Widespread and Long Duration Outages - Values of Customer Reliability

Consultation Paper

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AUSTRALIAN ENERGY REGULATOR

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Amendment Record

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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
HILP	high impact low probability
GWh	gigawatt hour
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, and as a potential input in recommendations arising from the AEMC's Black System Event Review.

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. We have engaged a consultant, ACIL Allen, to research and conduct this modelling, and produce an initial MS Excel "toolkit" or "calculator" (the model) that will be available for all stakeholders to use to model outage scenarios.

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

2 National Electricity Rules, Rule 8.12.

The model estimates the total costs and VCRs for specified WALDOs by modelling residential, commercial and industrial, and social costs as a result of the outage. The residential costs are based on the survey derived standard VCRs that have been adjusted to take into account the additional costs of widespread outages. The commercial and industrial costs are estimated using input-output modelling and multipliers. The social costs are based on studies of previous outages, and are estimated as an additional percentage of the residential and commercial and industrial costs.

The model is intended to assist stakeholders by providing estimates of the costs and VCRs associated with WALDOs. There are only a few studies that have assessed the costs of WALDO events. As such, there is a limited range of information on which to estimate factors such as the social costs of WALDO events. Given these uncertainties there are a number of limitations in the model and the estimated WALDO costs and VCRs generated by the model should be treated with caution.

This Consultation Paper is the final step in our development of the methodology for deriving WALDO VCRs. It provides background information on our VCR review and previous consideration of WALDOs, explains how the model estimates costs and WALDO VCRs and provides initial results of the model for three separate outages scenarios.

We are seeking stakeholder views on a number of matters relating to the model. The Consultation Paper asks key questions about aspects of the model including:

- the scope of outages to be included the model
- the assumptions and settings present in estimating the additional costs of widespread outages
- the assumptions and settings present in estimating social costs
- the results of the modelling.

Given the limitations in the modelling, the Consultation Paper also seeks to understand if stakeholders would be comfortable using the model and applying its outputs in applications such as reviews of the System Restart Standard and declarations of protected events.

Stakeholders are invited to submit written responses on the issues and questions identified in this Consultation Paper by **5 June 2020**.

2 Stakeholder consultation process

2.1 How to make a submission

Interested parties are invited to make submissions on this Consultation Paper by **5 June 2020**. In providing responses, please explain your reasons, including supporting evidence and data where possible.

Signposting of issues relevant to particular audiences

In each section, we have set out some preliminary views, issues and questions for consideration. This may guide your submission, however we encourage you to address any other matters of relevance.

You do not need to comment on all issues in your feedback and we invite you to respond to the questions that are relevant to you and your circumstances.

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

Alternatively, submissions can be sent to:

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

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

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

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

3 Background

3.1 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 (USE). 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 formally responsible for determining VCRs and updating VCR estimates on a regular basis. The first comprehensive NEM-wide study of VCRs was conducted by the Australian Energy Market Operator (AEMO) in 2014.

In its 2014 review AEMO calculated VCR values in the NEM for residential, business and direct connect customers. Residential customers were segmented by NEM jurisdiction, business customers were segmented by sector (industrial, commercial and agricultural) and size (small, medium and large) and direct connect customers were segmented by sector (metals, wood pulp and paper, and mining).[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 are derived from an extensive survey of residential and business customers and cover localised outages that last 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-

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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.

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).

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.

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

WALDOs are more severe than standard outages. We have defined WALDOs as ranging from 1 GWh to 15 GWh of USE. These outages cover a wider geographical region than localised outages associated with the set of standard VCRs, and can have longer durations than the standard VCRs, which only cover outage durations up to 12 hours.

The WALDO VCRs have applications including roles in reviews of the System Restart Standard and assessment of protected events, and as a potential input in recommendations arising from the AEMC's Black System Event Review. 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]

3.3 Consultation on WALDO VCRs to Date

This Consultation Paper on WALDO modelling follows a series of previous consultation processes during the VCR review that have considered WALDO VCRs.

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) [8] sub-committee (the Sub-committee) sitting under the VCR Consultative Committee[9] (Committee). The Sub-committee consists of

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5 AER, *Values of Customer Reliability Review: Final Decision on Methodology*, November 2019, p.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 We note that we have shifted in terminology from HILP VCRs to widespread and long duration VCRs to reflect the revised scope of the study to events of a magnitude equal to or less than 15 GWh of USE.

9 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.

a subset of Committee members with a particular interest in or expertise in this subject area.[10]

Meetings with the Sub-committee considered whether to develop WALDO VCRs and how to achieve this.[11] The Sub-committee considered that modelling, rather than surveys, should be used to assess the impacts of outage scenarios of increasing duration and geographical spread. This is because very few customers have experienced WALDOs and would have difficulty accurately stating their preferences in a survey, and also because surveys of individual customers may not capture the flow on/indirect costs borne by the broader society. Findings of the Sub-committee were also provided to the Committee for its consideration.

There were differing views among stakeholders in submissions responding to our April 2019 VCR consultation update[12] paper regarding WALDOs. A number of stakeholders identified uses for VCRs for these outages and supported the VCR methodology including a methodology for these outages.[13] These include roles in reviews of the System Restart Standard and assessment of protected events, and as a potential input in recommendations arising from the AEMC's Black System Event Review. However, other stakeholders were not supportive, expressing concerns that such VCRs may be misused, that these outages are difficult to define, and that corresponding VCRs would be difficult to measure as they are rarely experienced by customers and are not amenable to a survey methodology.[14]

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 with a total impact ranging from 1-2 gigawatt hours (GWh) to 15 GWh of USE. Specifically, we proposed using a macroeconomic modelling methodology, supplemented by other appropriate approaches to derive a WALDO cost curve describing the impact of outages of increasing severity on VCR.[15]

We considered a macroeconomic approach preferable to survey techniques because of the need to account for costs beyond an individual affected by an outage, such as economy-wide costs, flow-on costs, or other costs borne by society. Further, survey respondents would encounter great difficulty answering questions about severe outages that have either rarely occurred or have yet to occur in the NEM.

Stakeholder submissions in response to our Draft Decision supported using a model based methodology to determine VCR values for WALDOs.[16] However, we note some HILP

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10 The HILP Subcommittee has representatives from AEMO, AEMC, the Reliability Panel, ENA and PIAC.

11 The Subcommittee first met on 14 March 2019, with subsequent meetings on 23 May 2019, 17 July 2019 and 12 February 2020.

12 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.

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

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

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

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

Subcommittee members considered the upper limit of the modelling should be higher to include more extreme events.

We consider that 15 GWh is an appropriate limit for the WALDO modelling, and can be used in applications such as declarations of protected events and reviews of the System Restart Standard. We set out our reasons in section 3.4.1, however, we welcome views and additional information from stakeholders regarding the suitability of the 15 GWh limit in the WALDO model.

In late 2019 we engaged a consultant, ACIL Allen, to conduct a study into the costs associated with WALDOs. Consistent with the methodology for deriving WALDO VCRs set out in the VCR methodology, ACIL Allen has 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 have 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 HILP Subcommittee to discuss the model and have taken into account their feedback.

