing tensions of reliability and affordability. Importantly, VCR is not a single number but a collection of values across residential and business customer types, which need to be selectively applied depending on the context in which they are being used.

The AEMC's Rule Change became effective on 5 July 2018.[2] Our initial review and VCR values for 'standard' outages were published on 18 December 2019. These VCRs have a number of applications in network planning, regulation and pricing.

In addition to VCR values for standard outages, our review identified uses for VCRs relating to Widespread and Long Duration Outages (WALDOs). These are outages of longer duration and/or greater geographical coverage than those outages considered in the set of VCRs for standard outages. These applications include roles in the System Restart Standard Review and assessment of protected events.

Consistent with the rule requirements, we developed a VCR methodology which included techniques to derive VCRs for standard outages and WALDOs. The set of standard VCRs were derived from an extensive survey of residential and business customers and cover localised outages that last up to 12 hours.

Our final report did not include VCRs for WALDOs, as stakeholder feedback from previous consultation processes were supportive of using a separate macro-economic modelling approach to derive WALDO VCRs, rather than applying the survey methodology used to derive the standard VCRs.

On 23 March 2020, we published a draft WALDO model alongside a consultation paper. The consultation paper explained how the draft WALDO model would work and outlined limitations in the draft WALDO modelling. The consultation paper sought stakeholders' views

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

2 NER, Rule 8.12.

on whether stakeholders were comfortable with the draft WALDO model given these limitations.

Although stakeholders provided in-principle support for a macro-economic approach for estimating the costs of WALDOs and deriving WALDO VCRs, they did not support the draft WALDO model in its current form, mainly due to concerns with how the draft WALDO model estimates social costs. There were also differing views among stakeholders about the extent to which social costs should be included in the draft WALDO model, and whether their inclusion is consistent with the National Electricity Objective.

We have considered the issues raised in the submissions responding to the consultation paper, and have decided to discontinue the WALDO methodology and modelling approach. We believe there is merit in further work being undertaken on WALDO, and we are considering ways future primary research could be carried out by the AER via partnerships with universities or other similar academic institutions.

This document sets out our reasons for our decision and considers the issues raised by stakeholders in their submissions to the consultation paper. It also includes a revised Statement of Methodology, which supersedes our previous Statement of Methodology published on 26 November 2019.

2 Background

2.1 What are VCRs?

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

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

Prior to the AEMC's rule change there was no single body responsible for determining VCRs and updating VCR estimates on a regular basis. The first comprehensive NEM-wide study of VCRs was conducted by the Australian Energy Market Operator (AEMO) in 2014.

In its 2014 review AEMO calculated VCR values in the NEM for residential, business and direct connect customers. Residential customers were segmented by NEM jurisdiction, business customers were segmented by sector (industrial, commercial and agricultural) and size (small, medium and large) and direct connect customers were segmented by sector (metals, wood pulp and paper, and mining).[3]

Our initial review and VCR values for standard outages were published on 18 December 2019.[4] These VCRs have a number of applications in network planning, regulation and pricing. This set of VCRs is derived from an extensive survey of residential and business customers and covers localised outages of up to 12 hours. To derive standard outage VCR values for residential and business customers we used a combination of contingent valuation and choice modelling survey techniques:

- contingent valuation was used to determine the willingness to pay (WTP) to avoid a baseline outage scenario (defined as two localised one hour outages in a year, occurring in winter in off-peak times)
- choice modelling was used to determine the increment (or decrement) in value respondents' placed on specific outage attributes in addition to the baseline outage scenario. Attributes tested in the choice model were peak (7-10 am and 5-8 pm) and off-peak time of day, season (winter / summer), day of week (weekday / weekend), severity (localised / widespread) and duration (1 hour, 3 hours, 6 hours, 12 hours).

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

4 AER, *Values of Customer Reliability Review: Final Report, December 2019.* Available at: https://www.aer.gov.au/system/files/AER%20-%20Values%20of%20Customer%20Reliability%20Review%20-%20Final%20Report%20-%20December%202019.pdf.

The contingent valuation and choice modelling results were then combined to calculate the dollar value which a customer cohort places on specific outage scenarios. The dollar values for the outage scenarios are then used to derive the standard outage VCR for the customer segment.

In addition to VCR values for standard outages, our review identified uses for VCRs relating to Widespread and Long Duration Outages.

2.2 What are Widespread and Long Duration Outages (WALDOs)?

WALDOs are more severe than standard outages. These outages cover a wider geographical region than localised outages associated with the set of standard VCRs, and can have longer durations than standard VCRs that cover outage durations of up to 12 hours.

In our draft WALDO model and consultation paper, we considered the appropriate range is 1 GWh to 15GWh of unserved energy for WALDOs. However, as discussed in section 4.5.1, stakeholder submissions identified uses for modelling outage scenarios beyond the 15GWh range, and a potential use case for outages longer than 12 hours, but less than 1 GWh of unserved energy.

WALDO VCRs that have been derived with sufficient confidence would have applications including roles in the System Restart Standard Review and assessment of protected events. In our Final Decision on VCR Methodology, we determined we would use a macro-economic methodology supplemented by other techniques to derive WALDO VCR values.[5]

2.3 Timeline of WALDO work

Submissions to our initial VCR consultation paper in October 2018[6] were mostly supportive of deriving VCRs for WALDO,[7] and considered that survey techniques should not be used for calculating these values. These submissions also raised a number of complex issues regarding the development of WALDO VCRs. To give proper consideration to these issues we established a High Impact Low Probability (HILP) sub-committee (the Sub-committee) sitting under the VCR Consultative Committee[8] (Committee). The Sub-committee consisted of a subset of Committee members with a particular interest in or expertise in this subject

5 AER, *Values of Customer Reliability Review: Final Decision on Methodology*, November 2019, 3. Available at: https://www.aer.gov.au/system/files/AER%20-%20Values%20of%20Customer%20Reliability%20Review%20-%20Final%20decision%20on%20methodology%20-%20November%202019.pdf.

6 AER, *Values of Customer Reliability Review, Consultation Paper*, October 2018. Available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability/initiation.

7 Submissions to the Consultation Paper in support: AEMO, Ausgrid, AusNet, ENA, Ausgrid, Endeavour, Energy Queensland, Meridian Powershop, S&C Electric, TasNetworks, Transgrid; Submissions unsupportive: EUAA, MEU, Origin.

8 The VCR Consultative Committee was composed of stakeholders with expertise and interests in VCR including state economic regulators, market bodies, networks and consumer groups. See, AER, *Values of Customer Reliability Review, Consultation - VCR Consultative Committee.* Available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability/consultation.

area.[9] The Sub-committee considered whether to develop WALDO VCRs and how to achieve this.[10]

Stakeholders expressed differing views in submissions responding to our April 2019 VCR consultation update[11] paper regarding WALDOs. A number of stakeholders identified uses for VCRs for the outage scenarios mentioned above, and supported expanding the VCR methodology to encompass these outage types.[12] However, other stakeholders were concerned such VCRs may be misused, that these outages are difficult to define and corresponding VCRs would be difficult to measure because they are rarely experienced by customers and therefore not well measured by surveys.[13]

Considering the feedback from stakeholders throughout these consultation processes, our Draft Decision on the VCR methodology in September 2019 included the use of modelling techniques for producing WALDO VCRs. We proposed using a macroeconomic modelling methodology, supplemented by other measures to derive a WALDO cost curve describing the impact of outages of increasing severity on VCR.[14]

Stakeholder submissions in response to our Draft Decision supported using a model based methodology to determine VCR values for WALDOs.[15] In our Final Decision on Methodology,[16] we undertook to develop the WALDO VCRs and engaged a consultant, ACIL Allen, to conduct a study into the costs associated with WALDOs. ACIL used a combination of techniques to estimate the costs of WALDO scenarios for residential, commercial and industrial customers, as well as broader societal costs not captured in individual residential or commercial and industrial customer costs.

We developed a draft WALDO model allowing stakeholders to specify the WALDO scenario to be considered by inputting the timing and physical extent of the outage, as well as the relevant climate zones, remoteness categories and load proportions of different economic sectors and residential customers affected by the outage. On 12 February we met with the Sub-committee who provided feedback on the draft WALDO model.

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9 The HILP Sub-committee had representatives from AEMO, AEMC, the Reliability Panel, ENA and PIAC.

10 The Sub-committee first met on 14 March 2019, with subsequent meetings on 23 May 2019, 17 July 2019 and 12 February 2020.

