# Approaches to electricity network resilience & consumer electricity resilience

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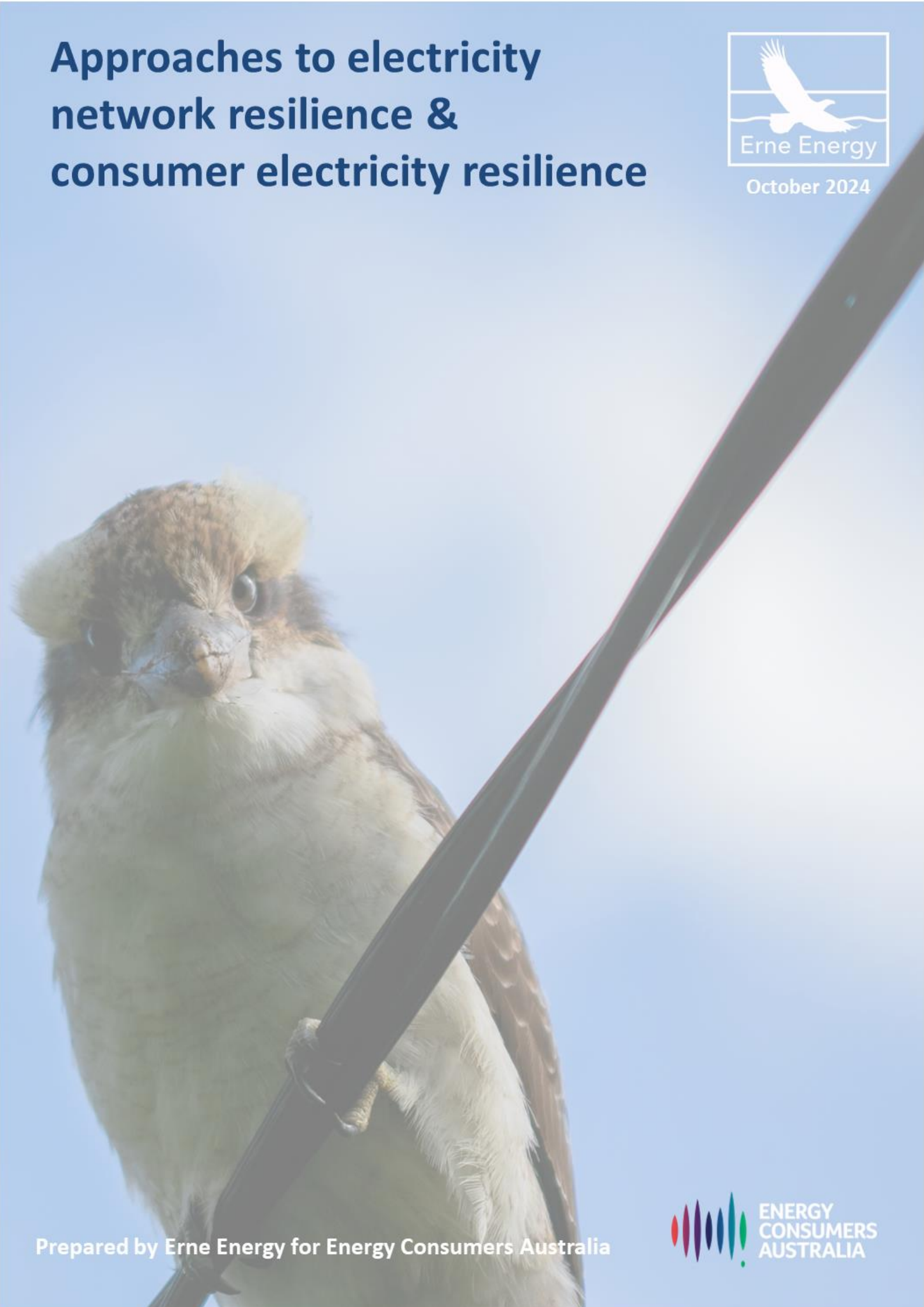

Prepared by Erne Energy for Energy Consumers Australia

ENERGY CONSUMERS AUSTRALIA

# Approaches to electricity network resilience & consumer electricity resilience

Electricity distribution networks, governments and the market bodies are exploring investment for "network resilience". While these investments may improve reliability, they will definitely increase costs for consumers without necessarily delivering a resilient electricity system. There are non-network led approaches that could provide consumers with cost-effective electricity resilience, while consumers in Victoria have expressed a preference for networks businesses to focus on responsiveness and readiness, rather than risk reduction through investment.

The aim of the project was to provide insights into community and consumer electricity resilience and the potential role (or otherwise) of Distribution Network Service Providers (DNSPs) in delivering that electricity resilience. These insights will help inform DNSP regulatory reset processes, particularly in Victoria, and any relevant market body projects and rule change processes that address network or consumer electricity resilience.

The project focuses on the ***National Electricity Market*** that encompasses the regions of Queensland, New South Wales, Australian Capital Territory, Victoria, Tasmania and South Australia.

The project recognises that damage to electricity networks because of severe weather occurs outside the National Electricity Market and that climate change and severe weather impacts all Australian electricity consumers. Consumer and community electricity resilience will be critical in both Western Australia and the Northern Territory.

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## Executive Summary

Electricity is an essential service that ensures consumers, including businesses, can meet their essential needs. The loss of electricity, even for an hour[1], impacts every aspect of everyday life for Australians, their homes and businesses.

Some electricity consumers are experiencing increasing periods without electricity[2]. This is particularly true for rural consumers, who already have poorer reliability outcomes than their urban counterparts[3]. Prolonged periods without electricity result in consumers experiencing significant distress, and poor communication and the lack of responsiveness by electricity network businesses can exacerbate that distress[4].

Climate change is altering the nature and location of severe weather events. Southern regions of Australia are now experiencing more storms that result in significant damage to electricity networks, like the damage the has been experienced in northern Australia for decades due to cyclones.

Under the National Electricity Rules the standard electricity network business approach to the costs of extreme weather events is to apply to the industry regulator for approval to fund the costs of repairs to damaged electricity network equipment through consumers electricity bills[5]. This approach means consumers pay for the costs after the event ("ex-post"). These applications have increased in frequency and size in recent years[6].

More recently electricity network businesses have been using climate modelling to try to predict where their network is at the greatest risk from severe weather. The electricity network businesses use the climate information to support a request to the regulator to approve additional capital investments for electricity network equipment "resilience" to reduce the impacts of anticipated severe weather events. If this investment is approved by the regulator, electricity consumers pay for it before any event ("ex-ante"), even if the event doesn't occur or occurs in another location.

However, while climate modelling can provide projections of some severe weather events, the models are not able to predict the location of storms with the certainty[7] needed to support electricity network business investment in risk reduction. Three-quarters of the severe weather that causes the most significant damage to electricity networks can only be predicted for a specific location on weather forecasting timescales of 5-10 days.

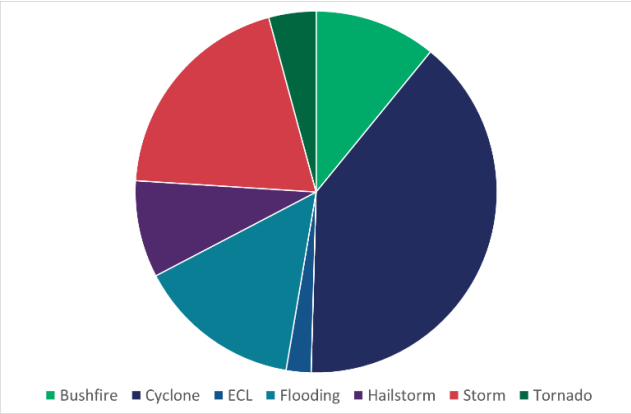


*Figure E1: Types of severe weather events in the National Electricity Market 1967-2024*[8]

[1] https://www.aer.gov.au/system/files/2024-09/Final%20Decision%20-%20Value%20of%20Network%20Resilience%202024.pdf
[2] https://www.aer.gov.au/system/files/Essential%20Energy%20-%206.02.01%20Network%20Resilience%202022%20Collaboration%20Paper%20-%202022%20-%20Public.pdf
[3] https://www.aer.gov.au/documents/aer-electricity-network-performance-report-2023-july-2023
[4] https://engage.vic.gov.au/download/document/35884
[5] https://www.aer.gov.au/industry/networks/cost-pass-throughs/cost-pass-throughs
[6] https://www.aer.gov.au/system/files/2022%20Electricity%20network%20performance%20report%20-%20July%202022.pdf
[7] https://www.climatechangeinaustralia.gov.au/en/projects/esci/learning-support/esci-key-concepts/#Uncertainty
[8] https://insurancecouncil.com.au/wp-content/uploads/2024/10/ICA-Historical-Normalised-Catastrophe-September-2024.xlsx

Because it is not possible with climate modelling to predict with confidence exactly when and where severe weather will arrive[9], there is a risk that electricity network businesses will invest in resilience solutions that will not be located in the correct place and that may never be called upon, while a different location is impacted by a prolonged outage due to severe weather.