We have published this draft model[17] and an accompanying report[18] by ACIL Allen (the report) alongside this Consultation Paper.

As intended users of the model, we encourage stakeholders to use this draft version and include their views in their responses to this Consultation Paper.

3.4 Purpose of this Consultation Paper

This Consultation Paper is designed to canvass stakeholder views on a number of aspects of the economic modelling in the WALDO VCR model including:

- the settings and assumptions in modelling the social costs of WALDO VCRs
- the settings and assumptions in modelling the additional costs due to outages being widespread
- the possible range in severity of the outage scenarios that could be included in the model.

This Consultation Paper also describes how the model works, how to use it to model different scenarios relevant to stakeholders, and discusses limitations present in the model.

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17 [reference to model on website - to be completed when website content is authored] There have been some minor revisions to the report since 12 February.

18 [reference to report - to be completed when website content is authored]. There have been some minor revisions to the report since 12 February.

3.5 Purpose of the model

The model has been designed to estimate the costs and the VCRs for more severe outages beyond the range of outages considered in the set of standard VCRs. If an outage scenario falls within the bounds of the set of standard VCRs, the applicable standard VCR or VCRs should be used instead of this modelling.

The model does not estimate the probability of the modelled outage scenarios occurring. We have instructed ACIL Allen to model the costs and VCRs of three outage scenarios in their accompanying report for demonstrative purposes, and to investigate the sensitivities present in the modelling. Choosing these particular scenarios for these purposes does not mean we consider these particular scenarios are likely to happen, or that they are more likely to happen than other severe outage scenarios.

The model has been designed to only estimate the costs incurred as a result of an outage. The model does not capture the costs incurred from the events that could cause WALDOs, such as the destruction to property and interruption to trade arising from severe storms, cyclones, fires and flooding.[19] The model has not been designed to capture the costs arising from government agencies such as the Australian Defence Force and emergency services deploying personnel and assets in response to extreme events to meet the needs of affected customers. This is because these services are funded outside of the mechanisms contained in the National Electricity Law framework.

3.5.1 Range of outage severity and intended uses for the model

The model has been designed primarily to estimate the costs and VCR values of outages ranging between 1 GWh and 15 GWh of USE. This covers scenarios ranging from a large regional town and its surrounding area being without power for an extended duration, to an event similar to the SA Black System event occurring on a day of higher demand and/or of longer duration. This model should not be used when considering outage scenarios that fall within the scope of the set of standard survey derived VCRs.

The WALDO modelling can be used to assist in applications, such as reviews of the System Restart Standard and declarations of protected events, that would involve cost benefit analyses to assess the economic merits of a proposed investment or action that:

- reduces the probability of WALDOs occurring and/or
- reduces the probable severity (that is, the amount of USE) of WALDOs when they occur.

The model estimates the costs arising from a particular outage scenario. However, this should be considered alongside the probability of that outage scenario occurring with and without the proposed investment or action. The benefit of the investment is the reduction in the probability of the outage occurring, or the reduction in the severity of the outage occurring, which is considered against the cost of the investment.

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19 The HILP Subcommittee discussed that a potential use case for the WALDO modelling could be evaluating the WALDO costs avoided for communities as a result of the DNSP deploying their generators to provide power to customers that had lost power due to the 2019-2020 summer bushfires. This could be done by using the WALDO model to estimate the costs of the additional USE that would have occurred if generators were not deployed to the affected communities.

The model could also be used to develop relevant WALDO VCRs for the purpose of informing decision makers required to have regard to VCR for particular applications.

We consider 15 GWh to be an appropriate limit for the WALDO modelling. We note that to date, the largest amount of USE considered in a Request for Protected Event Declaration is 7.8 GWh.[20]

The NER[21] specifies that the System Restart Standard must:

- identify the maximum amount of time within which system restart ancillary services are required to restore supply in an electrical sub-network under the assumption that supply is not available from any neighbouring electrical sub-network
- include guidelines to be followed by AEMO in determining electrical sub-networks.

The guidelines for determining the boundaries for electrical sub-networks in the NEM[22] include the following factors:

- the number and strength of transmission corridors connecting an area to the remainder of the power system
- the electrical distance (length of transmission lines) between generation centres and
- an electrical sub-network should be capable of being maintained in a satisfactory operating state to the extent practicable during the restoration process, and in a secure operating state from a stage in the restoration when it is practicable to do so, as determined by AEMO.

The WALDO modelling is intended to cover the largest events that we believe are plausible based on the boundaries for electrical sub-networks as defined by these guidelines. We do not consider it plausible for any sub-network to experience outages greater than 15 GWh. This is because we consider:

- events like the South Australia system black event, which have been estimated to have approximately 5-8 GWh of USE,[23] are considered extreme events, which are extremely unlikely to be exceeded
- for an outage to exceed 15 GWh of USE, it has to either affect a region that has greater demand than South Australia (Victoria, NSW, Queensland), or affect South Australia or a smaller region (Tasmania) for a longer duration
- the network topology of South Australia (single interconnector, highly concentrated demand in Adelaide) and supply and demand characteristics (highly variable demand

20 AEMO, *AEMO Request for Protected Event Declaration: Potential Loss of Multiple Generators in South Australia*, November 2018, pp.15-16.

21 NER 8.8.3(aa).

22 Reliability Panel, *The System Restart Standard*, p.3. Available at: https://www.aemc.gov.au/sites/default/files/content/a1041e28-7d15-4e62-8d7d-1180221b6d44/REL0057-Review-of-the-System-Restart-Standard-Final-Standard.pdf.

23 AEMO, *AEMO Request for Protected Event Declaration: Potential Loss of Multiple Generators in South Australia*, November 2018, pp.15-16 considered a range of 5,200 to 7,800 MWh.

with high concentration of dispatchable plant located in Adelaide, large proportion of wind generation, with no available local hydroelectric generation) are different to other regions such that total state-wide blackouts in the other regions are not plausible

- in other NEM regions, it is only possible for a part of a region to island and potentially go black for a short period of time. As a result the total region will not go black. For example, Queensland has groupings of generation and load, with control systems to automatically island the region into sub regions under extreme events
- Tasmania, despite being a very small region, is more robust than South Australia because of hydroelectric generation, which is very flexible and able to restore supply rapidly
- New South Wales, Victoria, Queensland have multiple interconnectors and/or large amounts of hydroelectric generation.

We welcome views and additional information from stakeholders regarding the suitability of the 15 GWh limit in the WALDO model.

We note that in recent HILP Subcommittee meetings, members have considered it useful for the model to be extended to include more extreme outage scenarios with USE greater than 15 GWh. Our consultant, ACIL Allen has advised that the model can be extended to include higher amounts of USE. However, the model assumes that a business will restart after an outage occurs, which is most likely to be the case if the outage lasts less than a week. The model outputs for outages with durations longer than a week should be treated with caution.