11 AER, *Values of Customer Reliability Review: Consultation Update Paper*, April 2019. Available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability/initiation.

12 Submissions to the Consultation Update Paper: ENA, AEMO, Business SA, Ausgrid, TasNetworks, S&C Electric, Transgrid.

13 Submissions to the Consultation Update Paper: EUAA, Origin.

14 AER, *Values of Customer Reliability Review: Draft Decision,* September 2019, 5. Available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability/draft-decision.

15 Submissions to Draft Decision: Ausgrid, ENA, PIAC.

16 AER, *Values of Customer Reliability Review: Final Decision on Methodology*, November 2019. Available at: https://www.aer.gov.au/system/files/AER%20-%20Values%20of%20Customer%20Reliability%20Review%20-%20Final%20decision%20on%20methodology%20-%20November%202019.pdf.

On 23 March we published the draft WALDO model[17] and accompanying report[18] by ACIL Allen, as well as a consultation paper.[19] The consultation paper sought stakeholder views on a number of matters including:

- the assumptions and settings present in estimating social costs
- the assumptions and settings present in estimating the additional costs of widespread outages
- the scope of outages to be included in the draft WALDO model
- whether stakeholders supported the use of the draft WALDO model, l noting the assumptions.

On 18 May we hosted an online workshop with a number of consumer stakeholders to provide further information about the draft WALDO model. We demonstrated the model and showed how it could be implemented in the identified use cases. We also sought to understand the level of support for the model among consumer stakeholders, and encouraged stakeholders to include these views in their submissions to the consultation paper.

We received seven submissions from stakeholders responding to our WALDO consultation paper.[20] Stakeholders did not support the draft WALDO model in its current form, mainly due to concerns with how the draft WALDO model estimates social costs. There were also differing views among stakeholders on the extent to which social costs should be included in the draft WALDO model, and whether inclusion of these costs is consistent with the National Electricity Objective.

We have considered the issues raised in submissions responding to the consultation paper and have decided to discontinue the WALDO methodology and modelling approach.

Section 4 outlines the issues raised by stakeholders and our consideration of them, and sets out the reasons for our decision.

17 ACIL Allen, *VCR WALDO model - for consultation,* March 2020. Available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability/updates.

18 ACIL Allen, *Value of Customer Reliability - For Widespread and Long Duration Outages,* March 2020. Available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability/updates.

19 AER, *Values of Customer Reliability Review - Widespread and Long Duration Outages Consultation Paper,* March 2020. Available at: https://www.aer.gov.au/system/files/WALDO%20VCR%20final%20report%28202759.1%29.pdf.

20 Submissions are available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability/updates.

3 Final Conclusions on modelling and guidance for stakeholders

3.1 Decision to not continue the model

We have decided to discontinue the WALDO modelling work, and we will not be publishing a final WALDO model.

To give effect to our decision to discontinue the WALDO methodology and modelling, we have updated the VCR Methodology so that it does not include a separate methodology for estimating WALDO VCRs. The methodology for deriving standard VCRs, and the derived VCR values published on 18 December 2019, remain unchanged by this update.

The VCR Methodology is contained within the Statement of Methodology, which is published as a standalone document on our website. This standalone e Statement of Methodology has been updated to reflect our decision to discontinue the WALDO methodology. [21]

The WALDO methodology is also contained in the AER VCR Review Decision on Methodology document published on 26 November 2019. We have added an update note to this document to indicate that the WALDO methodology and model has been discontinued.

This VCR Final Conclusions document includes our most recent Statement of Methodology, reproduced in section 5.

3.2 Application guidance for stakeholders

We recommend stakeholders apply the most relevant survey derived 'standard' VCRs from our 2019 VCR review, published on 18 December 2019.[22] Our review recommended applying a sensitivity analysis that considers a range of +-30% to the relevant VCRs in cost benefit analyses.

3.2.1 NSPs and AEMO (ISP and RIT-Ts)

Guidance on use of VCR(s) in ISPs and RIT-Ts is provided in AER Guidelines: "*Cost Benefit Analysis Guidelines*" and "*Application Guidelines - Regulatory Investment Test for Transmission*", as published on 25 August 2020.

In respect of the ISP, the Cost Benefit Analysis Guidelines[23] require:

21 AER, *Statement of Methodology, November 2019.*

22 AER, *Values of Customer Reliability Review: Final Report, December 2019.* Available at: https://www.aer.gov.au/system/files/AER%20-%20Values%20of%20Customer%20Reliability%20Review%20-%20Final%20Report%20-%20December%202019.pdf.

23 AER, *Cost Benefit Analysis Guidelines,* August 2020, p.10. Available at: https://www.aer.gov.au/system/files/AER%20-%20Cost%20benefit%20analysis%20guidelines%20-%2025%20August%202020.pdf

When applying a VCR to value a market benefit class for a development path, AEMO is required to use:

- the AER's most recent VCRs for unplanned electricity outages for the NEM, at the time of publishing an ISP timetable under clause 5.22.4 of the NER; and
- the most relevant VCR(s) for the load associated with the unplanned electricity outages.

When applying a VCR, AEMO must have regard to:

- any application guidance accompanying the VCR values it is using; and
- the load-weighted VCR that reflects the relevant composition of the different customer types in the specified loads that feature higher up on that jurisdiction's schedule of rotational load shedding.

We do not consider VCRs derived from the draft WALDO modelling to be 'the most relevant VCR(s)' to be used in ISP parameters and the IASR.

The AER's most recent VCRs are the set of 'standard' VCRs from our 2019 VCR review. We expect AEMO to use the load-weighted average of the relevant 'standard' VCRs from the AER 2019 VCR review, reflecting the mix of customers affected in the scenarios included in the IASR.

In respect of RIT-Ts for ISP and non-ISP projects, we expect RIT-T proponents to use the load-weighted average of the relevant 'standard' VCRs from the AER 2019 VCR review, reflecting the mix of customers affected by the investment option.

3.2.2 Reliability Panel and AEMO (Requests for protected events)

We do not consider VCRs derived from the draft WALDO modelling to be suitable for cost benefit analyses for managing non-credible contingencies as protected events.

We encourage the Reliability Panel and AEMO to use the load weighted average of the selection of relevant 'standard' VCRs from AER 2019 VCR review when estimating the value of managing non-credible contingencies as protected events.

3.2.3 Reliability Panel (Review of system restart standard)

We do not consider VCRs derived from the draft WALDO modelling to be suitable for cost benefit analysis for different levels of SRAS procurement and establishing the system restart standard.

We encourage the Reliability Panel to use the relevant load weighted averages of the 'standard' VCRs from AER 2019 VCR review when estimating the incremental benefit of procuring different levels of SRAS procurement, similar to the methodology used in the Reliability Panel's 2016 review of the System Restart Standard.

4 Issues raised in consultation and reasons for our decision

4.1 Purpose of consultation paper and other stakeholder engagement

During the WALDO modelling work we engaged in extensive consultation as discussed in section 2. This work has been a novel project for the AER, with little available guidance from previous regulatory reviews or academic studies.

Stakeholder feedback provided important input shaping our approach to this challenging work. We greatly appreciate the time and energy stakeholders have contributed in preparing submissions, attending (sometimes virtually) numerous meetings, including Sub-committee meetings and workshops. Recent consultation also coincided with the COVID-19 pandemic, and despite disruptions to standard business practices and many logistical challenges, we have continued to benefit from stakeholder participation.

A key focus for our consultation on the draft WALDO model was to:

- communicate the limitations and assumptions in the draft WALDO modelling due to the lack of prior information
- understand whether the potential users of the draft WALDO model, and the electricity consumers that ultimately pay for investments and benefit from reductions in unserved energy, supported the draft WALDO model, given these limitations and assumptions.

Stakeholder submissions clearly indicate a lack of sufficient support for the current WALDO model. The most significant concerns raised by stakeholders related to the treatment of social costs in the draft WALDO modelling. A number of other issues were also raised. The following sections set out our consideration of the issues raised by stakeholders.