Notably, the electricity network businesses in Queensland have established approaches to cyclones[10] that focus on supporting consumers to be ready for the cyclone season and for any prolonged loss of electricity[11]. Rather than investing in risk reduction before an event, the Queensland electricity network businesses focus on readiness and responsiveness by being in communities ahead of the forecast landfall, with spare network equipment and crews to enable rapid recovery[12]. This leads to lower investment costs being imposed on consumers, but still requires consumers to fund repair costs[13].

However, governments, the industry regulator and electricity network businesses focus on risk reduction investment to reduce the impact of a severe weather event on electricity network equipment. Industry approaches, such as the Value of Network Resilience[14] and the Victorian government rule change proposal[15] to include distribution network resilience in the National Electricity Rules[16], are likely to result in inequitable outcomes and increased costs to electricity consumers.

Electricity network businesses demonstrate a bias towards investing in network equipment, rather than spending money on operations, because the businesses earn a guaranteed regulated return on that equipment for duration of the life of that equipment, which can be decades[17].

This is true of approaches the electricity network businesses take towards resilience, with 3 of the 4 electricity network businesses that proposed investing in resilience focusing entirely (100 percent) on investment in network assets, rather than operational approaches. The fourth network business' proposal was based on capital investment of 92 percent[18].

As a result, risk reduction investment by the electricity network businesses is likely to focus on delivering complex technical assets in a specific location that may not be impacted by a severe weather event. The higher values provided by the regulator's Value of Network Resilience[19] decision will support greater investment. The Victorian government rule change proposal aims to ensure that electricity network businesses have a positive obligation to consider network resilience and proposes new criteria that explicitly support expenditure on electricity network resilience[20]. These approaches will further support the electricity network business' preference for capital investment approaches to resilience. The increased asset base will increase the regulated revenue electricity network businesses can earn and will result in higher electricity bills for consumers.

An important issue for all electricity consumers is how to balance the costs of investments in risk reduction before an event ("ex-ante") against the costs of funding repairs after an event ("ex post"). Both approaches have potentially large costs and there is a high risk that a focus on risk reduction will result in electricity consumers paying multiple times for resilience:

[9] https://www.climatechangeinaustralia.gov.au/en/projects/esci/learning-support/esci-key-concepts/#Uncertainty
[10] https://www.ergon.com.au/network/outages/storms-and-disasters/how-we-prepare-of-severe-weather-season
[11] https://www.energyq.com.au/__data/assets/pdf_file/0017/6362/Natural-Hazards-Strategy-2024-25.pdf
[12] https://www.ergon.com.au/network/news/2024/ergon-urges-communities-to-be-prepared-for-power-outages-as-cyclone-brews
[13] https://www.aer.gov.au/industry/networks/cost-pass-throughs/energex-cost-pass-through-2022-february-march-flood-event
[14] https://www.aer.gov.au/industry/registers/resources/reviews/value-network-resilience-2024
[15] https://www.aemc.gov.au/sites/default/files/2024-08/rule_change_request.pdf
[16] https://www.aemc.gov.au/sites/default/files/2024-10/consultation_paper.pdf
[17] https://www.aer.gov.au/system/files/Fact%20sheet%20-%20Indexation%20of%20the%20regulatory%20asset%20base.pdf
[18] https://www.aemc.gov.au/sites/default/files/2024-10/consultation_paper.pdf
[19] https://www.aer.gov.au/system/files/2024-09/Final%20Decision%20-%20Value%20of%20Network%20Resilience%202024.pdf
[20] https://www.aemc.gov.au/sites/default/files/2024-08/rule_change_request.pdf

1. Consumers fund routine electricity network business operation with aspects of routine reliability investments, such as routine maintenance and asset replacement, that support resilience
2. Consumers fund electricity network business investment in a (location) specific resilience solution ("ex-ante")
3. Consumers fund repairs following an event that damages electricity network equipment ("ex-post")
4. Consumers fund compensation for long outages, such as Guaranteed Service Level payments
5. Consumers invest in their own electricity resilience (regulator's "rational alternative")


*Figure E2: The mismatch on resilience approaches between consumers, industry and governments*

The focus on electricity network equipment for resilience results in a mismatch between the approach electricity network businesses and governments want to take to electricity resilience and what consumers say they need for electricity resilience.

Consumer electricity resilience is not the same as electricity network equipment resilience. While definitions for electricity resilience have been proposed[21], there is no industry-wide agreed definition of electricity network resilience. To support this project an agreed definition for consumer electricity resilience was developed and should be used underpin any industry definitions of resilience:

> *Consumer electricity resilience ensures that all consumers are ready for a loss of network electricity, and that they can quickly respond and recover from a loss of network electricity, while continuing to meet their essential needs with a supply of electricity.*

A resilient supply of electricity to a consumer during a prolonged outage is not necessarily continuous with the network or via the connection point.

New technologies, such as rooftop solar PV, batteries and electric vehicles, mean that consumers and communities can support their own electricity resilience[22], where they can afford to invest. Many of these consumer-centric solutions are not appropriate for, nor the responsibility of the electricity network business to deliver. The electricity network businesses do have a critical role in identifying consumers and communities that may be vulnerable to prolonged outages and this information should be shared to ensure that grant support from governments for consumer and community electricity resilience solutions is provided to those that need help.

[21] https://www.aer.gov.au/system/files/Network%20resilience%20-%20note%20on%20key%20issues.pdf
[22] https://assets.nationbuilder.com/boomerangalliance/pages/295/attachments/original/1657688880/TEC_Autonomous_Resilience_20220630_final_clean_sm.pdf?1657688880

Prolonged outages are typically defined as major event days and fall outside the incentive scheme that governs the performance of electricity network businesses in delivering their essential service (the Service Target Performance Incentive Scheme, STPIS). Ignoring minutes without electricity on Major Event Days means that while most electricity network businesses can demonstrate improving reliability, some consumers are experiencing worse outcomes and longer periods without electricity than the accepted reliability data allows.

Those electricity network businesses and their customers experiencing increasing minutes without electricity due to Major Event Days are typically also the networks with the oldest poles and wires suggesting that the ability of electricity network equipment to withstand severe weather is dependent on effective and cost-efficient asset maintenance and replacement strategies.

While the current regulatory framework does not explicitly support consumer electricity resilience, the proposed rule change and the Value of Network Resilience project will not deliver consumer electricity resilience. It is not clear that any risk reduction investment would cost less than repairs, particularly given the likely complexity of potential network-led resilience solutions versus standard network equipment. Rather, these approaches will embed inequity and increased costs for consumers without delivering the aspects of resilience that consumers have identified as being essential to them: responsiveness, including improved communications, and readiness[23,24].

As identified in the Victorian Network Outage Review, consumer electricity resilience can only be delivered through collaboration and is a shared responsibility[25]. There are roles and responsibilities for all levels of government, the electricity industry regulator, the electricity network businesses, communities and consumers themselves in delivering consumer electricity resilience. An assessment of the roles and responsibilities needed to ensure that the electricity network businesses and the industry regulator have a very clear understanding of the role for electricity network businesses in delivering consumer electricity resilience.