Accounting for High impact, low probability events in RIT-T assessments

The primary use of WALDO VCRs is not Regulatory Investment Tests for Transmission (RIT-T). However, the RIT-T guidelines provide guidance on how RIT proponents can account for HILP[24] events when applying a RIT.[25] Consistent with these guidelines, a RIT-T proponent could potentially use WALDO VCRs to capture the economic impacts of HILP events using scenario analysis, provided:

- The WALDO VCRs are based on plausible scenarios where relevant HILP events occur.
- In assessing this event, the RIT–T proponent includes the market benefit category of changes in involuntary load shedding. In valuing this change in market benefit, the RIT–T proponent should use a VCR that is appropriate for the customers that the HILP event would affect and the duration of the event. If the appropriate VCR for the HILP event is a WALDO VCR, the RIT–T proponent should have supporting evidence to clearly justify this. We would expect the RIT–T proponent to consult directly with both us and the customers to whom the WALDO VCR applies.
- The economic impact of the event is weighted by a reasonable estimate of its probability of occurring.

When exploring the economic impacts of HILP events, RIT–T proponents should:

24 The RIT-T guidelines refer to HILP events as they predate our change in terminology to WALDO.

25 AER, Final Decision: Application guidelines for the regulatory investment tests, December 2018, pp. 30-32.

- Explore the viability and effectiveness of non-network options in managing or responding to the effects of HILP events.
- Recognise the different factors influencing the impact of certain HILP events. For example, a response to HILP events is often through control schemes and operational practices rather than through building network assets. As such, RIT–T proponents should have regard to AEMO's role in determining new 'protected events' when considering the impact of HILP events.

Questions:

Are there additional factors that the AER should consider in developing the range of outages used in the WALDO modelling?

Is the 15 GWh limit sufficient for the Reliability Panel to make determinations of AEMO requests for the declaration of protected events? [26]

Is the 15 GWh limit sufficient for estimating the economic value of procuring differing levels of System Restart Ancillary Services?[27]

26 National Electricity Rules, Rules 8.8.1(a)(2c) and 8.8.4.

27 See e.g. AEMC, *Review of the System Restart Standard Final Determination*, December 2016, p.vi.

3.5.2 Limitations/caveats of the modelling

ACIL Allen has conducted an extensive literature review in developing this model.[28] However, due to the novel nature of this work, there are limited historical studies that have assessed the costs of WALDO events. As a result, the outputs from the modelling need to be treated with care as there are a number of assumptions that have been made. This is true of:

- the multiplier that is applied for social costs
- the multipliers that are applied for the wideness of the outage
- the industry recovery factors
- the industrial load profiles.

This is discussed further in section 4. We are interested in stakeholders' views on these assumptions, and any evidence or information they may have to assist in refining the settings for these parameters.

Users of the model are able to adjust these factors provided these adjustments can be justified with evidence relevant to the scenario they are modelling.

We have determined to develop an interactive model that allows stakeholders to specify the outage scenarios relevant to them, instead of modelling a number of specific scenarios. This means the model needs the flexibility to cater for a broad range of outage scenarios occurring within the NEM. To achieve this, the model uses generalised sets of industry input-output multipliers for CBD, metropolitan and regional areas based on the economic information from particular locations within Australia from different states, climate zones and remoteness categories.[29] We note that while users of the model cannot enter a set of input-output multipliers specific to a precise location in the NEM, they are able to specify the relevant business and industrial sectoral composition affected by the outage.

Presentation of WALDO modelling results

Given these assumptions, we consider the model is best placed to investigate the magnitude of estimated costs and VCRs for specified WALDO scenarios relative to less severe outages falling within the set of standard VCRs. It may also be sufficient for stakeholders to consider the estimate of the total costs of the specified WALDO, rather than an estimated WALDO VCR in terms of $/kWh.

We are also interested in stakeholder views regarding whether it will be useful for the AER to determine and publish a particular WALDO VCR (or set of WALDO VCRs) in addition to the final WALDO model, or alternatively, only publish the final WALDO model.

There are a number of reasons to consider only publishing the model and not setting a WALDO VCR (or set of WALDO VCRs):

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28 See ACIL Allen Report, p.6 and Appendix A.

29 ACIL Allen report, table 2.7 and discussion on pp.17-18.

- there are a number of uncertainties present in the model (discussed in section 4), and setting a particular $/kWh figure may be too deterministic. It may be more appropriate for stakeholders to use the model to perform sensitivity analyses for scenarios (such as varying the start time for the outage across multiple runs of the model) and consider a range of costs and WALDO VCR.
- there are many possible outage scenarios that could be modelled by stakeholders. It may therefore be impractical to anticipate and set out all potential scenarios for which it would be useful to set a WALDO VCR.
- the model is designed to be transparent and reproducible. It is possible to review how stakeholders have configured the model to derive a WALDO VCR for a particular scenario, such as timing and severity of the outage and the mix of customers.

However, it may also be useful to stakeholders if the WALDO modelling includes publishing WALDO VCRs for a small set of outages for demonstrative purposes.

Alternatives to using the model

In the absence of a model to estimate WALDO costs and VCRs, previous System Restart Standard reviews and declarations of protected events have applied standard VCRs available at the time.[30] In these applications, the economic cost of WALDOs were estimated by multiplying the estimated USE associated with the WALDO by the applicable overall state VCRs. In the case of the request for protected event declaration of potential loss of multiple generators in South Australia, an additional sensitivity of doubling the VCR was applied, as it was considered that the average VCR would underestimate the WALDO costs.[31] These approaches could be continued in the future as an alternative option if the WALDO model is not implemented.

A further alternative approach would be a study that would undertake a detailed examination of the cost impacts associated with a WALDO event with a focus on factors such as social costs. This would represent a longer term approach to the examination of WALDO and may need to be undertaken with the assistance of or led by a university. If stakeholders are supportive of this approach, we could give further consideration to undertaking such a study as part of the next VCR review.

Questions:

Should we publish VCRs for a number of WALDO scenarios in addition to publishing the final WALDO model?

30 See *Economic assessment of System Restart Ancillary Services in the NEM*, report prepared by Deloitte Access Economics for AEMC, November 2016, p.9 and AEMO, *AEMO Request for Protected Event Declaration: Potential Loss of Multiple Generators in South Australia*, November 2018, p.9.

31 AEMO, *AEMO Request for Protected Event Declaration: Potential Loss of Multiple Generators in South Australia*, November 2018, p.9.

Noting the limitations in the model, are stakeholders comfortable using the model and applying its outputs in applications such as reviews of the System Restart Standard and declarations of protected events? If not, what other steps could be taken to evaluate the costs of a WALDO related event?

4 Using the model

This section describes:

- how to configure the model for a specific scenario
- how the model estimates costs and VCRs
- how to interpret the outputs of the model.

For further details on the model, please refer to ACIL Allen's report accompanying this Consultation Paper.[32]

4.1 Configuring the model for a specific scenario

Users first specify the aspects of the scenario they intend to model. This includes the:

- timing of the outage
- location of the outage
- load impacted by the outage
- severity of the outage.