4.2 Treatment of social costs

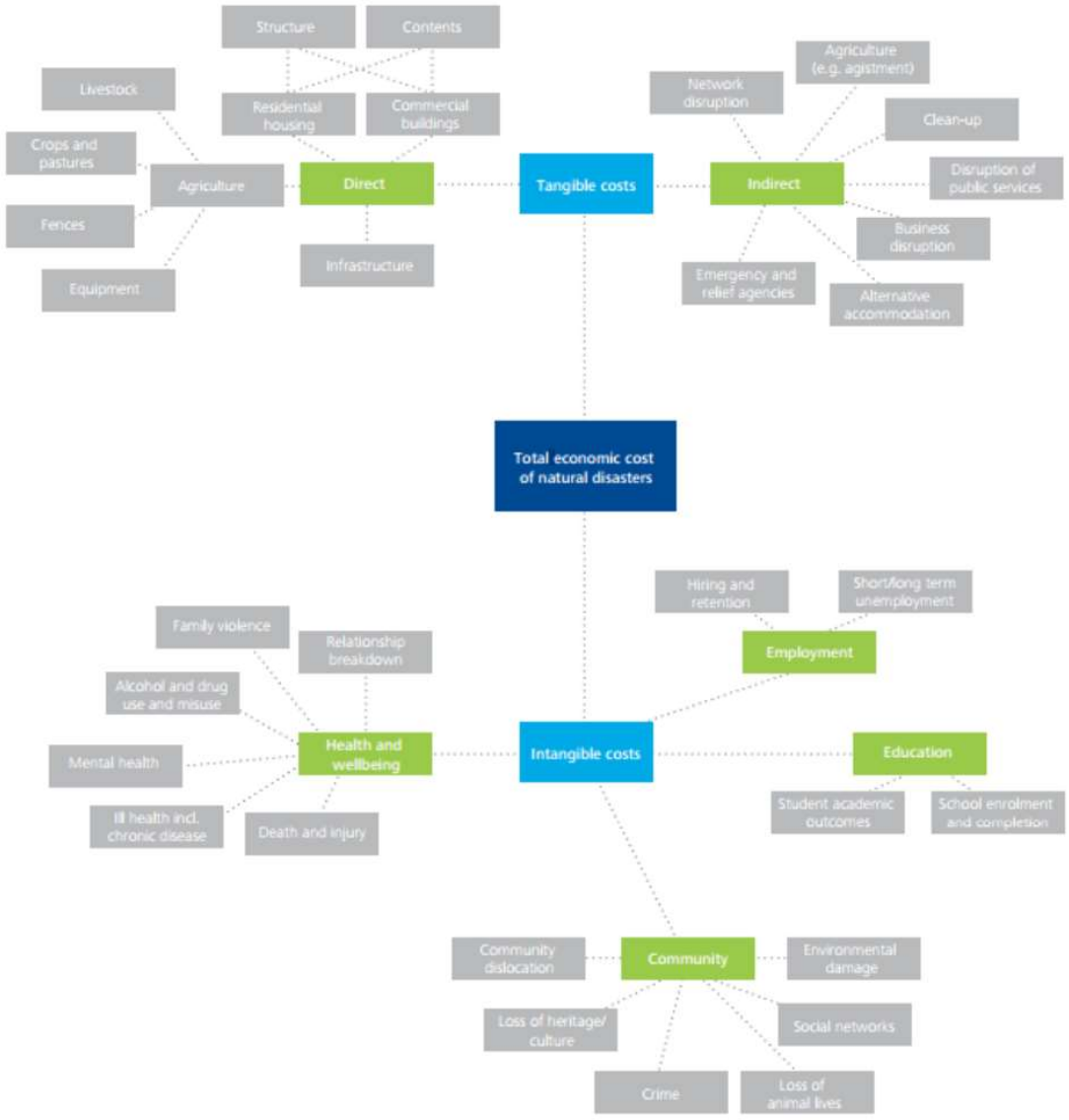
4.2.1 What are social costs?

The social costs estimated in the draft WALDO modelling aim to capture the broader social impacts of outages that are not captured through the residential and business direct cost components of the WALDO VCR. Social costs include indirect costs and flow-on costs incurred by individuals and businesses beyond individual energy consumers. In its report, ACIL Allen defines social costs considered in the draft WALDO model to include the:

- financial cost of managing social responses to an outage (e.g. increased crime)
- financial and non-financial costs of consumers being unable to access the services they previously organised to access.

In its report prepared for the Reliability Panel's 2016 review of the system restart standard,[24] Deloitte Access Economics identified a number of tangible and intangible outcomes arising from natural disasters, illustrated in Figure 1 below. While not all intangible costs of natural disasters may be incurred during a major system outage, there could be substantial impacts on health and wellbeing, employment, education and community.[25]

Figure 1: Impacts of natural disasters



Source: Deloitte Access Economics

24 *Economic assessment of System Restart Ancillary Services in the NEM*, Report Prepared by Deloitte Access Economics for AEMC, 30 November 2016, 63.

25 *Economic assessment of System Restart Ancillary Services in the NEM*, Report Prepared by Deloitte Access Economics for AEMC, 30 November 2016, 64.

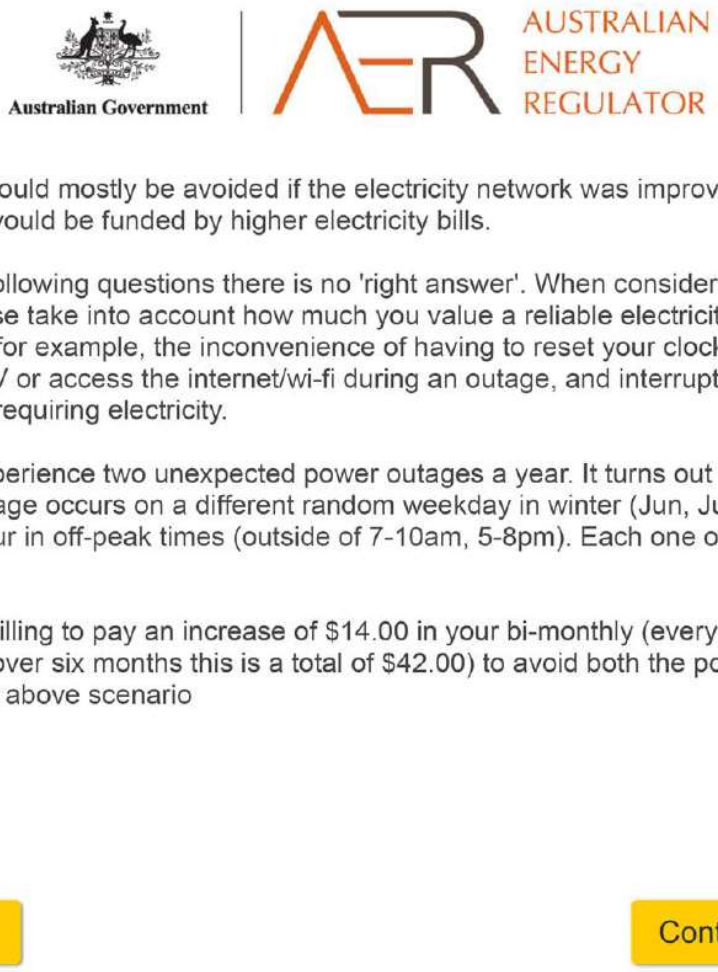
4.2.2 Are social costs already included in the standard VCRs?

MEU and EUAA's submissions argue that social costs may already be included in the standard residential VCRs, and that to account for social costs as separate and additional to the residential cost component (which is based on the standard residential VCRs) could result in double counting of social costs.

We agree this is a relevant consideration for modelling relying on standard VCRs and separate estimates for additional social costs. However, this is not a relevant consideration for models that estimate costs using techniques that do not rely on standard VCRs in quantifying costs. In the draft WALDO model, this is relevant to the estimation of residential costs, and the restart costs for business customers. However, it is not relevant to calculating the business cost component that represents lost gross value-add due to the outage. It is estimated using input-output modelling, rather than the standard business (Agriculture, Commercial, Industrial) VCRs. In most modelled scenarios, residential costs only account for a small portion of overall costs.

The residential and business VCRs are derived from survey respondents stating their reliability preferences. We agree it is possible that some respondents to the surveys may have considered costs beyond their own direct costs when stating their willingness to pay to avoid an outage. However, we consider this would be uncommon because of the way the questions are framed in the survey. Outage scenarios were localised to the respondents' street, and respondents were asked to consider 'how unexpected power outages affect you'. Figure 2 is an example of how the AER's VCR survey asked respondents to state their reliability preferences by considering how they, rather than their neighbours and the broader society, would be impacted by an outage.

Figure 2 AER VCR Survey



Source: AER VCR Review 2019

4.2.3 Should the risk of managing social costs be the sole responsibility of electricity consumers?

A number of consumer stakeholders[26] argued social cost risks should not be managed exclusively by electricity consumers by funding additional investment in the NEM to reduce the risk of WALDOs occurring.