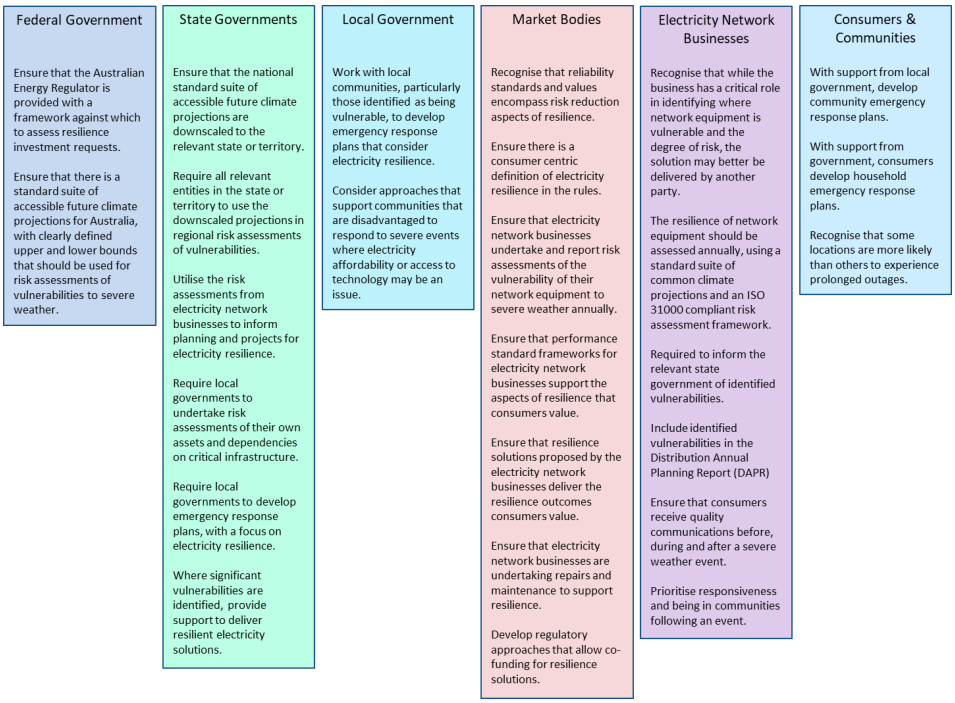


*Figure E3: Responsibilities for delivering consumer electricity resilience*

[23] https://engage.vic.gov.au/download/document/35884
[24] https://engage.powercor.com.au/90144/widgets/421911/documents/273220
[25] https://engage.vic.gov.au/download/document/35884

## Recommendations

1. Any approach to electricity resilience needs to focus on consumer outcomes and be equitable. This means that any investment in electricity resilience should:
   - Ensure consumers don't pay multiple times to resolve prolonged outages
   - Ensure that all consumers benefit from an investment in electricity resilience
   - Delivers consumer electricity resilience

2. Of the four aspects of resilience assessed, consumers are clear that responsiveness and readiness are required from electricity network businesses. There is no evidence that investing in electricity network equipment before an event is a prudent and efficient approach that will result in lower costs to consumers and improve consumer electricity resilience. To enhance responsiveness, the industry should consider whether the development of an incentive for rapid recovery, which is easy for consumers to understand, and that applies during Major Event Days would deliver beneficial electricity resilience outcomes for consumers.

3. Electricity resilience is best delivered through collaborative approaches and is not the sole responsibility of the electricity network business. Clarification of the roles and responsibilities for delivering consumer electricity resilience is required. Identifying appropriate roles and responsibilities is critically dependent on an agreed industry-wide definition for consumer electricity resilience. Without a definition for resilience that focuses on consumer outcomes, it is impossible to determine whether an investment in electricity resilience is merited or has delivered the intended resilience benefit to consumers.

4. Electricity network businesses have a preference for capital investments in network equipment. Consumer electricity resilience may be better supported by operational expenditure or solutions that are not delivered by electricity network businesses. Further work is needed to explore:
   - The balance between (ex-ante) investment in risk reduction for electricity network equipment before an event and (ex-post) recovery costs to repair damaged electricity network equipment after event, that ensures prudent and cost-efficient outcomes for consumers.
   - Whether a specific engagement framework is needed to support electricity network businesses and consumers to explore consumer electricity resilience.
   - Whether the decades of experience electricity network businesses in Queensland have in managing the impact of cyclones can be applied by southern Australian electricity network businesses to deliver the responsiveness and readiness consumers want during prolonged outages.

5. Electricity network businesses are required to undertake risk assessments, including to natural hazards, as owners and operators of Systems of National Significance. Electricity network businesses should undertake regular (annual) risk assessments of their operations. The results of any risk assessments should be shared transparently with governments and included in the Distribution Annual Planning Report. This may require a rule change request to ensure that risk and vulnerability assessments are shared publicly in a timely manner.

## Context

Climate change is impacting Australia's weather, leading to more severe weather events, like bushfires, extreme heat and flooding[26]. Cyclones are expected to be fewer in number, but more intense[27]. While it is difficult to use climate modelling to predict thunderstorms (downdrafts), hail and windstorms, the increased energy in the atmosphere as it warms will result in more intense events and potentially more frequent events[28].

The rise in severe weather events increasingly results in damage to electricity networks with prolonged outages that have significant impacts on consumers, households and communities[29]. Both the reliance on electricity to mitigate climate change and the increase in the severity of bad weather is driving a focus on the need for electricity resilience[30].

## Changes in severe weather events

*Number of events*

An analysis of the Insurance Council of Australia's record of events[31] suggests that nationally severe weather events resulting in insurance claims has decreased over the last 5 decades, however the number of claims have significantly increased in the southern states while decreasing in Queensland.

Insurance for homes and businesses is becoming increasingly costly or limited[32], with some consumers opting to forego insurance. This decrease in insurance cover, may also represent a reduction in insurance claims related to severe weather in Queensland. However, meteorological data supports the fact that cyclone numbers have reduced, while becoming more intense[33].

The Insurance Council of Australia's data only records events resulting in damage to insured assets, so doesn't record extreme heat events. However, extreme heat events can have a significant impact on the operation of the electricity network[34] and on the health of consumers, particularly if they are without electricity or can't afford the electricity to run air conditioners[35].


*Figure 1: Number of events by state, 1967-2024[36]*

[26] https://www.csiro.au/-/media/OnA/Files/SOTC22/22-00220_OA_REPORT_StateoftheClimate2022_WEB_221115.pdf
[27] https://www.abc.net.au/news/2024-10-12/australia-facing-one-of-hottest-summers-on-record-bom/104464014
[28] https://earthobservatory.nasa.gov/features/ClimateStorms
[29] https://engage.vic.gov.au/download/document/35884
[30] https://www.publish.csiro.au/rs/pdf/RS19005
[31] https://insurancecouncil.com.au/wp-content/uploads/2024/10/ICA-Historical-Normalised-Catastrophe-September-2024.xlsx
[32] https://www.unsw.edu.au/newsroom/news/2024/09/this-is-why-your-insurance-premiums-keep-going-up
[33] https://www.abc.net.au/news/2024-10-12/australia-facing-one-of-hottest-summers-on-record-bom/104464014?utm_source=abc_news_web&utm_medium=content_shared&utm_campaign=abc_news_web
[34] https://www.energysafe.vic.gov.au/sites/default/files/2022-12/ESV_Technical_Report-Australia_Day_Outages-FINAL.pdf
[35] https://onlinelibrary.wiley.com/doi/epdf/10.5694/mja12.10218
[36] https://insurancecouncil.com.au/wp-content/uploads/2024/10/ICA-Historical-Normalised-Catastrophe-September-2024.xlsx

*Cost of events*

The cost of severe weather events is increasing. It is not clear whether the increase is due to the increased intensity of storms resulting in more damage or whether the insured value is increasing or both.

The increasing cost of events may be related to the changing locations where Australians live. Australians are moving away from cities and into the regions[37], but also to the fringe of urban areas, closer to the bush[38] where consumers and communities may be more vulnerable to severe weather.

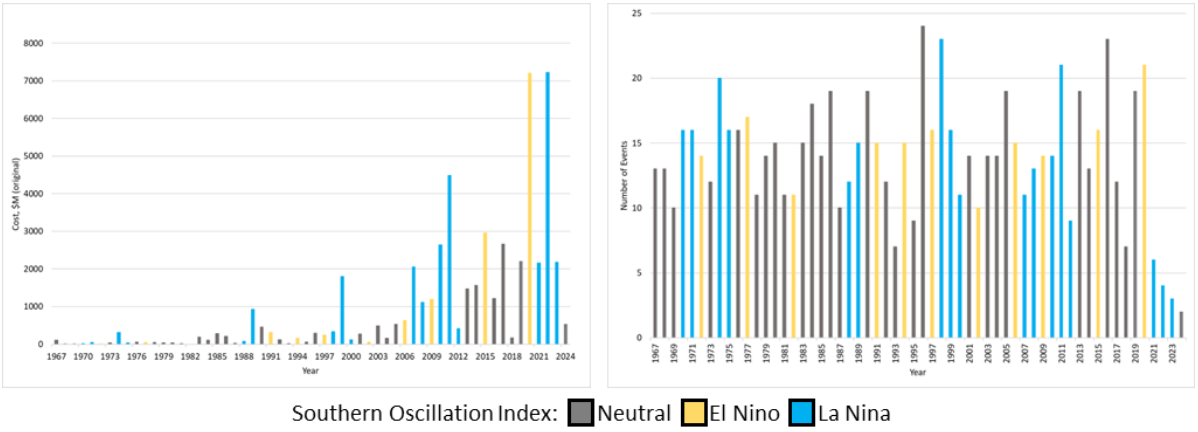


*Figure 2: The cost (left) and number (right) of severe weather events in Australia 1967-2024[39]*

The industry regulator and the Victorian government have also noted the increasing cost and frequency of repairs to electricity network equipment following severe weather events[40,41].