These aspects are discussed below. Chapter 2 of ACIL Allen's report[33] provides further detail on the user inputs.

4.1.1 Timing of the outage

As electricity consumption varies throughout the day, week and year, the timing of an outage will impact the amount of USE for residential and commercial customers. The timing is also relevant for selecting the applicable standard VCRs for residential and commercial customers that are one of components used in the calculation of the costs incurred during the outage.

The user specifies:

- the season (summer or winter)
- day of the week (weekday or weekend)
- outage start time (a time during the day in one hour blocks).

4.1.2 Location of the outage

Our main VCR survey found that residential reliability preferences vary with respect to climate zones and remoteness classifications. Business sector compositions also vary with location within the NEM.

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32 [Reference to ACIL Allen's preliminary report - link will be updated when website content is authored]

33 ACIL Allen report, pp.3-26.

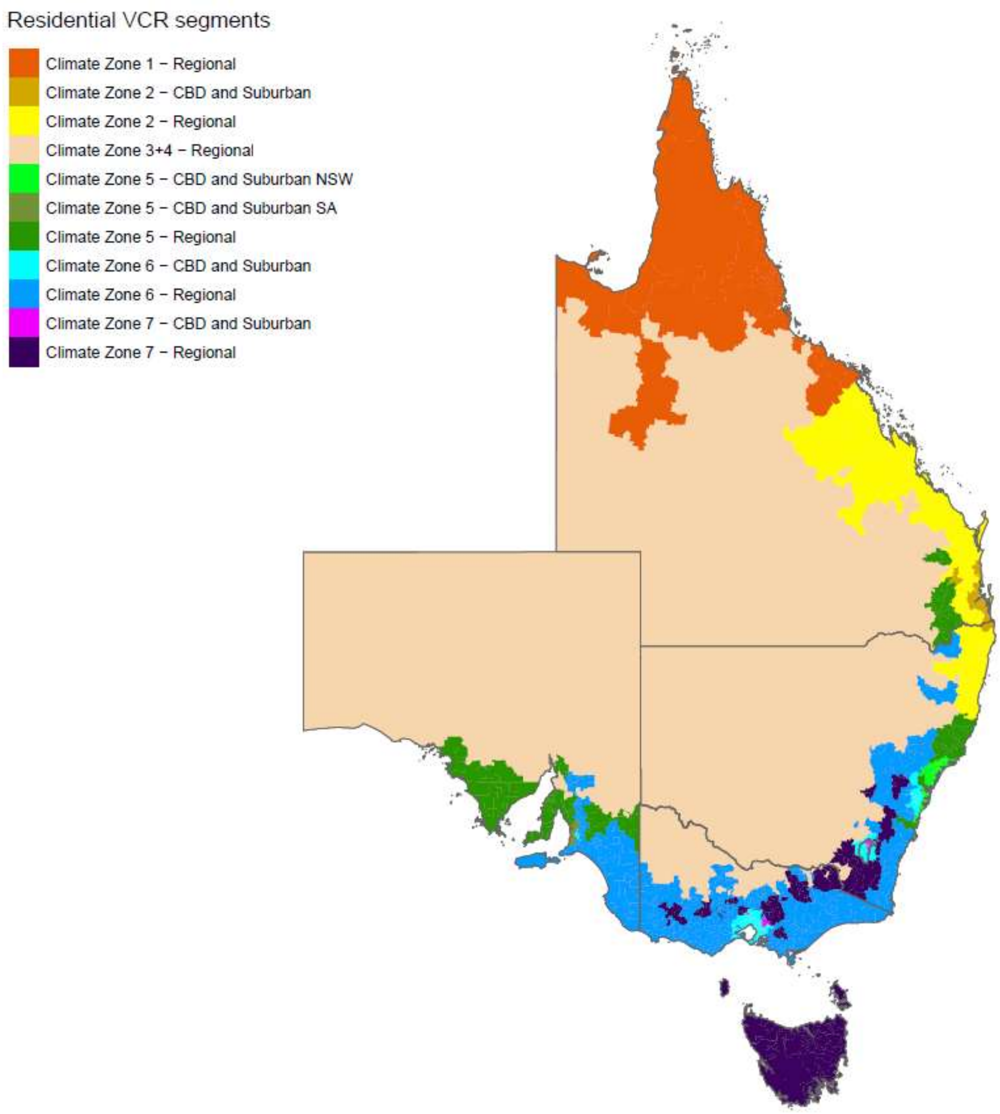
The user specifies:

- the climate zones and remoteness classifications affected by the outage
- the geographical coverage or 'width' of the outage.

When the user specifies the relevant climate zone and remoteness categories affected by the outage, the model suggests typical business load compositions. However, these load weightings can be overridden by the user if they have specific load compositions they wish to model.

Figure 1 below maps the locations of the different climate zone and remoteness combinations within the NEM.

Figure 1. Residential VCR segments



4.1.3 Load impacted by the outage

The characteristics of customers affected by an outage have an impact on the model's estimated cost and VCR of the outage. The model allows the user to specify the proportions of residential and business customers affected, with the business load then being further broken down into the different industry sectors.

The user specifies:

- residential load (in GWh per annum)
- business load (in GWh per annum)
- [suggested or user specified] business load breakdown by Australian and New Zealand Industrial Classification (ANZIC) Division
- proportion of business load consumed by small and transmission connected businesses.

4.1.4 Severity/Duration of the outage

Lastly, the user specifies the severity or duration of the outage. If the user chooses to specify the amount of USE (in GWh), the model estimates the required duration based on the other characteristics of the outage specified by the user. If the user specifies the duration of the outage, the model estimates the amount of USE associated with the outage.

4.2 Modelling the outage cost components

The model estimates the following cost components and VCRs:

- Residential
- Commercial and Industrial
- Social.

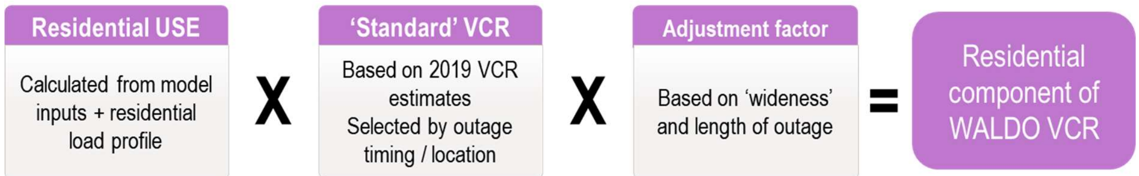
These aspects are summarised below. Chapter 2 of ACIL Allen's report[34] provides further information about the user inputs.

[34] ACIL Allen report, pp. 3-26.

4.2.1 Residential

The Residential component of the WALDO model is based on the set of standard residential VCRs. Figure 2 provides a high level overview of the Residential component. Section 2.2 of ACIL Allen's report[35] provides a detailed explanation of the Residential component.

Figure 2. Residential component of WALDO VCR



Residential USE depends on the outage characteristics specified by the user:

- annual energy consumed by the residential customers impacted by the outage
- climate zone(s)
- timing of the outage (season, day of week and time of outage)
- duration of the outage (either specified by the user, or estimated from overall USE specified by the user).