These stakeholders argued that societal costs effect everyone, not just electricity consumers and that managing the risks of social costs should be the role of government. In its submission, PIAC noted the broad public benefits of preventing WALDOs and considered it is appropriate and fairer to socialise the cost of avoiding them through tax revenue rather than through consumers' electricity bills.

[26] Submissions from EUAA, MEU and PIAC responding to 23 March 2020 WALDO Consultation Paper.

Stakeholders also noted that the draft WALDO model was deliberately designed to not include the costs of State Emergency Services and other similar government agencies responding during an outage. They contended that where this line is currently drawn is arbitrary, social costs could be excluded altogether depending on where the line is drawn.

Other stakeholders[27] considered these costs significant, and that they should be estimated with sufficient confidence when modelling the costs of WALDOs. AEMO's submission noted research that has estimated WALDO social costs could be similar to or exceed the direct costs to energy consumers.[28] The Reliability Panel considered that social costs in Australia arising from blackouts during heatwaves could be extreme.[29]

We consider social costs—indirect or flow-on costs in addition to those incurred by electricity consumers (such as increased crime, as well as transport, communication and financial system failures, and impacts to mental and physical health)—are potential consequences of WALDOs. It follows that avoiding these types of costs are also benefits of avoiding WALDOs. As discussed in section 4.2.1, we think it is unlikely these costs are included in the standard VCR values for residential and business customers.

There may not be sufficient incentives for businesses to purchase products that manage all these types of costs. Indirect costs are by definition incurred by individuals and/or businesses (in addition to costs incurred by individual energy consumers experiencing an outage). It is unlikely rational businesses would take steps to comprehensively manage any (let alone all) indirect costs. For example:

- businesses operating financial payment networks may consider the cost of lost commission/transaction fees during an interruption to their network and manage these risks, but may not consider the additional costs incurred by third party businesses and customers relying on the payment network who are unable to engage in trade
- a public transport operator may consider the cost of lost ticket sales during an interruption to the transport network, but may not consider the additional costs to passengers stranded in a CBD for hours.

We also recognise that not all the recipients of the benefits arising from increased investment reducing the likelihood of WALDOs receive these benefits in their capacity as energy consumers. For example,

- the customer that gains utility by being able to transact using a payment network does not receive this benefit in their capacity as an energy consumer, as they do not pay for the electricity consumed to operate and maintain the financial payment network
- a person avoiding being stranded in the CBD for several hours due to a public transport failure during a WALDO does not receive this benefit in their capacity as an energy consumer, as they do not pay for the electricity consumed to transport them to their destination.

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27 Submissions from the Reliability Panel, AEMO, ENA and Ausgrid responding to 23 March 2020 WALDO Consultation Paper.

28 Submissions from AEMO responding to 23 March 2020 WALDO Consultation Paper, 7.

29 Submissions from AEMO responding to 23 March 2020 WALDO Consultation Paper, 2.

The AER is required to promote the National Electricity Objective, which is:

> "to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to: price, quality, safety and reliability and security of supply of electricity."[30]

There is a risk that including all potential indirect benefits in WALDO modelling would result in a higher level of investment (paid for by energy consumers) that is not met by a commensurate realisation of benefits to those energy consumers, as some benefits are realised by non-energy consumers.

However, there is also a risk if none of these costs are included in WALDO modelling, they will not be fully accounted for elsewhere in other investment decisions and other mechanisms for managing these risks. Alternatively, these risks may be managed via non-efficient, deterministic approaches[31] that do not consider cost benefit analyses.

The alternative solutions available to other government agencies, as well as private individuals and businesses to manage these risks arising from a WALDO occurring, may not be as cost effective as measures available to the Reliability Panel and AEMO to prevent WALDOs occurring in the first instance.

This may result in undesirable outcomes of sub-optimal levels of investment that are either:

- lower, due to risks of social costs being left unmanaged, with the greater social cost incurred from outages exceeding the cost reductions from lower levels of investment[32]
- higher, due to risks of social costs being managed via deterministic standards or other non-cost benefit analyses, with the incremental reduction in social costs being exceeded by the costs of higher levels of investment
- not cost-effective due to risks of social costs being managed via more expensive alternative measures, with the incremental reduction in social costs being exceeded by the additional costs of the alternative measures.

We agree with stakeholders there is no obvious complete set of criteria for including or excluding different types of social costs. Identifying where to draw the line to exclude certain

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30 NEL, s. 7.

31 For example, the application of deterministic standards. Deterministic standards specify how much redundancy needs to be built into a network. Standards are expressed using 'N-x' notation, where N refers to the number of elements in a part of the network and x is the number of elements that can fail at the same time without causing an interruption to power supply. For example, a network built to a strict N-1 standard will be able to supply peak load with one element not operating, even if it is the largest element in the network. See Productivity Commission Inquiry Report, *Electricity Network Regulatory Frameworks*, 2013 Appendix F.

32 Some costs may be inadvertently managed through investment if an investment prevented or reduced the risk of these excluded social costs, and would still pass a cost benefit analysis without consideration of these benefits. However, there could also be a subset of investments that would only pass a cost benefit analysis if these additional social benefits were included.

social costs will necessarily involve a degree of judgment that aims to strike a balance between the above risks. It is important for future modelling work to establish the scope of costs to be included, and for this to be accepted by stakeholders.

Wherever this line is drawn should be clear, expressed in objective criteria and transparent, and is consistent with the NEO. Any agencies that manage the risks of social costs that are ultimately decided to be excluded from modelling should be made aware that these risks are not being comprehensively managed through measures available to the Reliability Panel and AEMO.

One obvious criterion for including or excluding costs is that modelling should only include costs that arise from power outages themselves, and not the circumstances giving rise to the power outage. However, this will be difficult when considering some scenarios relevant to Australia. For example:

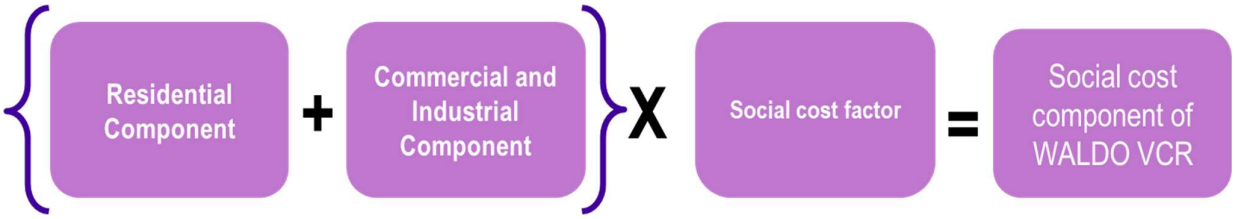
- in a heatwave scenario, social costs should include only deaths resulting from an inability to cool premises during a heatwave. This would be a subset of the total deaths during a heatwave.
- in a bushfire scenario, it is unclear whether affected customers would have been using electricity in their usual manner, and whether the unserved energy is the same as it would have been absent the fire. Towns may have been evacuated, or a portion of residential customers may have left, and businesses may be unable to trade through an inability to restock, or experience reduced trade.

4.2.4 Are social costs being quantified appropriately?

All stakeholders raised concerns with how social costs are estimated in the draft WALDO model. Most stakeholders did not support the use of the draft WALDO model unless these limitations were addressed.

Social costs are accounted for in the draft WALDO model by applying a social cost factor to the residential, and commercial and industrial cost components, as illustrated in Figure 3.

Figure 3 Estimation of Social Cost Component



The estimation of the social cost factor was based on studies of the direct and indirect costs incurred in the 1977 New York City blackout that lasted roughly 25 hours and was estimated to result in 84 GWh of unserved energy. These studies suggest social costs account for an additional 30 per cent of the direct costs electricity consumers incur because of an outage.

Stakeholders considered estimations of social costs should be based on modern Australian contexts.[33] AEMO, the Reliability Panel and ENA's submissions argued that applying the costs arising from the 1977 New York City outage would not reflect the degree of reliance modern society places on electricity, nor would they reflect Australian specific scenarios, such as outages during heatwaves.

EUAA raised an additional concern about estimating social costs. The 1977 New York study considered systemic increases in insurance premiums after a WALDO as a social cost, and these costs are included in the estimation of the social cost factor. EUAA argued increasing insurance premiums should not be included in WALDO social costs (and considered a benefit to energy consumers when WALDOs are avoided) as EUAA do not consider it likely that insurers would lower premiums to reflect an increase in reliability as a result of investment.