*Type of events*

Cyclones are Australia's most common and most expensive severe weather event, which tend to be more common during La Nina events, as is flooding[42]. Because the number of cyclones is expected to decrease with climate change, the national trend for the number of events shows a decrease. However, while numbers of cyclones are expected to decrease, the intensity of each cyclone is expected to increase with landfall potentially moving southward[43].

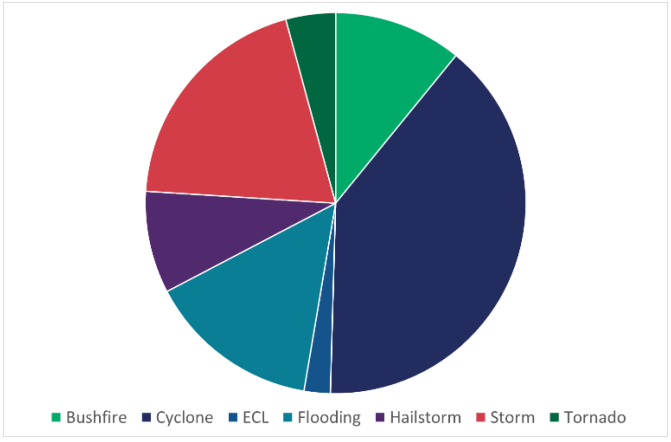


*Figure 3: Types of severe weather events in the National Electricity Market 1967-2024[44]*

[37] https://www.regionalaustralia.org.au/common/Uploaded%20files/Files/Big%20Movers%202023/Big%20Movers%202023.pdf
[38] https://www.infrastructure.gov.au/media-communications-arts/phone/mobile-services-and-coverage/peri-urban-mobile-program
[39] https://insurancecouncil.com.au/wp-content/uploads/2024/10/ICA-Historical-Normalised-Catastrophe-September-2024.xlsx
[40] https://www.aer.gov.au/system/files/2022%20Electricity%20network%20performance%20report%20-%20July%202022.pdf
[41] https://www.aemc.gov.au/sites/default/files/2024-08/rule_change_request.pdf
[42] https://insurancecouncil.com.au/wp-content/uploads/2024/10/ICA-Historical-Normalised-Catastrophe-September-2024.xlsx
[43] https://nespclimate.com.au/wp-content/uploads/2019/11/A4_4pp_brochure_NESP_ESCC_Tropical_Cyclones_FINAL_Nov11_2019_WEB.pdf
[44] https://insurancecouncil.com.au/wp-content/uploads/2024/10/ICA-Historical-Normalised-Catastrophe-September-2024.xlsx

In the National Electricity Market, cyclones represent 40% of all severe weather events. Cyclones along with storms (20%) and flooding (15%) represent nearly three-quarters of the severe weather events in the National Electricity Market (74%). Bushfires represent 15% of events. In the National Electricity Market, cyclones typically impact Queensland and occasionally New South Wales.

Electricity consumers may lose their electricity supply for several reasons including the failure of electricity generators[45], the collapse of towers in the transmission electricity network[46] or as a result of damage to the electricity distribution network equipment[47].

Ninety-six percent of prolonged electricity outages are the result of damage to the electricity distribution network, to which all consumers are directly connected[48]. This project explored only the resilience of the electricity distribution network because severe weather damage to this network equipment results in prolonged outages that impact many consumers over a wide geographic area[49].

Power system reliability vs electricity network reliability

To confuse the unwary, power system reliability is not the same as electricity network reliability. From a consumer perspective, however, the impact is the same: a loss of electricity supplied via the network.

The Australian Energy Market Operator (AEMO) is required to meet the "reliability standard"[50]. For the power system, reliability refers to the ability of electricity generation to meet the electricity demand of electricity consumers. Events where generation fails to meet demand are extremely rare. When these reliability events occur AEMO requires the electricity network businesses to "shed load" by cutting electricity to consumers to reduce demand[51].

Electricity network reliability refers to the ability of the electricity network equipment to transport electricity to consumers. The network businesses monitor the times when electricity minutes are "lost" because their network equipment is damaged. The number of lost minutes is expected to reduce over time and the network businesses are incentivised to ensure that reliability improves[52].

## Exploring consumer electricity resilience

This project focuses on consumer electricity resilience and uses the 4Rs model of resilience[53] to explore the important aspects of both reliability and resilience.

**Risk reduction**: approaches and solutions that reduce the risk of a loss of electricity

**Readiness**: taking steps to minimise the impact of a loss of electricity in the lead up to an event

**Response**: after the event, providing support to reduce the impact of a loss of electricity and making Network equipment safe

**Recovery**: ensuring equipment is repaired quickly and enabling lasting solutions to reduce the impact of future event.


*Figure 4: Resilience Circle*

[45] https://www.abc.net.au/news/2024-02-14/victoria-melbourne-power-outage-storms-how-did-it-happen/103464714
[46] https://www.abc.net.au/news/2024-10-22/generator-shut-down-broken-hill-blackout/104500400
[47] https://knowledge.aidr.org.au/resources/storm-low-pressure-system-south-east-australia-2021
[48] https://www.aemc.gov.au/media/92652
[49] https://www.energy.gov/sites/prod/files/2017/02/f34/Chapter%20IV--Ensuring%20Electricity%20System%20Reliability%2C%20Security%2C%20and%20Resilience.pdf
[50] https://www.aemc.gov.au/media/92652
[51] https://www.aemc.gov.au/energy-system/electricity/electricity-system/reliability
[52] https://www.aer.gov.au/industry/registers/resources/schemes/service-target-performance-incentive-scheme-2018-amendment
[53] https://www.civildefence.govt.nz/cdem-sector/the-4rs#:~:text=The%20New%20Zealand%20integrated%20approach,%2C%20readiness%2C%20response%20and%20recovery

## Current industry focus on electricity resilience

Governments tend to focus on recovery (98% of funding[54]), providing disaster support after severe weather events have caused serious damage[55]. This is true of the electricity industry, where the electricity network businesses apply to the regulator for funding to support recovery repairs. Some electricity network businesses have previously proposed investing in risk reduction[56], but the regulator decided that the network businesses had not demonstrated that climate change exacerbated severe weather was likely to result in network equipment damage[57].

### *Problems with predictions*

While in some states the number of severe weather events has increased because of climate change, it is not possible for electricity network businesses to accurately identify the locations where storms will cause damage that will result in prolonged electricity outages.

Climate modelling has identified that the risk of extreme heat events, flooding and bushfires will increase[58] and while locations that are vulnerable to flooding and bushfires can be identified by their proximity to rivers and forests, this does not mean that flooding and bushfires will always occur in the future with a certainty that justifies electricity network business investment in complex network resilience solutions[59].

It is not possible with climate modelling to predict with confidence exactly when and where severe weather will arrive[60] (see table 1 below for detail). As a result, there is a risk that electricity network businesses will invest in resilience solutions that will not be located in the correct place and that may never be called upon, while a different location is impacted by a prolonged outage due to severe weather.

| Confidence | Climate Hazard | Projected change | Impact |
|---|---|---|---|
| Very high | Temperature | Substantial warming | |
| | Heatwaves & extreme heat | Increased frequency of large-scale heatwaves and record high temperatures | |
| | Sea level | Sea levels will continue to rise with extreme sea level (storm surge) increasing in frequency | |
| | Bushfire weather | Longer fire seasons and more extreme fire danger (catastrophic) days. Less certainty in the east (only medium confidence) | |
| Medium | Rainfall | Cool season rainfall will decline in southern Australia, while extreme rain events will be more intense<br>Time in drought will increase with increasing frequency of severe droughts | |
| | East Coast Lows | There may be fewer east coast lows but those that do occur will be more intense | |
| | Tropical cyclones | May be less frequent, but more intense, with a southward | |
| | Extreme wind | Small decreases in wind speed may be seen | |
| Low | Thunder, lightning & hail | Severe convective storms may increase in frequency and intensity (hail, rain and lightning). | |

*Table 1: Climate model confidence (confidence decreases from the top to the bottom) and impact on electricity network equipment for severe weather events (based on [61])*

[54] https://www.aspistrategist.org.au/defending-australia-from-disasters/
[55] https://www.pc.gov.au/inquiries/completed/disaster-funding/report
[56] https://www.aemc.gov.au/sites/default/files/2024-10/consultation_paper.pdf
[57] https://www.aer.gov.au/documents/aer-final-decision-overview-ausgrid-2024-29-distribution-revenue-proposal-april-2024
[58] https://www.csiro.au/-/media/OnA/Files/SOTC22/22-00220_OA_REPORT_StateoftheClimate2022_WEB_221115.pdf
[59] https://www.aer.gov.au/documents/aer-final-decision-overview-ausgrid-2024-29-distribution-revenue-proposal-april-2024
[60] https://www.climatechangeinaustralia.gov.au/en/projects/esci/learning-support/esci-key-concepts/#Uncertainty
[61] https://www.climatechangeinaustralia.gov.au/en/projects/esci/learning-support/esci-key-concepts/#Uncertainty

Electricity network resilience solutions may also fail because the severe weather was more severe than anticipated, damaging all or part of the solution so that electricity cannot reach consumers[62,63], for instance a bushfire damaging the poles and wires in a microgrid. Sometimes the resilience solution fails to operate as intended[64].