The model includes a residential load profile for each climate zone by summer and winter and by weekday and weekend. These are based on metering data collected for the AER's energy consumption bill benchmarks.[36]

The relevant standard VCR used in the modelling also depends on the above outage characteristics specified by the user.

The standard VCRs relate to localised outages that affect homes and businesses in a customer's street and surrounding streets.[37] Customers experiencing localised outages can continue to meet their energy supply needs by seeking alternatives, such as travelling to different locations unaffected by the outage, or by having goods and services delivered from a business unaffected by an outage.

WALDOs impact residential customers' abilities to access these substitutes, depending on the extent of the outage. The modelling applies an adjustment factor to take into account the additional financial and non-financial costs to residential customers incurred as a result of widespread outages limiting or preventing customers from seeking substitutes.

35 ACIL Allen report, pp. 11-14.

36 See, AER, *Electricity and gas bill benchmarks for residential customers 2017*. Available at: https://www.aer.gov.au/retail-markets/retail-guidelines-reviews/electricity-and-gas-bill-benchmarks-for-residential-customers-2017.

37 For residential customers on rural acreage properties and farms, 'localised' was defined in our survey as the customer's community.

The standard VCR is adjusted to take into account the wideness of the outage by multiplying the standard VCR by a 'wideness factor'. The wideness factor varies with the geographical spread of the outage specified by the user:

Table 1 - Wideness factor

Area impacted as specified by user	Standard VCR multiplier
Radius of impacted area <5 km	1.0 (no adjustment)
Radius of impacted area between 5 km and 85 km	1.1
Radius of impacted area >85 km	1.3

These values for the wideness factor are based on the results of previous overseas studies that found residential customers' WTP to avoid widespread outages is 26.75 to 32.7 per cent higher than for localised outages.[38]

We note that these increases in the WTP are based on the results of surveys of electricity customers from countries in the European Union. Widespread outages are defined as outages that affect either multiple contiguous provinces or the entire country. These findings may differ to the preferences of Australian customers due to factors such as population densities and sizes of regions in the NEM.

As a result, the values of the wideness factors for WALDOs occurring in the NEM have required a degree of judgment. Users of the model are able to adjust the wideness factors provided this adjustment can be justified with evidence relevant to the scenario that they are modelling.

Question:

Are there additional issues that the AER should consider in setting the wideness factor for outages occurring in the NEM?

The standard VCRs cover outages lasting up to 12 hours. However, it is possible for WALDOs to have durations longer than 12 hours depending on the amount of USE (or duration) specified by the user for a particular outage scenario. In these situations, the model uses further adjusted standard VCRs to take into account the longer duration of the outage. This is done by assuming that when the duration of an outage exceeds 12 hours, the costs incurred are the costs associated with a 12 hour outage plus the flow costs[39] for the remaining duration of the outage.[40]

4.2.2 Commercial and Industrial

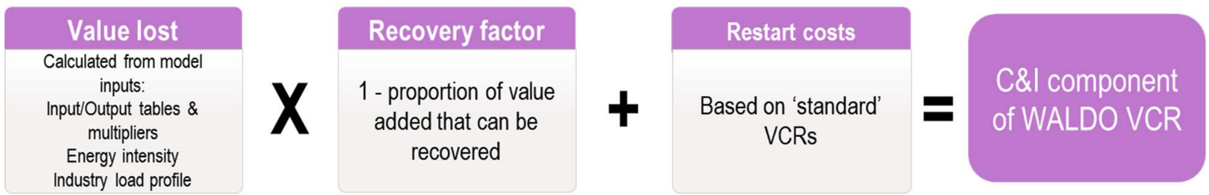
38 Please refer to section 2.1.2 and Appendix A of ACIL Allen's report for further detail, pp. 5, A-18, A-26.

39 Flow costs are the value of lost opportunities arising from a lack of power.

40 Please refer to section 2.2.3 of ACIL Allen's report, pp.13-14 for further detail.

The Commercial and Industrial component of the model uses macroeconomic techniques to estimate the wider economic impact of WALDOs. Figure 3 provides a high level overview of the Commercial and Industrial component. Section 2.3 of ACIL Allen's report[41] provides a detailed explanation of the Commercial and Industrial component.

Figure 3. Commercial and Industrial component



The model calculates the value lost by each industry sector due to the outage. The estimate is made for each industry sector by multiplying the potential economic value lost during the outage, as estimated using Input-Output (I-O) modelling, by a recovery factor for that industry sector, and adding restart costs.

Implicit in this modelling is the assumption that affected businesses resume trading once power has been restored, and the model does not account for businesses that may close as a result of an outage.

Modelling the potential economic value lost

The potential economic value lost by each industry sector as a result of a WALDO is estimated using I-O modelling based on:

- I-O tables
- I-O gross value add multipliers
- 'Energy Intensity' by industry sector
- the energy load profile for each industry sector
- outage characteristics specified by the user:
  - annual energy consumption OR economic output by industrial customers affected by the WALDO
  - timing of the outage (season, day of week and time of outage)
  - duration of the outage.

41 ACIL Allen report, pp. 14-24.

Input-Output tables

I-O models represent all inter-industry relationships or flows in an economy. For example, these models express in a system of linear equations how the output of one industry is used as an input by other industries.

The I-O tables used in this modelling are taken from the Australian National Accounts[42] that have been escalated from 2016-17 to September 2019 dollars using the Consumer Price Index. The I-O tables contain the value added by each industry and the economic output of each industry, which can be expressed as value added and given as a percentage of economic output.[43]

Input-Output multipliers

The modelling also uses I-O multipliers that express the economy-wide gross value added per unit change in the gross value-add of a specific sector. This modelling uses sets of I-O multipliers for CBD, Suburban and Regional locations calculated from I-O tables for specific locations in the NEM.[44]

Energy intensity

I-O tables are typically expressed in terms of value added as dollars per year (or other time period) and not per unit of electricity consumed. However, as the I-O tables also capture both the value of the electricity sector as an input for each industry sector, and the value of the output of each industry sector, by assuming a value for the electricity generated[45] it is possible to convert the value of the electricity sector input for each sector into an estimated annual electricity consumption.

The value added to the economy in the I-O table for each sector can then be divided by this estimated electricity consumption for that sector to estimate the 'Energy Intensity' of each industry sector, which is the amount of value added to the economy per unit of electricity.[46]

The Energy Intensity variable is important as it allows the I-O modelling and the potential economic value lost for each sector due to the outage to be scaled to the outage scenario being modelled.

As discussed in section 4.1.3, the user inputs the total annual consumption for all industry in the area affected by the outage and specifies the proportion of this load consumed by each industry in the area. The amount of USE attributable to each industry can then be calculated by considering the timing of the outage and the energy load profile for each industry. The potential economic value lost for a given sector can then be estimated by multiplying its Energy Intensity by its USE. The I-O multipliers can be used to estimate the additional

42 ABS series 5209.0.55.001, Australian National Accounts: Input-Output Tables, 2016-17, Table 8.

43 Table 2.6 ACIL Allen report, p.16.

44 Table 2.7 ACIL Allen report, p.17.

45 The modelling has assumed a value of $100/MWh.

46 Table 2.9 ACIL Allen report, p.19.

potential economic value lost in the economy due to the economic value lost in the given sector.