We acknowledge there are current limitations in the way social costs are estimated due to a lack of data relevant to modern Australian contexts. A key purpose of the consultation paper was to explain these limitations and gauge whether stakeholders were comfortable with these limitations. The lack of support among stakeholders in their submissions to the consultation paper due to these limitations is the main reason why we have decided to discontinue the WALDO model.

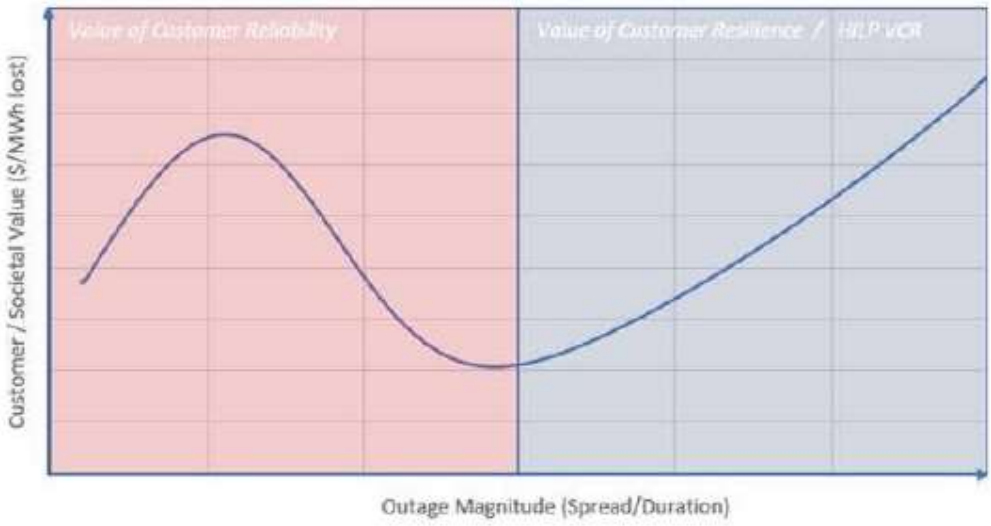
Stakeholders have expressed a desire for in-depth primary research based on previous modern Australian outages. This would require significant work that would ideally benefit from academic research.

4.3 Shape of the WALDO VCR curve

AEMO's submission raised concerns with the 'shape' of the WALDO VCR curve resulting from the draft WALDO model's approach to estimating costs. Early in the consultation process, the HILP subcommittee was presented with a conceptual framework for WALDO VCRs that posited an inflection point of increasing costs at a certain threshold of outage severity as demonstrated in Figure 4. In our 2019 VCR review, we found that for 'standard' localised outages of up to 12 hours, the VCR decreased as duration increased similar to the red panel in Figure 4. This is because respondents to the survey were generally not willing to pay three, six or twelve times more to avoid localised outages that lasted three, six or twelve times longer than a one hour outage. However, for outages of longer duration, and/or covering wider areas, the VCR could begin to increase again beyond a certain threshold as different types of costs are incurred that would not arise in the surveyed 'standard' localised outages, as demonstrated in the blue panel in Figure 4. These costs could include cascading failures of other utility and social services including transport, water, telecommunications and health impacts, and also damages incurred directly by residential and business customers.

33 Submissions from the Reliability Panel, AEMO, ENA, Ausgrid, EUAA, MEU and PIAC responding to 23 March 2020 WALDO Consultation Paper. As discussed in 4.2.3, EUAA, MEU and PIAC do not support the risks of social costs being managed exclusively by electricity consumers.

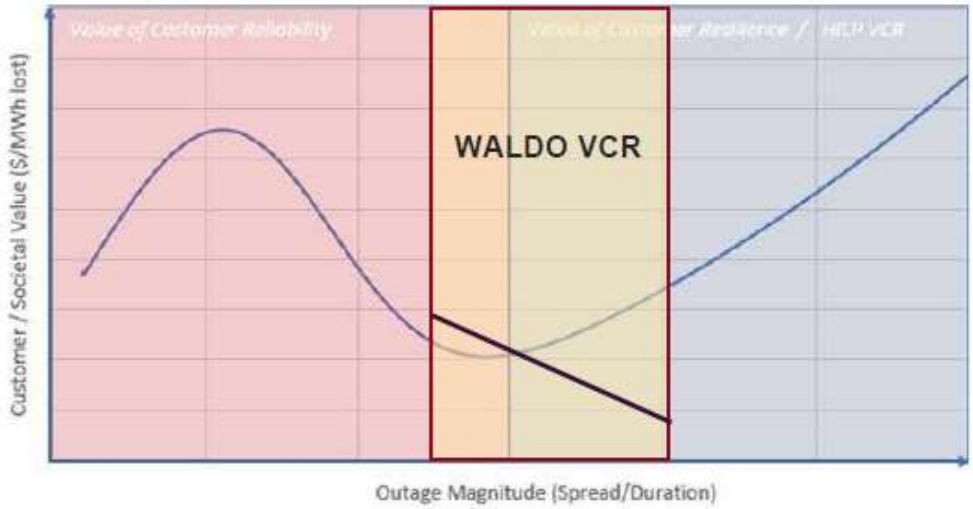
Figure 4: Theoretical Value Framework



Source: AEMO submission

However, the draft WALDO model produces a curve that will reach a peak rate beyond which it will then begin to decline towards a $/kWh 'floor' as outage magnitude increases.

Figure 5 Theoretical Value Framework (Updated)



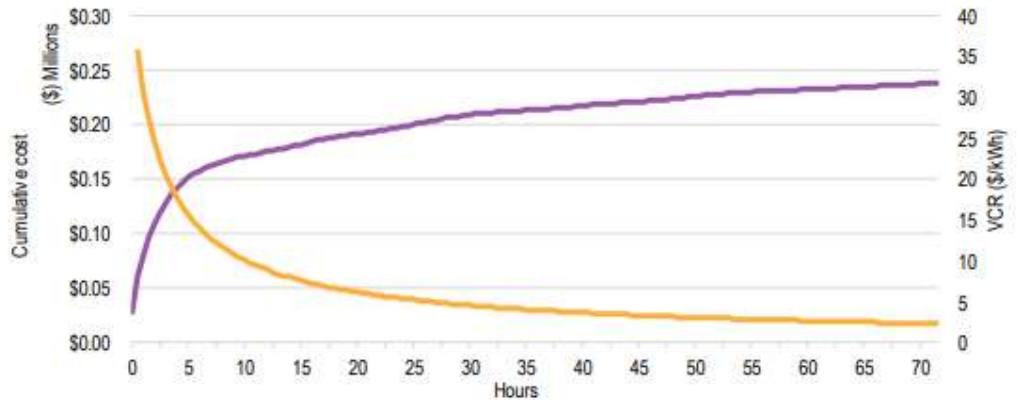
Source: AEMO submission

This $/kWh 'floor' is composed of:

- a business cost component that approaches the economy-wide $Gross Value Add/kWh. Business costs are estimated as the GVA/kWh to the economy + restart costs/kWh. The restart costs are assumed to be fixed costs (with the exception of smelters, which have a large step change in restart costs after a certain outage duration) and the restart costs/kWh will approach zero as unserved energy increases.

- a residential cost which we have assumed declines as duration increases, based on fitting a logarithmic curve to the surveyed residential WTP values from our 2019 VCR review and projecting the total costs beyond 12 hours (the purple curve in Figure 6).

Figure 6: Residential cumulative cost and VCR of outage by duration



SOURCE: ACIL ALLEN ANALYSIS

- an additional social cost, with is estimated as 30 per cent of the cost of the residential and business cost components. This social cost factor of 30 per cent does not vary with outage duration and/or the amount of unserved energy of the outage.

Due to the limited data available, it was not possible to establish with sufficient confidence detailed estimates of social costs and business restart costs that vary with outage duration and/or unserved energy. The draft WALDO model assumes that restart costs for businesses are fixed and do not vary with time (except for metal smelting). The draft WALDO model also assumes that all businesses resume trading once power is restored.

However, it is possible that industries beyond metal smelting experience time varying restart costs. It is also possible that for extremely long outage durations some businesses would not resume trading once power has been restored and may permanently close as a result of the interruption to trade and revenue.

As discussed in section 4.2.4, significant research would be required to establish a detailed understanding of how social costs and restart costs may evolve over time, and whether an inflection point exists in WALDO VCRs beyond a threshold outage severity. This would also depend on the extent to which social costs are included in WALDO modelling.