*Queensland*

The approach of electricity network businesses in the south of Australia can be contrasted with that of the network business in Queensland, Energy Queensland. Queensland is impacted by cyclones and while these can be predicted well using traditional weather forecasting over 5 to 10 days, it is not possible to predict when and where a cyclone will make landfall over years or decades. Rather than invest in risk reduction, Energy Queensland has invested in readiness and responsiveness, ensuring that when the Bureau of Meteorology advises that a cyclone is likely, repair crews and spares are stationed in the locations that are likely to be directly impacted by the cyclone[65]. Once the cyclone has passed, the repair crews are exactly where they are needed and more likely to reach the damaged network equipment and impacted communities.

The Queensland government and the electricity network business also focus on readiness as the cyclone season approaches and when a cyclone is forecast, encouraging Queenslanders to make their own preparations, including being ready for prolonged electricity outages that could last up to 3 days[66,67]. The electricity network business prepares by ensuring they have a good stock of replacement network equipment, which can be moved, along with crew, to the likely impact areas[68].

*Rural communities*

Everyday reliability in rural locations is significantly worse that in urban areas and as a result rural consumers will have experienced more minutes without electricity. Rural power lines are also more vulnerable to severe weather, which means rural consumers also experience more prolonged outages than urban consumers[69]. Rural consumers are likely to have to have invested in their own resilience solutions, like batteries and small generators[70].

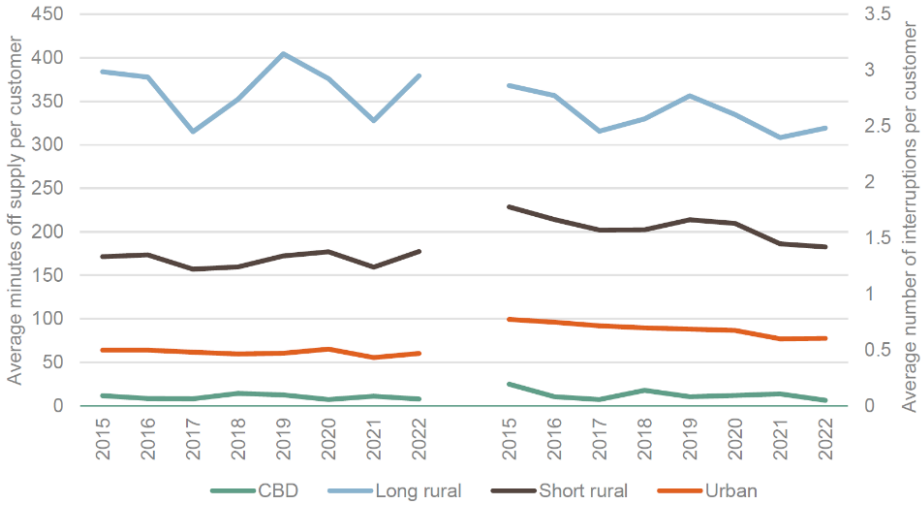


*Figure 5: Reliability experience by feeder type[71]*

[62] https://bsgip.com/wp-content/uploads/2024/05/Exploring-design-challenges-and-opportunities-for-microgrids-to-improve-resilience-in-the-Eurobodalla.pdf
[63] https://energyconsumersaustralia.com.au/wp-content/uploads/ECA-Connections-That-Matter-August-2021.pdf
[64] https://reneweconomy.com.au/broken-hill-has-a-wind-farm-a-solar-farm-and-a-big-battery-so-why-are-the-lights-out/
[65] https://www.ergon.com.au/network/news/2024/ergon-urges-communities-to-be-prepared-for-power-outages-as-cyclone-brews
[66] https://www.getready.qld.gov.au/
[67] https://www.energyq.com.au/__data/assets/pdf_file/0017/6362/Natural-Hazards-Strategy-2023-24.pdf
[68] https://www.ergon.com.au/network/outages/storms-and-disasters/how-we-prepare-of-severe-weather-season
[69] https://www.aer.gov.au/documents/aer-electricity-network-performance-report-2023-july-2023
[70] https://energyconsumersaustralia.com.au/wp-content/uploads/ECA-Connections-That-Matter-August-2021.pdf
[71] https://www.aer.gov.au/documents/aer-electricity-network-performance-report-2023-july-2023

However, not all consumers can invest in their own resilience solutions, and not all consumers feel able to operate complex solutions like small generators. Community-scale electricity resilience is also an important approach to ensure all consumers can access a resilient supply of electricity[72].

*A note on trees*

Trees are an important part of the environment and important to consumers sense of place[73]. Trees are also one of the major causes of electricity outages when a tree or a branch falls directly on a power line or tree debris lands on a power line[74]. Electricity network businesses spend a great deal of time and money on managing the vegetation close to power lines[75]. Often this is motivated by safety requirements, to reduce the risk of trees and power lines contacting and starting a fire[76], however trees are not often managed to improve resilience outcomes[77].

Undergrounding power lines is seen as a way to reduce the impact of trees[78]. However, underground lines can also be damaged and lifted by tree roots as a result of severe weather[79]. Uprooted trees represented nearly 40 percent of tree damage in Cyclone Yasi[80]. Underground lines are difficult to assess for damage and harder to repair when damage does occur.

Trees will be increasingly important in urban locations to provide cooling shade on hot days[81]. Some electricity network businesses are actively working with councils and exploring joint funding, to ensure that overhead power lines and electricity network equipment can coexist safely with trees[82].

## Key issues for consumers

Electricity consumers have been clear that the aspects of resilience that they value are responsiveness and readiness[83].

Consumers have identified that the quality of communication from electricity network businesses, before and during a prolonged loss of electricity, needs to be improved[84]. Being without electricity and the prospect of being without electricity distresses consumers as they seek to manage the loss of electricity. Constantly assessing and reassessing the options for managing the loss of electricity supply is mentally exhausting[85]. Managing the loss of electricity supply may also be physically exhausting because of the additional activities that might be required.

Communications from electricity network business need to be timely, accurate, sufficient and relevant. Too often call centres fail because they cannot scale to meet consumer demand[86], websites also fail due to demand[87], various communication channels do not show consistent information and not all potential channels are used. Once the telecommunications networks fail, access to information becomes impossible.

The physical presence of electricity network business personnel in impacted communities is highly valued during a prolonged electricity outage. In the absence of a functional telecommunications network, network personnel may be able to access the electricity network business' own

[72] https://energyconsumersaustralia.com.au/news/new-guidance-to-help-australian-communities-be-summer-resilient
[73] https://www.energysafe.vic.gov.au/sites/default/files/2022-12/Powerlines-and-vegetation-management_brochure.pdf
[74] https://www.energysafe.vic.gov.au/sites/default/files/2023-12/2023-safety-performance-report-on-victorian-electricity-networks.pdf
[75] https://assets.infrastructurevictoria.com.au/assets/Economic-assessment-of-adapting-electricity-distribution-networks-to-climate-change.pdf
[76] https://www.energysafe.vic.gov.au/sites/default/files/2023-12/2023-safety-performance-report-on-victorian-electricity-networks.pdf
[77] https://www.ofgem.gov.uk/publications/storm-arwen-report#:~:text=Storm%20Arwen%20brought%20widespread%20disruption,supply%20for%20over%20a%20week.
[78] https://assets.infrastructurevictoria.com.au/assets/Economic-assessment-of-adapting-electricity-distribution-networks-to-climate-change.pdf
[79] https://www.publish.csiro.au/rs/pdf/RS19005
[80] https://www.greeningaustralia.org.au/wp-content/uploads/2017/11/RESEARCH_Yasi_TreeReport_NewFormat.pdf
[81] https://www.cityofsydney.nsw.gov.au/-/media/corporate/files/publications/strategies-action-plans/urban-forest-strategy/urban-forest-strategy_june23.pdf?download=true
[82] https://meetings.cityofsydney.nsw.gov.au/mgDecisionDetails.aspx?IId=23584&Opt=1
[83] https://www.energy.vic.gov.au/__data/assets/pdf_file/0021/710409/interim-report-network-outage-review-2024.pdf
[84] https://www.energy.vic.gov.au/__data/assets/pdf_file/0021/710409/interim-report-network-outage-review-2024.pdf
[85] https://www.aer.gov.au/documents/23072024-draft-decision-value-network-resilience-2024
[86] https://www.energy.vic.gov.au/__data/assets/pdf_file/0021/710409/interim-report-network-outage-review-2024.pdf
[87] https://www.energy.vic.gov.au/__data/assets/pdf_file/0021/710409/interim-report-network-outage-review-2024.pdf

communications networks to keep communities and consumers updated[88,89]. Network crews also provide an essential contact to the situation beyond the community, providing information to consumers on road access and telecommunications.