Energy load profile by industry

The modelling uses assumed consumption profiles for each ANSZIC division[47] to estimate the USE associated with each sector during the outage depending on the time of the day and the week specified by the user.[48]

Recovery Factor

The actual impact of an outage on the economy depends on the extent to which each industry sector's economic activity can be recovered following an outage. The modelling has assumed recovery factors for each industry sector based on:

- the characteristics of the sector, such as the ability to continue production without an electricity supply, the ability to defer production, and the time to restore production following the restoration of supply
- the extent to which the industry sector has back up generation installed.

The recovery factors for each industry sector are set at one of four levels:

- low – the sector has no back-up generation and the production that is lost during the outage largely cannot be recovered following the outage
- medium – the sector loses some but not all production through the use of back-up generation and/or recovery of some lost production following an outage
- high – either the sector has sufficient back-up generation to continue operation for the entirety of the outage and / or the production that is lost during the outage can be fully recovered following the outage
- smelted metals – if back-up generation is not installed and the outage exceeds 4 hours, the model assumes metal pots solidify and the economic impact of the outage may persist for around three months.

These values are summarised in table 2 below:

47 Appendix E ACIL Allen report.

48 Unlike residential customers, it is assumed that industrial consumption profiles do not vary with season.

Table 2. Recovery factors by industry sector

Recovery level	Industry sectors	Proportion of value that can be recovered
Low	Electricity, gas water and waste services Accommodation and food services Information, media and telecommunications Financial and insurance services Public administration and safety Arts and recreation services	0.1
Medium	Agriculture, forestry and fishing Mining Manufacturing, excluding metal smelting Construction Wholesale trade Retail trade Transport, postal and warehousing Rental, hiring and real estate services Professional, scientific and technical services Administrative and support services Health care and social assistance Other services	0.5
High	Education and training	0.9
Smelted metals (with no back-up generation) for outages longer than 4 hours		1-3 months disruption

We note that although these recovery factors aim to represent the ability of different sectors to recover from outages, there is a range of businesses within each industry sector with varying abilities to recover from outages. The ability for a business to recover may also depend on factors such as the duration of the outage. The model allows for these recovery factors to be changed if there is further information and/or if warranted by the circumstances of the outage being modelled.

Restart costs

Businesses incur costs to restart after an outage. The modelling estimates restart costs from the standard VCRs for businesses.

ACIL Allen undertook a literature review of previous studies of WALDOs.[49] It found costs associated with long duration outages are composed of three types of costs:

- fixed costs - costs that are incurred regardless of the duration of the outage
- flow costs - these costs are the value of lost opportunities arising from a lack of power
- stock costs - these costs occur after a period of time when stock starts to spoil. These costs have a 'cap' which is when all stock has spoiled. [50]

The modelling assumes**:**

- restart costs are the fixed costs component of the standard business VCRs for 1 hour durations
- the standard business VCR for 1 hour durations is composed of fixed costs and flow costs (and no stock costs)
- the flow costs can be approximated as the costs incurred for one hour based on the standard business VCR for 12 hour durations.

Our VCR review produced standard business VCRs for commercial, industrial and agricultural customers, and standard VCRs for customers directly connected to the transmission system (direct connect customers) in Services, Mines, Industrial and Metals categories, which were defined as grouped ANZSIC sectors. VCRs for non-direct connected customers were further segmented into VCRs for Small/Medium and Large businesses. The correlation between these standard VCRs used to estimate the restart cost component in the modelling and the ANSZIC sectors are set out in Table 3.

49 For more detail, refer to ACIL Allen report, p.6.

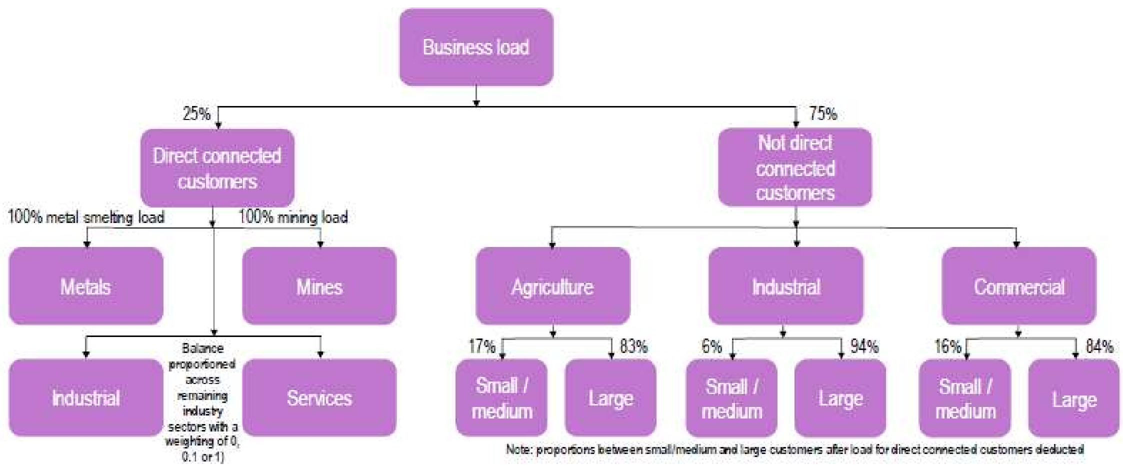
50 For more detail, refer to ACIL Allen report, Appendix A, Reference 10, p.A-8.

Table 3. Correlation between standard VCRs and industry sectors

Industry Sector	Not Direct Connected VCR	Direct Connected VCR
Agriculture, forestry and fishing	Agricultural	Services
Mining	Industrial	Mines
Manufacturing, excluding metal smelting	Industrial	Industrial
Metal smelting	Industrial	Metals
Electricity, gas, water and waste services	Commercial	Services
Construction	Commercial	Services
Wholesale trade	Commercial	Services
Retail trade	Commercial	Services
Accommodation and food services	Commercial	Services
Transport, postal and warehousing	Commercial	Services
Information, media and telecommunications	Commercial	Services
Financial and insurance services	Commercial	Services
Rental, hiring and real estate services	Commercial	Services
Professional, scientific and technical services	Commercial	Services
Administrative and support services	Commercial	Services
Public administration and safety	Commercial	Services
Education and training	Commercial	Services
Health care and social assistance	Commercial	Services
Arts and recreation services	Commercial	Services
Other services	Commercial	Services

The modelling assigns proportions of business load that are shared between direct connect and non-direct connect customers, as well as the proportion of non-direct connect load that is consumed by small/medium and large businesses within the agricultural, industrial and commercial sectors as set out in Figure 4. The overall restart costs for each ANZSIC sector are weighted averages of the restart costs estimated from the applicable direct connect/non-direct connect VCRs and the small/medium and large business VCRs, reflecting the proportion of load consumed by each of these connection types and business sizes. These load proportions can be configured by the user to reflect the circumstances of the outage scenario to be modelled.