4.4 Wideness factor

Stakeholders raised concerns with how the draft WALDO model estimates the additional impact of widespread outages.[34] The draft WALDO model uses three levels of additional impact corresponding to different outage radii, which are based on the results of an Austrian survey. Stakeholders argued this aspect of the modelling needs to be based on Australian circumstances, considering population density and geography.[35] Stakeholders also considered this impact of widespread outages may vary depending on the location of outage. PIAC contended the draft WALDO model approach departs from a macro-economic approach supported by stakeholders in earlier consultation, as the quantification of the widespread factor was based on the stated reliability preferences of survey respondents.

Similar to the discussion in section 4.2.2, estimating a wideness factor is relevant to any modelling that modifies the standard VCRs that represent localised outages. If future modelling approaches estimate WALDO costs using another technique, it would not be necessary to quantify a 'wideness factor'.

In the draft WALDO model, estimating a wideness factor is also relevant for estimating residential costs but not business costs as these are not estimated using standard business VCRs. In most modelled scenarios, residential costs only account for a small proportion of the overall costs.

We agree a modelling approach that modifies standard VCRs to account for additional impacts of wide geographic spread should include Australian data. The only data we are currently aware of is the set of Willingness To Accept (WTA)[36] estimates for the Widespread/Severity coefficient in the AER 2019 VCR review (and earlier AEMO review).

Importantly, these coefficients do not consider interaction effects with other outage attributes. It could be the case that the incremental WTA for a widespread/peak period outage compared to a localised/peak period outage could be much greater than widespread/off-peak compared to localised/off peak. This could be also true for a widespread/12 hour outage compared to localised/12 hour outage. Additional respondents and observations are required to conduct choice modelling to examine interaction effects between attributes. It is unlikely this can be achieved with the same level of granularity as the current set of standard VCRs.

Significant primary research work would be required to develop the evidentiary basis and certainty for estimates sought by stakeholders in submissions.

34 Submissions from EUAA, MEU and PIAC responding to 23 March 2020 WALDO Consultation Paper.

35 Submissions from EUAA, MEU and PIAC responding to 23 March 2020 WALDO Consultation Paper.

36 The minimum amount of additional compensation required to accept a widespread outage compared to an identical localised outage.

4.5 Range of outages to be modelled

4.5.1 Extending modelling beyond 15 GWh of unserved energy

The Reliability Panel argued the upper limit should to be extended beyond 15 GWh to accommodate all scenarios of unserved energy for use in modelling for Reviews of the System Restart Standard.[37] AEMO's submission argued there was no need to limit the range of scenarios to include in modelling. ENA's submission suggested WALDOs it considered plausible could approach 100 GWh of unserved energy, although no details were provided. The previous review of the system restart standard analysed a range of possible maximum unserved energy scenarios, the largest being all of NSW and totalling 50 GWh. EUAA and MEU's submissions considered the 15 GWh upper limit to be sufficient.

In light of the feedback and examples provided by stakeholders, it would be appropriate to extend the range of unserved energy included in future WALDO modelling so that all relevant scenarios in all use cases can be included. Based on the information provided by stakeholders, a 50 GWh upper limit appears appropriate.

Any scenario that is being modelled should be plausible, evidence-based and have a non-zero probability of occurring. Scenarios with large amounts of unserved energy may have high modelled costs, but the actual benefit of avoiding these scenarios would need to consider the low probability of the scenario occurring.

We also consider that the uncertainty in the estimated costs of any modelling will increase for increasingly extreme outage scenarios. This is because there will be a small amount of real-world data relevant to modern Australia to inform these estimations due to the historical rarity of these events.

4.5.2 Including long duration outages with less than 1 GWh of USE

PIAC and ENA's submissions identified a set of scenarios of long duration (>12 hours) that would not be covered by the set of standard VCRs, but due to the small load sizes, would not reach 1 GWh of unserved energy. Examples include communities without power for multiple days due to bushfires. Another example is Bruny Island losing power due to faults with the undersea cable supplying electricity to the island. PIAC and ENA suggest removing the lower threshold of 1 GWh of USE so that the cost of these scenarios could be estimated using WALDO modelling.

We recognise the set of 12 hour standard VCRs may not fully capture all the costs associated with these scenarios. Future modelling could be broadened to cover these scenarios. However, we note that the draft WALDO model was not designed with these scenarios in mind, and some of the assumptions such as all businesses re-opening once power is restored may not hold under extended outages.

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37 In its previous Review of the System Restart Standard, the largest amount of unserved energy considered was 97 GWh, in a scenario where NSW experiences a system black with no SRAS procured, Economic assessment of System Restart Ancillary Services in the NEM, Report Prepared by Deloitte Access Economics for AEMC, 30 November 2016, 11-12.

Some of the scenarios, that would fall in the <1 GWh range, such as outages due to bushfires, would involve additional complexities to model. For example,

- it is unclear whether the unserved energy relates to expected (based on historic) demand, or another amount considering evacuation
- it is also unclear if the value of the unserved energy is different due to the circumstances giving rise to the outage. Customers in these situations may not be using electricity for their usual purposes. Businesses may not be able to trade, experience a drop in trade as towns are evacuated, or they may experience increased trade as customers stock up on essential goods.

5 Revised Statement on Methodology

This document sets out our methodology to calculate values of customer reliability (VCR) for unplanned outages for standard outages with a typical duration equal to or less than 12 hours.

From March to June 2020, we consulted on a draft model for estimating widespread and long duration outages. Although stakeholders provided in-principle support for a macro-economic approach for estimating the costs of WALDOs and deriving WALDO VCRs, they did not support the draft WALDO model in its current form, mainly due to concerns with how the draft WALDO model estimates social costs. There were also differing views among stakeholders on the extent to which social costs should be included in the draft WALDO model, and whether including these costs is consistent with the National Electricity Objective.

We have considered the issues raised in the submissions responding to the consultation paper in our Final Conclusions document[38] and have updated the VCR methodology to discontinue the WALDO methodology and modelling approach.

We believe there is merit in further work being undertaken on WALDO, and we are considering ways future primary research could be carried out via partnerships with universities or other similar academic institutions. The VCR methodology is set out in Tables 1.1 to 1.3 below. It is also published on the AER website in chapter 4 of our *Final decision on methodology for determining VCR values.* This document serves as a standalone statement of the final methodology.

Table 1.1: Methodology for standard outages

Standard outages	
Residential and business customers with a peak demand of less than 10 MVA	Stated preference surveys using combined contingent valuation and choice experiment techniques. *Contingent valuation* The contingent valuation technique asks a respondent two closed questions followed by one open-ended question about their willingness to pay (WTP) to avoid two unexpected power outages a year (the baseline scenario) affecting either the home of a residential customer or the specified place of business of a business customer. Each unexpected outage in the baseline scenario occurs on a different random weekday in winter and lasts for one hour during off-peak times. Each outage only affects the local area. The closed questions present a respondent with a bill increase of $x and ask the respondent to indicate (YES or NO) as to whether they

38 AER, *Widespread and Long Duration Outages Final Conclusions*, September 2020.

would be willing to pay the $x bill increase to fund network investment and avoid the baseline scenario.

The bill increase of $x for the first closed question is randomly selected. The second closed question is double the first cost prompt if the respondent answers YES to the first question and is half the first cost prompt if the respondent answers NO to the first question.

The initial cost prompts for residential customers are the following monthly bill increase amounts: $2, $3, $4, $5, $6, $7, $8 and $9.

The initial cost prompts for business customers are the following bill increase percentage amounts: 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9% and 10%.

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

Responses to the open-ended question are capped. For residential customers the cap is $22 per month, which is the approximate cost of a backup power system which can supply a household for the duration of the baseline scenario.[39] Where a respondent enters a value more than the cap, they will be asked a follow up question as to whether they would be willing to pay $22 per month to install the described backup power system. If the respondent answers NO, they will then be presented with an open-ended question asking them how much they would be willing to pay to install the described backup power system.