Consumers also expect the electricity network businesses to rapidly identify and make safe damaged network equipment so that consumers can move around their communities, or evacuate their community if necessary[90,91]. Consumers and communities expect electricity network businesses to provide temporary solutions that provide electricity, such as generators, while repairs to the network are made.

Consumers expect electricity network businesses to focus on readiness, with early warnings of severe weather that may result in a prolonged outage to help them prepare[92], as well as information that indicates that the electricity network business is readying for any potential severe weather event.

### Delivering "consumer electricity resilience"

Consumer electricity resilience ensures that all consumers have a supply of electricity to meet their essential needs. This supply of electricity may be provided in a variety of ways and may not necessarily be continuous or be delivered via the connection point.

Consumers' essential needs[93] are described in figure 6 below and developed by this project:

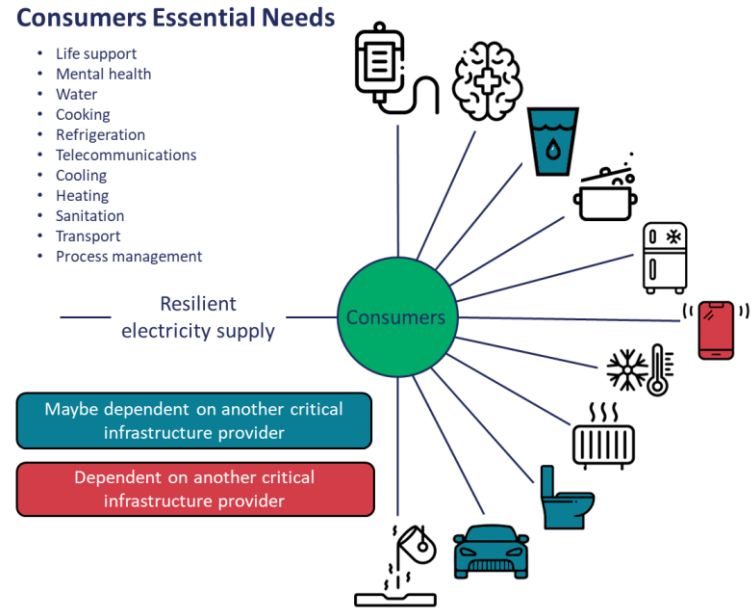


*Figure 6: Consumers' Essential Needs*

Ensuring that electricity network equipment is resilient is only one way to deliver the resilient supply of electricity that consumers need.

Consumers can have a resilient supply of electricity by investing in solutions such as islandable rooftop solar PV, with a battery, or a portable generator. However, not all consumers can invest in "rational alternatives" or may not want the responsibility of operating a portable generator. In this case, either

[88] https://www.energy.vic.gov.au/__data/assets/pdf_file/0021/710409/interim-report-network-outage-review-2024.pdf
[89] https://energyconsumersaustralia.com.au/wp-content/uploads/ECA-Connections-That-Matter-August-2021.pdf
[90] https://www.energy.vic.gov.au/__data/assets/pdf_file/0021/710409/interim-report-network-outage-review-2024.pdf
[91] https://energyconsumersaustralia.com.au/wp-content/uploads/ECA-Connections-That-Matter-August-2021.pdf
[92] https://www.theenergycharter.com.au/community-energy-resilience/
[93] https://www.sciencedirect.com/science/article/pii/S0301421516300453/pdfft?md5=f20a56a118597410e5dab205bf32586c&pid=1-s2.0-S0301421516300453-main.pdf

community-based solutions and/or grant support for consumer- and community-focused solutions are needed[94,95].

Many of these consumer-centric solutions are not the responsibility of the electricity network business to deliver. The electricity network businesses do have a critical role in identifying consumers and communities that may be vulnerable to prolonged outages and this information should be shared to ensure that grant support from governments for consumer and community electricity resilience solutions is provided to those that need help.

## The regulatory framework

The electricity network businesses operate under the National Electricity Rules[96] that are maintained by the Australian Energy Market Commission (AEMC). The Australian Energy Regulator (AER) ensures that the electricity network businesses comply with the rules, developing and maintaining the guidelines that support the electricity network businesses to comply with the rules. This includes incentive schemes, such as those that encourage electricity network businesses to improve reliability.

The current rules and schemes do not cover resilience. There is no definition for resilience, although the regulator has provided a note to help guide electricity network businesses in applying for expenditure to support resilience[97].

*No definition of "resilience"*

There is currently no definition of "resilience" in the national electricity rules, under which all electricity network businesses operate. The recent rule change proposal from the Victorian government[98] seeks create a framework for investment in resilience that will apply to both the electricity network businesses and the regulator. It is a key feature of the Victorian government rule change proposal that there is no specific definition of resilience. While the rule change proposal acknowledges that ongoing disagreement is likely on what constitutes "resilience", it still embeds a need for investment in "resilience" before an event occurs to reduce the risk of prolonged outages[99].

There are likely to be detrimental outcomes for consumers if electricity network businesses invest in "resilience" without any definition. It will be difficult for consumers and the regulator to identify if any investment is merited or has been a success without a definition for resilience to assess performance.

If resilience is to be incentivised or supported by the rules, then a clear definition of resilience is essential, with focus on electricity resilience as it applies to consumers, rather than network equipment.

The definitions developed in this project for consumer electricity resilience are:

> *Consumer electricity resilience ensures that all consumers have a supply of electricity to meet their essential needs*
>
> *Consumer electricity resilience ensures that all consumers are ready for a loss of network electricity, and that they can quickly respond and recover from a loss of network electricity, while continuing to meet their essential needs with a supply of electricity.*

[94] https://www.energy.vic.gov.au/about-energy/safety/community-hubs-energy-backup-systems
[95] https://www.sustainability.vic.gov.au/our-work/community-power-hubs-program
[96] https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules
[97] https://www.aer.gov.au/documents/aer-note-key-issues-network-resilience-april-2022
[98] https://www.aemc.gov.au/rule-changes/including-distribution-network-resilience-national-electricity-rules
[99] https://www.aemc.gov.au/sites/default/files/2024-08/rule_change_request.pdf

Note: a resilient supply of electricity is not necessarily continuous with the electricity network or via the connection point.

*The difference between reliability and resilience*

Electricity network reliability and resilience are not the same, although some aspects are the same.

The regulator does not have a specific definition of electricity network reliability, instead focusing on the definition of an "interruption" and guidelines to measure reliability[100]. Even in the absence of a definition for reliability, the ability of an electricity network business to reliably deliver electricity to consumers is monitored through service standards[101].

The Victorian Essential Services Commission defines reliability as:

"*reliability of supply* means the measure of the ability of the *distribution system* to provide *supply* to *customers*."[102]

Others define reliability as the ability of the electricity network equipment to consistently and continuously support the delivery of electricity to consumers[103]. Reliability is binary, the electricity network is either reliable (operational) or it is not.

Resilience is the ability of electricity network equipment to recover from a reliability event that has prevented the successful delivery of electricity to consumers[104,105]. The ability of the electricity network to recover rapidly from a reliability event is underpinned by the four aspects of resilience: risk reduction, readiness, response and recovery.

It is important to note that all the definitions of reliability and resilience focus on electricity network equipment, rather than the outcomes for consumers.

| | ***Reliability*** | ***Resilience*** |
|---|---|---|
| Events considered | High Probability, low consequence hazards | Low Probability, high consequence hazards |
| Risk Based | No | Yes |
| Binary or Continuous | Operationally the system is reliable or not, confidence is unspecified | Resilience is considered a continuum, confidence is specified |
| Measurement focus | Focus on measuring the impact to the system | Focus is on measuring impact to customers |

*Table 2: Comparison of the approaches to Reliability and Resilience[106]*

While conceptually reliability and resilience are different, in the rules and frameworks, reliability shares the same aspects as resilience. When designing for a reliable electricity network, electricity network businesses are addressing the four aspects of resilience: risk reduction, readiness, response and recovery.