Figure 4. Proportion of load consumed by industry sector



4.2.3 Social costs

The Social cost component aims to capture the costs resulting from a WALDO that are not captured through the Residential and Commercial and Industrial components of the WALDO VCR. Social costs include the financial cost of managing social responses to an outage (e.g. increased crime) and the financial and non-financial costs for consumers from being unable to access services. Depending on the outage scenario, examples of social costs could include:

- **Emergency and essential services –** police would need to prioritise responses as traffic congestion builds, public transport services cease, security systems fail, public lighting fails and opportunistic crime rises; hospitals will have to cancel elective surgery and procedures, and will be put under strain with an increase in traffic accidents caused by the congestion, and prison inmates may be confined to cells. Fire alarm systems may be inoperable and firefighting may be hampered in those areas where some electricity is required to pump water. Goods and services requiring a controlled environment, such as pharmaceuticals, the blood bank, and frozen samples, may be impacted. There may also be safety concerns with fallen power lines.
- **Transport –** traffic congestion would increase with traffic lights and ventilation fans in tunnels inoperable, petrol stations would close, train and tram services would cease,

potentially stranding many passengers and air travel may be limited. There may be major delays at airports, with ripple effects through the entire network.

- **Communications –** mobile phones, computers and handheld devices that are the mainstay of modern communications may run out of charge and/or be inoperable as communication towers power down when (if) back-up batteries are depleted. This would disrupt people broadly, including preventing them from contacting emergency services, and will impact on the operation of emergency services that depend on telecommunications.
- **Commercial sector –** banking operations including ATMs and EFTPOS machines will be significantly impacted; businesses and shopping centres are likely to close early without access to electricity for air conditioning or to operate emergency exits and fire alarm systems. The impact of this reaches beyond lost commerce to include loss in activity through shopping etc. Lights and lifts would fail, potentially trapping people in office or other buildings or forcing them to use stairs to exit (not an option for people with reduced mobility). Entertainment venues will close with commercial impact, but also loss of entertainment to would be patrons.
- **Households and individuals –** most households would be unable to perform their usual routines which, for some, causes increased tension and may result in increased levels of violence. The vulnerable (the very young, elderly and people with chronic or serious health conditions) will be at risk generally, but also due to lack of cooling or heating. Depending on time and duration, food may spoil and be discarded. At the extreme, there have been deaths reported during electricity outages due to lack of cooling, heating, inoperability of medical support equipment or spoilt food.[51] Residents in apartment buildings may be impacted by inoperable lifts and water pumps.
- **Animal welfare –** animals will also be at risk. Sensitive processes include incubation, milking, pumping, heating, air-conditioning and refrigeration. Impacts may be felt on farms and at veterinary hospitals and in other contexts.

The types of social costs that are incurred during a WALDO will vary depending on the remoteness of the outage. For example, the transportation impacts will be greater in urban areas than rural areas, but the animal welfare impacts will be greater in rural areas than in urban areas. Households in apartment buildings are more likely to be in urban areas, and households reliant on water for pumping are more likely to be in rural areas.

Section 2.4 of ACIL Allen's report provides a detailed explanation of the types of costs considered social costs.[52]

Social costs are accounted for in the modelling by applying a social cost factor to the Residential and Commercial and Industrial cost components, as illustrated in Figure 5.

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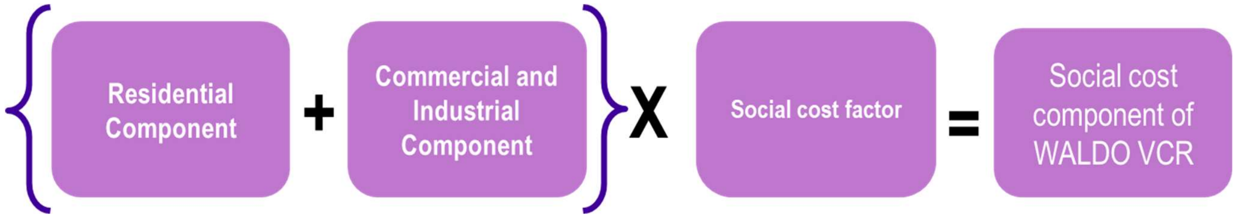
51 For example, Royal Academy of Engineering, *Counting the cost: the economic and social costs of electricity shortfalls in the UK: a report for the Council for Science and Technology*, (2014) and Office of Technology Assessment, *Physical vulnerability of electric systems to natural disasters and sabotage,* Congress of the United States, June 1990.

52 ACIL Allen report, pp. 24-26.

Figure 5. Social cost component



The value of the social cost factor is based on estimates in the existing literature of direct costs experienced by electricity customers and the indirect/flow-on costs arising from WALDOs. In reviewing the literature, ACIL Allen found it is difficult to quantify social costs as they are dependent on the specific circumstances of an outage and socio-economic conditions.

Most of the literature reviewed considered the costs resulting from the 1977 blackout in New York City that lasted for roughly 25 hours and was estimated to result in 84 GWh of USE. The direct and indirect costs resulting from that blackout are summarised below in Table 4.

As a result, setting the social cost factor for WALDOs occurring in the NEM has required a degree of judgment. Users of the model are able to adjust the social cost factor provided this adjustment can be justified with evidence relevant to the scenario they are modelling.

The model also allows users to specify separate social costs additional to those derived from the social cost factor if this is relevant to the outage scenario. Users doing so must take care to avoid including social costs that are attributable to the event that has caused the WALDO, such as severe storms, heatwaves, fires or flooding. These social costs should not be included as they are incurred independently of customers losing electricity supply during a WALDO, and if included would incorrectly inflate the estimated cost of the WALDO and the WALDO VCR.

Table 4. Costs associated with 1977 New York City Blackout

Impact areas	Direct cost ($ million)		Indirect cost ($ million)	
Business	Food spoilage	1.0	Small businesses	155.4
	Wages lost	5.0	Emergency aid (private sector)	5.0
	Securities industry	15.0		
	Banking industry	13.0		
Government (Non-public services)			Federal Assistance Programs	11.5
			New York State Assistance Program	1.0
Consolidated Edison (electricity authority)	Restoration costs	10.0	New capital equipment (program and installation)	65.0
	Overtime payments	2.0		
Insurance			Federal crime insurance	3.5
			Fire insurance	19.5
			Private property insurance	10.5
Public Health Services			Public hospitals - overtime, emergency room charges	1.5
Other public services	Metropolitan Transportation Authority (MTA) revenue:		MTA vandalism	0.2
			MTA new capital equipment required	11.0
	Losses	2.6		
	MTA overtime and unearned wages	6.5	Red Cross	0.01
			Fire Department overtime and damaged equipment	0.5
			Police Department overtime	4.4
			State Courts overtime	0.5
			Prosecution and correction	1.1
Westchester County	Food spoilage	0.25		
	Public services equipment damage, overtime payments	0.19		
Totals		**55.54**		**290.16**

Source: Congress of the United States: *Office of technology assessment, physical vulnerability of electric systems to natural disasters and sabotage*, June 1990, p.33.