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

Choice experiment

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

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

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

39 Appendix 4 of our *Draft decision* discusses how we set the cap of $22 per month.

	• Outage duration: 1 hour, 3 hours, 6 hours and 12 hours • Geographic impact: 'localised' and 'widespread' • Time of day: Peak time and Off-peak time • Season: Summer or Winter • Day of the week: Weekday or Weekend • Bill discount (residential): no change, $3 per month, $7 per month and $15 per month • Bill discount (business), no change, 1%, 2% and 3%.
Business customers with peak demand of equal or greater than 10 MVA	*Direct cost survey* The direct cost survey asks respondents to outline and quantify the actual costs they expect to incur as a result of an unplanned outage affecting their identified business site. There are two versions of the survey - one for business sites with continuous 24/7 operations and one for business sites with non-continuous operations. For customers with continuous 24/7 operations, respondents are asked to outline and quantify the costs they would expect to incur in an unplanned outage of the following durations: 10 minutes, 1 hour, 3 hours, 6 hours, 12 hours, 24 hours and 48 hours. For customers with non-continuous operations, respondents are asked to outline and quantify the costs they would expect to incur for: • unplanned outages that start at peak times (between 7am and 10am, or 5pm and 8pm on a weekday) for the following durations: 10 minutes, 1 hour, 3 hours and 6 hours • unplanned outages that occur at off-peak times (anytime except between either 7am and 10am or 5pm and 8pm), on a weekday for the following durations: 10 minutes, 1 hour, 3 hours and 6 hours • unplanned outages that start at any time and have the following durations: 12 hours, 24 hours and 48 hours.

Table 1.2: Methodology for annual adjustment mechanism

Annual adjustment mechanism
Published values will be adjusted on an annual basis using a CPI-X approach, where X is set to zero. This ensures that in economic terms, real values of VCR are maintained between VCR reviews. Due to the lack of available information on what the key drivers of changes in customer reliability preferences are and how they affect VCR, X is set to zero. We consider these difficulties are likely to remain an impediment to calculating a non-zero X in the near future. The AER welcomes further discussions with stakeholders on how real changes in VCR could be monitored annually, prior to the next review. To measure CPI changes we will apply the annual percentage change in the Australian Bureau of Statistics' (ABS) consumer price index (CPI) all groups, weighted average of eight capital cities, for the four quarters preceding the most recently reported figure.[40] For example, to publish annual adjustments in December, we will use the reported CPI figures for the four quarters preceding September, which are the most recently reported figures available. ΔCPI_t is the annual percentage change in the ABS CPI All Groups, Weighted Average of Eight Capital Cities[41] from the September quarter in regulatory year t–2 to the September quarter in regulatory year t–1, calculated using the following method: The ABS CPI All Groups, Weighted Average of Eight Capital Cities for the September quarter in regulatory year t–1 divided by The ABS CPI All Groups, Weighted Average of Eight Capital Cities for the September quarter in regulatory year t–2 minus one. For example, for the 2021 regulatory year, t–2 is September quarter 2019 and t–1 is September quarter 2020; and for the 2022 regulatory year, t–2 is September quarter 2019 and t–1 is September quarter 2020 and so on.

40 ABS, Catalogue number 6401.0, Consumer price index, Australia. We note this measure is consistent with our approach to indexation employed elsewhere by the AER, for example to index network business' regulatory asset bases.

41 If the ABS does not or ceases to publish the index, then CPI will mean an index which the AER considers is the best available alternative index.

Table 1.3: Methodology for converting VCR survey results into dollars per kilowatt hour ($/kWh) VCR values and aggregating values

Converting survey results into dollars per kilowatt hour ($/kWh) and aggregating values	
Deriving $/kWh standard outage VCR for each residential segment	For each residential customer segment, the contingent valuation and choice experiment results are combined to produce a dollar value for a range of outage scenarios relevant for customers in that segment. To convert into $/kWh values, the dollar value are divided by an estimate of the consumption which a residential customer would have consumed over the period had the outage not occurred. This estimate is based on residential consumption data obtained from one or more of the following sources: • the residential survey • network business data, or • other available sources (actual or estimated) of residential consumption data. An aggregate $/kWh for each residential cohort is derived by summing the probability-weighted $/kWh VCR of each outage scenario. The probability for each outage scenario is based on estimates derived from historical network outage data.

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

6 Conclusions and next steps

This work has made clear that there is a desire among stakeholders for robust and accurate estimations of WALDOs, and most stakeholders have provided in-principle support for modelling to estimate the costs of WALDOs.

However, stakeholders do not support the current model mainly because of the uncertainties present in estimating the social cost component. In light of the lack of support from stakeholders we have decided to vary the VCR methodology and discontinue the WALDO modelling. In order to develop a model that meets stakeholder expectations, further extensive work would be required to address issues raised by stakeholders including:

- resolving the extent to which inclusion of indirect social costs would be consistent with the NEO; and if so
- establishing the evidentiary basis for the quantification of social costs with sufficient confidence.

We believe there is merit in further work being undertaken on WALDO, and we are considering ways future primary research could be carried out by the AER via partnerships with universities or other similar academic institutions.

7 Appendix - Summary of Submissions

Issue	Party	Summary of submissions	AER response
Using the WALDO model	AEMC Reliability Panel, AEMO, Ausgrid, Energy Networks Australia (ENA), Energy Users Association (EUAA), Major Energy Users (MEU), Public Interest Advocacy Centre (PIAC)	The Reliability Panel, AEMO, Ausgrid, ENA, EUAA and PIAC provide in-principle support of modelling to estimate the costs of WALDOs. However, all stakeholders recommend improving how the draft WALDO model estimates social costs. AEMO, PIAC, EUAA do not support the model in its current form. AEMO encourages further collaboration between the AER and other stakeholders to develop a model for WALDO VCRs PIAC recommends further work in collaboration with a university or other qualified institution to undertake further work in estimating the social costs of WALDOs. Ausgrid, ENA, The Reliability Panel, EUAA recommend a more detailed examination of the impact of social costs during a WALDO event occurring in Australia. EUAA does not support users of the model changing input parameters (such as the social cost and widespread factors) to other assumed values, because if evidence indicated other settings for these parameters, the AER would have considered them in its model. MEU does not support the model. However, if the AER were to continue with the WALDO modelling, the ACIL Allen model is a logical approach, provided that the multipliers for widespread and social costs are adjusted to 1 (i.e. effectively no additional impact from these factors). AEMO recommends as an interim measure, that the AER declare that bodies assessing WALDO cost benefit analysis should consider the evidence presented by the applicant/proponent for valuing the unserved energy other than 1x the short duration 'standard' VCRs, and not immediately revert to 1x short duration 'standard' VCRs by default. EUAA notes concerns in the status quo approach in current applications (using standard VCRs and applying estimated multipliers to account for additional costs of WALDO outages) due to the absence of a WALDO model.	We have considered the lack of support among stakeholders for the model in its current form. We have updated the VCR methodology to discontinue the WALDO modelling.

Issue	Party	Summary of submissions	AER response
Applications of WALDO VCR	AEMC Reliability Panel, AEMO, ENA, MEU	The Reliability panel supports WALDO VCRs being used in its work assessing requests for declarations of protected events and reviews of the system restart standard. AEMO and ENA support WALDO VCRs being used in RIT-T assessments in addition to the other identified applications. ENA would welcome clarification from AER that the application of WALDO VCRs in ISP/RIT-T would be consistent with ISP/RIT-T guidelines. MEU does not consider WALDO VCRs necessary. MEU considers WALDO VCRs: • would introduce additional costs to consumers and increase reliability above a level that consumers want. • place an unnecessary premium on calculated VCRs. MEU does not support WALDO VCRs being used in RIT-Ts.	The following discussion relates to WALDO VCRs generally, derived from a methodology that has been accepted by stakeholders, rather than WALDO VCRs derived from the draft WALDO model. We consider WALDO VCRs appropriate for the scenarios typically considered in requests for declarations of protected events and reviews of the system restart standard. If the scenarios included in the IASR issued by AEMO as part of the ISP process extend beyond the range of outages covered by the 'Standard' VCRs, it may be more suitable to apply WALDO VCRs to value a market benefit class for a development path in these instances.
Range of unserved energy considered in the model	AEMC Reliability Panel, AEMO, ENA, EUAA, MEU, PIAC	The Reliability Panel, AEMO and ENA consider the 15GWh upper limit may be too low. The Reliability Panel suggest the limit should be large enough to account for the amounts of unserved energy considered in its last system restart standard review. AEMO considers that there should be no upper limit. ENA recommends increasing the upper limit to better represent likely loss in each state for a significant widespread outage. ENA argues some plausible scenarios could exceed 100GWh of USE: • Far North Queensland and North Queensland being hit by a cyclone could result in 160km of transmission lines and 1100MW of load affected. • Full shutdown of NSW network. 80% of load could take 12 hours to be restored, would range from 50GWh to 80Gwh ENA and PIAC recommend removing the lower threshold of 1GWh to account for scenarios where an area of low demand is without power for longer than 12 hours. These scenarios may not reach the 1GWh USE threshold due to the small load. These could cover scenarios such as:	In light of the information provided in submissions to the consultation paper, we consider an upper limit of 50 GWh to be appropriate in WALDO modelling. Any future modelling could also include scenarios of long duration but less than 1 GWh, as this may better reflect consumer preferences than applying the standard VCRs, which do not extend beyond 12 hours. We note that some of these scenarios (such as outages due to bushfires) would present additional complexities in modelling costs attributable to the outage due to the circumstances causing the outage.