Before resilience was introduced as a specific area for investment by electricity network businesses[107], the businesses were managing the risks to electricity network equipment posed by severe weather under reliability investments[108].

[100] https://www.aer.gov.au/system/files/AER%20-%20Distribution%20reliability%20measures%20guideline%20-%20August%202022.pdf
[101] https://www.aer.gov.au/system/files/AER%20-%20Service%20Target%20Performance%20Incentive%20Scheme%20v%202.0%20-%2014%20November%202018%20%28updated%2013%20December%202018%29.pdf
[102] https://www.esc.vic.gov.au/sites/default/files/documents/COD%20-%20Electricity%20Distribution%20Code%20of%20Practice%20%28version%202%20-%20updated%29%20-%2020230428.pdf
[103] https://engage.powercor.com.au/reliability-and-resilience-citipower#:~:text=Reliability%20refers%20to%20the%20ability,heating%2C%20or%20running%20your%20devices.
[104] https://www.researchgate.net/profile/Aaron-Clark-Ginsberg/publication/320456274_What's_the_Difference_between_Reliability_and_Resilience/links/59e651230f7e9b13aca3c2ba/Whats-the-Difference-between-Reliability-and-Resilience.pdf
[105] https://www.aer.gov.au/documents/aer-note-key-issues-network-resilience-april-2022
[106] https://www.osti.gov/biblio/1367499
[107] https://www.aer.gov.au/system/files/Essential%20Energy%20-%206.02.01%20Network%20Resilience%202022%20Collaboration%20Paper%20-%202022%20-%20Public.pdf
[108] https://www.statedevelopment.qld.gov.au/__data/assets/pdf_file/0021/33663/planning-resilient-electrical-infrastructure.pdf

Routine asset management strategies and the delivery of new electricity network equipment incorporated risk assessments, such as the probability of flooding[109] to ensure that the electricity network could meet reliability standards. Routine planning and asset management is still based on risk assessments of the vulnerabilities of the electricity network equipment to a range of hazards including severe weather[110]. The vulnerability of the electricity network equipment has never been static or "set and forget". Assessments need to be made regularly and planning updated.

While severe weather events are becoming more frequent and the vulnerability of, and risk to the electricity network equipment are changing, this can be accommodated in the approaches to reliability. The investment needed to manage the risk to the electricity network equipment posed by increasing severe weather is accommodated in the current reliability frameworks and standards.

What is new is the desire to characterise risk reduction investments related to severe weather as "resilience" rather than reliability. Even where an electricity network business doesn't propose a specific "resilience" investment, the regulator has extracts severe weather-related reliability investment (e.g. to address bushfire risk) and describes the investment as resilience[111].

Investments that may not fall into the reliability criteria are those that focus on responding to a major event. The recovery from a major event is likely to be prolonged and needs to focus on agile and mobile approaches by the electricity network businesses. Consumers are clear that responsiveness from the electricity network businesses is needed following a severe weather event.

Since the major difference between a routine "reliability" outage (low impact, high probability) and a "resilience" outage (high impact, low probability) is the scale of the event, both in terms of the number of consumers impacted and the geographic spread of the event, it is the scale of the response and recovery efforts needed to address a "resilience" outage that should be the focus of any specific resilience investment by electricity network businesses.

| ***Resilience aspect*** | ***Framework*** | ***Time frame*** | ***Potential network activities (non-exhaustive list)*** |
|---|---|---|---|
| Risk reduction | Reliability | Long-term planning, investment horizon | Risk assessments, planning, vegetation management, ABC, REFCL, undergrounding, SAPS, composite poles |
| Readiness | Reliability | 5-10 days, when an event is forecast | Tweets, SMS, radio, TV, seasonal advice on webpages, prolonged outage advice on webpages, ensuring there are sufficient spares |
| | Resilience | | Moving crews & spares into position, cancel planned work, community liaison staff |
| Event resulting in prolonged outage (Major Event Day threshold crossed) | | | |
| Response | Reliability | 2-8 weeks, after event occurs | Communications (as above for readiness), telephone helpline |
| | Resilience | | Mutual aid schemes, redeploy workforce, mobile response vehicles, community liaison staff, mobile network equipment assets, temporary generation |
| Recovery | Reliability | 2-8 weeks, end of event | Repair damaged network equipment |

*Table 3: Comparison of the approaches to Reliability and Resilience*

Many of the approaches that electricity network businesses describe as resilience investments, such as replacing wooden poles with taller poles or composite poles, either after damage has occurred or as part of routine maintenance, are investments that improve reliability and should be delivered as part of routine network equipment repair and maintenance schedules that support reliability standards[112,113].

[109] http://www.floodcommission.qld.gov.au/__data/assets/pdf_file/0014/11714/QFCI-Final-Report-Chapter-10-Essential-services.pdf
[110] https://www.energyq.com.au/__data/assets/pdf_file/0017/6362/Natural-Hazards-Strategy-2024-25.pdf
[111] https://www.aer.gov.au/documents/aer-draft-decision-overview-ergon-energy-2025-30-distribution-revenue-proposal-september-2024
[112] https://assets.infrastructurevictoria.com.au/assets/Economic-assessment-of-adapting-electricity-distribution-networks-to-climate-change.pdf
[113] https://media.powercor.com.au/wp-content/uploads/2024/09/09130920/Draft-proposal-2024-part-B-Powercor.pdf

*STPIS and MEDs*

The Service Target Performance Incentive Scheme (STPIS) covers electricity network business reliability performance. The regulator manages and monitors the scheme[114], with the network businesses defining rewards and penalties under the scheme as part of their 5-yearly revenue request to the regulator.

Records of the number of minutes consumers are without electricity due to unplanned outages are maintained and reported on annually by electricity network businesses. Network businesses record the total number of minutes without electricity and then correct this "raw" data by removing any minutes that occurred on a Major Event Day. Network businesses also record the frequency of electricity outages.

A Major Event Day is defined by a calculated threshold number of total consumers without power during an event and is based on past outages for a particular network business. Since Major Event Days are typically caused by severe weather, this means that the loss of power due to severe weather can be ignored and falls outside the incentive scheme.

As a result, all the electricity network businesses show improving reliability (except one), or fewer minutes without electricity, which can result in a reward under the performance scheme. However, for several electricity network businesses, consumers are experiencing increasing periods without electricity due to major event days.

| ***Network Business*** | ***State*** | ***% Long Rural*** | ***Average age of poles & wires (<33 kV), years*** | ***Minutes lost due to Major Event Days*** | ***Reliability*** |
|---|---|---|---|---|---|
| Ergon Energy | Qld | 11 | 13 | Decreasing | Improving |
| Energex | Qld | 0 | 13 | Decreasing | Improving |
| Essential Energy | NSW | 15 | 47 | Increasing | Improving |
| Endeavour Energy | NSW | 0 | 14 | Increasing | Improving |
| Ausgrid | NSW | 0 | 15 | Decreasing | Improving |
| EvoEnergy | ACT | 0 | 35 | Increasing | Deteriorating |
| Ausnet Services | Vic | 16 | 37 | Increasing | Improving |
| Citipower | Vic | 0 | 30 | Decreasing | Improving |
| Powercor | Vic | 24 | 26 | Decreasing | Improving |
| United Energy | Vic | 0 | 16 | Decreasing | Improving |
| Jemena | Vic | 0 | 28 | Decreasing | Improving |
| SA Power Networks | SA | 15 | 44 | Increasing | Improving |
| TasNetworks | Tas | 13 | 13 | Decreasing | Improving |
| | | ***Average age*** | ***25*** | | |

*Table 4: Impact of major events on minutes without electricity 2006-2023[115] (See also Appendix A)*

There is no clear relationship between the location of power lines (feeder type) and increasing minutes lost to major event days. For instance, Powercor, a Victorian electricity network business, has the highest percentage of consumers on long rural lines (24%), and demonstrates both improving reliability and decreasing minutes lost to major event days. In comparison, Ausnet Services, another Victorian electricity network, has the second highest percentage of consumers on long rural lines (16%), but demonstrates stable reliability and a significant increase in minutes lost to Major Event Days.

Feeder density-based performance metrics

To assess reliability, the electricity network businesses use well-defined performance metrics. These metrics are dependent on the density of consumers on a particular power line (feeder). This ensures that any investments an electricity network business makes to support reliability are "economically efficient".

An "economically efficient" investment minimises the cost while maximising the number of consumers that benefit.

[114] https://www.aer.gov.au/industry/registers/resources/schemes/service-target-performance-incentive-scheme-2018-amendment
[115] https://www.aer.gov.au/publications/reports?search=regulatory%20information%20notice&f%5B0%5D=type%3A130&page=0

Typically, rural power lines connect fewer consumers than urban power lines, meaning they are less dense. This lower density of consumers and the longer power lines means that any business case that would improve reliability or resilience for rural consumers is unlikely to be "economically efficient" and so the investment would not progress.