This analysis finds a ratio of direct to indirect costs of approximately 1:5. This cost breakdown into direct and indirect costs is somewhat comparable to the cost components in our modelling approach. The Residential and Commercial and Industrial cost components are similar to direct costs, whereas the Social cost component is similar to indirect costs. However, there are some key differences:

- small business costs of $155.4 million would be captured by Commercial and Industrial costs
- we do not consider the same costs associated with arson, looting and vandalism would be applicable in the contemporary Australian context. Many studies attribute these phenomena to the particular socioeconomic circumstances of New York during the 1970s.[53]

Taking this into account, ACIL Allen estimates social costs to be approximately 47 per cent of direct costs (or a social cost factor of 1.47).[54] ACIL Allen has used its judgement in setting the social costs factor to 1.3. This is to reflect the variability in social costs based on the circumstances of the outage, including location and socioeconomic conditions.

HILP Subcommittee members raised concerns that estimations of social costs based on studies of the 1977 New York outage may not fully capture the increased reliance contemporary society places on electricity.

We note a review by Nous Group prepared for the then Victorian Department of Primary Industries into the 16 January 2007 Victorian outage[55] estimated that it involved 7.1 GWh of USE and $235 million in direct costs to electricity customers. However, this outage also caused significant disruptions to public infrastructure services including transport, telecommunications and healthcare. The review applied what it considered to be a conservative estimate of an additional 25% increase in costs (similar to a social cost factor of 1.25) to account for these indirect impacts.

Question:

Are there additional issues that the AER should consider in setting the social cost factor?

HILP Subcommittee members considered that there may be additional social costs specific to Australian WALDOs that would not be unaccounted for in the studies of the 1977 New York outage. This could include the effects of prolonged high ambient temperatures if a WALDO was to occur during a heatwave. An inability to cool premises during a heatwave

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53 When a widespread outage occurred in New York in 2003 there were lower social impacts because the rioting and looting that was experienced during in the 1977 outage was not repeated. See Royal Academy of Engineering, *Counting the cost: the economic and social costs of electricity shortfalls in the UK*, November 2014, p.37.

54 ACIL Allen report,p.26.

55 NOUS report prepared for the Victorian Department of Primary Industries, *16 January 2007 electricity supply interruptions in Victoria: What happened and why and Opportunities and recommendations*, executive summary accessed at https://www.energy.vic.gov.au/safety-and-emergencies/past-energy-emergencies/january-supply-interruptions-executive-summary.

could have very serious health effects for vulnerable people and place additional strain on health services.

Question:

Are there circumstances unique to Australia that need to be considered in the calculation of social costs?

If so, how should these circumstances be incorporated into the modelling?

4.3 Initial modelling results

ACIL Allen modelled the costs and VCRs for three WALDO scenarios. These scenarios are set out in Table 5 below. Please refer to sections 3.2[56] and 3.3[57] of ACIL Allen's report for a more detailed discussion of the modelling results and sensitivity analysis.

Table 5 - WALDO scenarios modelled

	Scenario 1 - Regional Victoria	Scenario 2 - Suburban Queensland	Scenario 3 - South Australia
Timing of outage			
Season	Winter	Summer	Summer
Day of Week	Weekend	Weekday	Weekday
Start time	5pm (peak)	7 am (peak)	7 am (peak)
Location			
Climate Zone/Remoteness	6/Regional Australia	2/Suburban Australia	5/CBD Adelaide 5/Suburban South Australia 5/Regional Australia
Area Impacted	Medium	Medium	Large
Residential load impacted	258 GWh pa	1,176 GWh pa	3,120 GWh pa
Business load impacted	774 GWh pa	5,881 GWh pa	9,362 GWh pa
Business composition by industry sector	As suggested by the model based on the inputs and National Accounts		
Nature of the outage	USE = 1 GWh Duration = 10.5 hours	USE = 7 GWh Duration = 5.5 hours	USE = 14 GWh Duration = 7 hours

The summary of estimated total costs and VCRs for each scenario are set out below in Table 6 and Table 7.

56 ACIL Allen report, pp. 32-34.
57 ACIL Allen report, pp. 34-40.

Table 6 - WALDO total costs ($ million) by scenario

	Scenario 1 - Regional Victoria	Scenario 2 - Suburban Queensland	Scenario 3 - South Australia
Residential	5.3	16.1	57.6
Agricultural	1.3	2.6	8.8
Industrial	9.4	92.6	194.4
Commercial	8.9	116.1	202.6
Social	5.7	63.9	111.0
Total	**30.5**	**291.3**	**574.48**

Table 7 - WALDO VCR ($/kWh) by scenario

	Scenario 1 - Regional Victoria	Scenario 2 - Suburban Queensland	Scenario 3 - South Australia
Residential	12.4	23.8	29.7
Agricultural	41.8	30.8	27.8
Industrial	35.0	39.6	48.8
Commercial	32.5	29.8	26.1
Social	5.7	9.1	8.0
Overall	**30.5**	**41.6**	**41.0**

Table 8 compares the VCR results to relevant standard VCRs derived from the main survey. Please refer to section 3.4[58] of ACIL Allen's report for a detailed comparison of the WALDO VCRs to the standard VCRs.

58 ACIL Allen report, pp. 40-41.

Table 8 - Comparison of WALDO VCR ($/kWh) by scenario

	Scenario 1 - Regional Victoria	Scenario 2 - Suburban Queensland	Scenario 3 - South Australia	Standard Aggregated[59] VCRs
Residential				
Climate zone 6 regional	12.4			21.77
Climate zone 2 CBD & suburban		23.8		22.95
Climate zone 5 CBD & Suburban SA			34.7	33.23
Climate zone 5 regional			34.7	24.57
Business				
Agricultural	41.8	30.8	30.2	37.87
Industrial	35.0	39.6	57.4	63.79
Commercial	32.5	29.8	29.3	44.52
Social	5.7	9.1	9.1	N/A
Overall	**30.5**	**41.6**	**47.3**	

Question:

Do you have comments on the estimated WALDO costs and VCRs?

59 These 'standard' VCRs are probability weighted averages of different outage scenarios (combinations of summer/winter, peak/off-peak, weekday/weekend, 1 hour, 3 hours, 6 hours and 12 hours). For more information see AER, *Values of Customer Reliability Review: Final Report*, December 2019, pp.51-52, 62-63. Available at: https://www.aer.gov.au/system/files/AER%20-%20Values%20of%20Customer%20Reliability%20Review%20-%20Final%20Report%20-%20December%202019.pdf.

5 Next Steps

Submissions to the Consultation Paper close **5 June 2020**. Our next steps will be to review submissions responding to the Consultation Paper and consider any issues raised by stakeholders. We anticipate publishing the final WALDO model and report, having regard to feedback from submissions, in June 2020.