Issue	Party	Summary of submissions	AER response
		• Bruny Island being without power for over 12 hours due to undersea cable damage. • Small coastal towns being without power for long periods due to bushfires. • ENA suggests modelling the costs of these scenarios could encourage a range of innovative solutions such as investing in spare or mobile generator sets. EUAA and MEU consider the 15 GWh upper limit sufficient.	
Estimation of social costs	AEMC Reliability Panel, AEMO, Ausgrid, ENA, EUAA, MEU, PIAC	All stakeholders express concerns with studies of the 1977 New York outage being the basis for the estimation of social costs, due to the changes to society over time. AEMO consider the estimation of the social cost multiplier in the draft WALDO model has an insufficient basis, and does not capture non-linear increases in costs after exceeding certain outage durations. All submissions recommend that modelling the social costs of WALDOs needs to account for Australian circumstances, such as health-related consequences of blackouts in extreme weather conditions (e.g. heat waves), and the greater reliance modern society places on electricity. All stakeholders recommend looking at more recent outages. The Reliability Panel suggested historic outages such as: • SA system black 2016, • Alice Springs system black incident in October 2019 • Darwin/Katherine black system 2014 • Melbourne blackout Jan 2009 • Auckland power crisis 1998. However, the Reliability Panel also notes that data from actual events will be limited. Social costs should not be estimated solely based on data from an actual event, and should be augmented with analysis and judgment that is relevant to the unique circumstances of the outage scenarios to be modelled. EUAA, MEU and PIAC are not convinced energy consumers should bear the sole responsibility of managing social costs through higher electricity prices. EUAA, MEU and PIAC argue these costs should be funded outside of the mechanisms	We agree with stakeholders that it is preferable to base estimations of social costs on data relating to more recent outages occurring in Australia. We based the estimation of social costs on data from the 1977 New York outage, as there was data available that had disaggregated costs into direct and indirect costs. We recognised that this approach had limitations and lead to uncertainties in the modelling, which we discussed with stakeholders in consultation to understand if stakeholders supported such modelling despite these limitations. We have considered the lack of support among stakeholders for the model in its current form due to these limitations and discontinued the WALDO modelling. Unfortunately, there is currently no detailed, granular data from primary research relating to the direct and indirect costs of previous Australian outages. Obtaining this information would likely require significant primary research. We note the issues raised by EUAA, MEU and PIAC and agree that there is no obvious complete set of criteria for including or excluding different types of social costs. Future modelling work would benefit from establishing at the outset a sound basis for the scope of costs to be included that is accepted by stakeholders. Any agencies that manage the risks of social costs that are ultimately decided to be excluded from modelling should be made aware that these risks are not being comprehensively managed through measures available to the Reliability Panel and AEMO. We do not agree with EUAA and MEU's suggestion that social costs are included

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		in the NEL. For example, police, fire departments, hospitals are effectively paid for by consumers through taxes and levies. Other risks are best managed by the industry impacted (e.g. telecommunications and financial services, or building owners that install back-up electricity generation in the building). PIAC considers investment risk should be borne by those best placed to manage it and costs should be recovered according to a beneficiary-pays framework, such that those who benefit from a given investment should also pay for that investment, and where there are multiple beneficiaries, the costs should be recovered proportionally to their share of the benefits. As consumers will not be the sole beneficiaries of preventing WALDOs and are not best-placed to manage the risk, it is not appropriate for consumers to bear the entire investment risk and costs associated with avoiding WALDOs. EUAA also considers the distinction in treatment of costs borne by Australian Defence Force and emergency services helping out in a widespread blackout (not intended to be counted in the model) vs costs of police and emergence services personnel (counted in the model) to be arbitrary. EUAA and MEU suggests that social costs are already included in the standard VCRs which form the basis for the calculation of the residential component. Respondents would have considered the social costs in their survey responses. There is a risk that social costs are being 'double counted' by applying the 30% social cost factor. MEU notes firms carry insurances for loss of production, and are concerned that such firms could pay twice to avoid WALDOs if increased network charges (through increased investment to make the network more reliable) do not result in commensurate reduction in insurance premiums.	in the standard VCRs that underpin the estimation of the residential cost component in the WALDO modelling. We think it is unlikely that respondents considered indirect social costs when stating their WTP to avoid outages in the VCR survey. This is because the survey asked respondents to consider localised outages, and consider how outages affected them.
Estimation of wideness factor	EUAA, MEU and PIAC	EUAA, MEU and PIAC argue the wideness multiplier needs further evidentiary basis, as the Austrian study underpinning the wideness multiplier is not relevant to Australian geography. EUAA supports further work examining the interaction effects between the widespread aspect of WALDOs and the other variables (such as duration, weather, and timing). PIAC agrees with the assumption in the model that widespread outages have a	We agree with stakeholders that it is preferable to base estimations of the additional costs of outages being widespread on data relating to more recent outages occurring in Australia. We based the estimation of the additional impact of widespread outages for residential customers on data from an Austrian study as there was data available that had surveyed customers on their reliability preferences for outages that

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		greater impact than localised outages, but are concerned the quantification of the impact is arbitrary, not based on relevant data and fails to reflect the differences in population densities in what is considered 'widespread'. PIAC suggest that remote areas with low population densities may be more severely impacted by widespread outages than densely populated urban areas. PIAC is also concerned that the use of a WTP survey in the Austrian study (which underpins wideness factor in WALDO model) contradicts advice from previous VCR consultations that WTP is not an accurate methodology to quantify widespread outages because they are rarely experienced, and cannot be accurately valued by survey respondents. PIAC noted stakeholders agreed to a macro-economic approach, and it does not consider this component of the WALDO model to follow this approach, as the value of the widespread factor is based on the surveyed preferences of a sample of electricity customers. MEU is not convinced in the implicit assumption that VCR increases with duration and/or geographical extent of outage. WALDOs are rare so there is limited experience on which to base this assumption, as these occur at the transmission level, which is very reliable.	only differed by their geographic coverage. Obtaining sufficiently detailed information relating to Australian outages that would capture all the potential variation on impact among different customers would likely require significant primary research.
Publishing specific WALDO VCRs	AEMC Reliability Panel, EUAA, MEU and PIAC	The Reliability Panel, EUAA and PIAC do not support the AER publishing specific WALDO VCR estimates if they were to be used by default by policy makers. EUAA views publishing specific WALDO VCRs as too deterministic an approach that may result in the published WALDO VCRs being given more prominence than deserved given the large range of possible scenarios. The Reliability Panel suggests if the AER were to publish specific WALDO VCR estimates, these should be used as "worked examples" to be published alongside the model. PIAC recommends that the AER should instead publish clear guidelines for the application of WALDO VCRs, what they represent, and their limitations. ENA would welcome guidance from the AER in the form of a table of WALDO VCRs for intra-regional RITs.	The following discussion relates to WALDO VCRs generally, derived from a methodology that has been accepted by stakeholders, rather than WALDO VCRs derived from the draft WALDO model. We consider specific WALDO VCR estimates would be useful for demonstration purposes in documents such as an application guideline. However, such VCRs should only be used in applications if they were the most relevant VCR for the scenarios being considered.

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Estimation of business costs	AEMO, EUAA, MEU	AEMO considers restart costs and stock losses are underestimated in the model, as it assumes that restart costs are fixed costs that do not increase with outage duration (with the exception of the metal smelting sector). EUAA considers the I-O modelling and estimated $GVA/kWh should be averaged over a period of time (instead of 2016-17 data that has been escalated) to account for the fluctuations in value of energy-intensive commodities (e.g. aluminium).	AEMO and EUAA' s suggestions could be investigated in any future modelling. Businesses are highly heterogeneous consumers. Obtaining sufficiently detailed information relating to how different businesses incur restart costs, and how these costs change with outage duration would likely require significant primary research.