This means that the poor reliability and resilience outcomes for rural consumers may persist[116].

*Maintenance and age of assets – impact on resilience*

Electricity network equipment is long-lived, and the average age of poles and wires is 25 years, ranging between 13 years for TasNetworks (Tasmania) and 47 years for Essential Energy (New South Wales). Distribution and zone substations and transformers also have an average age of around 25 years[117]. Except for Endeavour Energy, the five networks that exhibit increasing minutes without power due to major event days have the oldest network equipment in the NEM (see table 4).

While climate change was an established scientific issue decades ago, the electricity network equipment in use today was built before the impacts of severe weather was confirmed. Electricity network equipment is built to Australian standards and while equipment operational today was built to the required standard of the day, standards have been updated to account for changing weather conditions (e.g. AS7000, the standard for overhead lines, now includes downdrafts). However, network equipment built today will need to withstand the weather of the future, which may not be accounted for in current standards.

Electricity network businesses undertake routine repairs and maintenance on all their assets, with routine replacement strategies. This routine maintenance offers an opportunity to replace and repair old equipment with new equipment that could address known vulnerabilities, such as replacing a wooden pole with a composite/concrete pole in a bushfire prone area. This would likely improve both reliability and resilience and is possible under the regulatory framework today[118].

*Values of customer reliability and network resilience*

In 2019, the industry regulator developed Values of Customer Reliability (VCR). The Value of Customer Reliability plays an important role in ensuring consumers pay no more than necessary for reliable electricity. The Value for Customer Reliability places a cap on the investment electricity network businesses can make in approaches that improve reliability. This is to ensure that electricity network businesses identify the efficient level of investment to deliver reliable electricity to consumers at a cost consumers are willing to pay[119].

However, the Values of Customer Reliability are not high enough to support the investment that the electricity network businesses might want to make in resilience solutions, like islandable microgrids[120]. A higher value is needed to support a successful business case for investment in network business led resilience solutions[121,122].

The industry regulator previously considered Widespread And Long Duration Outages (WALDOs), however this did not reach an industry consensus on the best approach[123]. More recently, the regulator undertook work on the Value of Network Resilience (VNR), which extends the Value of Customer Reliability to resilience[124] to between 1.5 times and twice the Value of Customer Reliability, depending on outage length.

[116] https://media.powercor.com.au/wp-content/uploads/2024/10/03182336/Net-Zero-2045-Regional-and-Rural-Roadmap.pdf
[117] https://www.aer.gov.au/documents/aer-operational-performance-data-2024-electricity-distribution-networks
[118] https://assets.infrastructurevictoria.com.au/assets/Economic-assessment-of-adapting-electricity-distribution-networks-to-climate-change.pdf
[119] https://www.aer.gov.au/industry/registers/resources/reviews/values-customer-reliability-2024
[120] https://www.energynetworks.com.au/resources/reports/2020-reports-and-publications/opportunities-for-saps-to-enhance-network-resilience/
[121] https://www.climatechangeinaustralia.gov.au/en/projects/esci/esci-case-studies/case-study-fire-distribution/
[122] https://www.energynetworks.com.au/resources/reports/2020-reports-and-publications/opportunities-for-saps-to-enhance-network-resilience/
[123] https://www.aer.gov.au/news/articles/communications/aer-publishes-reasons-discontinuing-widespread-and-long-duration-outages-approach
[124] https://www.aer.gov.au/industry/registers/resources/reviews/values-customer-reliability-2019

| *Value* | *Factor* | *$/kWh* |
|---|---|---|
| Value of Customer Reliability: no electricity for up to 12 hours (residential) | | 28.23[125] |
| Value of Network Resilience: no electricity between 12-24 hours (residential) | 2 x VCR | 56.46[126] |
| Value of Network Resilience: no electricity for more than 24 hours (residential) | 1.5 x VCR | 42.35[127] |
| Victorian residential consumers prepared to pay for resilience | | 26.17[128] |
| Victorian business consumers prepared to pay for resilience | | 11.85[129] |

*Table 5: Values of Customer Reliability and Network Resilience*

Consumers in Victoria have identified that electricity network resilience does have a high value to them ($70/kWh)[130]. However, residential consumers are not willing to pay that value when it is translated into electricity bill increases, indicating that they were prepared to pay $26/kWh for increased electricity network resilience[131]. This is significantly lower than the values proposed by the regulator for the Value of Network Resilience and consistent with the Value of Customer Reliability.

However, even the proposed higher Values for Network Resilience are not high enough to support investments in risk reduction solutions the electricity network businesses favour, and the electricity network businesses are suggesting that the Value for Network Resilience needs to be significantly higher[132].

The regulator and industry need to be cautious when exploring the Value of Network Resilience because work indicates that consumers place a lower value on electricity as outages progress[133].

Careful engagement with consumers is critical to understanding the value they place on electricity resilience. Consumers that have experienced prolonged outages want electricity network businesses to be responsive. Consumers that have never experienced a prolonged outage support risk reduction investment[134]. Consumers that have experienced prolonged outages may have residual trauma that impacts their ability to engage[135]. These differing consumer experience require the development of a specific engagement framework that electricity network businesses use when discussing electricity resilience with their customers.

Resilience investments by electricity network businesses are likely to result in higher costs to consumers for resilience solutions that don't deliver the aspects of resilience that consumers say that they want from electricity network businesses for prolonged outages: quality communications and responsiveness[136].

The industry and government approach to electricity resilience needs to pivot from a focus on risk reduction investment in network equipment before an event reducing the costs of network equipment repairs after the event (the "one ounce of prevention is worth a pound of cure" fallacy), as this benefit has not be demonstrated, to a focus on consumers' preferences for managing the risk associated with the prolonged outages caused by severe weather.

*Electricity network business bias towards investment in equipment*

Electricity network businesses demonstrate a bias towards investing in equipment, rather than spending money on operations, because the business earns its revenue as a fixed percentage of the total value of the assets it owns[137].

[125] https://www.aer.gov.au/system/files/2023-12/2023%20VCR%20Annual%20Adjustment%20update%20summary%2816100739.1%29.pdf
[126] https://www.aer.gov.au/system/files/2024-09/Final%20Decision%20-%20Value%20of%20Network%20Resilience%202024.pdf
[127] https://www.aer.gov.au/system/files/2024-09/Final%20Decision%20-%20Value%20of%20Network%20Resilience%202024.pdf
[128] https://engage.powercor.com.au/91972/widgets/437539/documents/292420
[129] https://engage.powercor.com.au/91972/widgets/437539/documents/292420
[130] https://womeninenergyandrenewablessummit.com.au/sites/womeninenergyandrenewablessummit.com.au/files/Renate%20Vogt.pdf
[131] https://engage.powercor.com.au/91972/widgets/437539/documents/292420
[132] https://www.aer.gov.au/system/files/2024-09/AusNet%20submission%20-%20VNR%20Draft%20Decision_Redacted.pdf
[133] https://www.enwl.co.uk/globalassets/innovation/enwl010-voll/voll-general-docs/voll-phase-3-report.pdf see page 21
[134] https://engage.powercor.com.au/90144/widgets/421911/documents/273220
[135] https://energyconsumersaustralia.com.au/wp-content/uploads/ECA-Connections-That-Matter-August-2021.pdf
[136] https://engage.vic.gov.au/download/document/35884
[137] https://www.aer.gov.au/system/files/Fact%20sheet%20-%20Indexation%20of%20the%20regulatory%20asset%20base.pdf

This is true of approaches electricity network businesses take towards resilience, with 3 of the 4 electricity network businesses that proposed investing in resilience focusing entirely (100%) on investment in network assets, rather than operational approaches. The fourth network business' proposal was based on capital investment of 92 percent[138].

Capital investment versus operation expenditure approaches to resilience

Electricity network businesses can invest in new equipment to improve resilience that can then be added to the regulated asset base, increasing the returns the business and its shareholders can earn[139].

The electricity network business could also target resilience by taking operational approaches.

| *Capital investment* | *Operational expenditure* |
|---|---|
| Build, own and operate a battery in community impacted by bushfires | Employ more crew to rapidly repair lines damaged by bushfires |
| **Pros** | **Pros** |
| The battery provides backup power to the community<br>Maintained by experienced engineers | Repair of damaged lines undertaken rapidly<br>Crew in impacted community to share information<br>Crew is mobile and can be used where-ever there is problem |
| **Cons** | **Cons** |
| Battery will eventually go flat during prolonged outage<br>Battery will have to be defended against bushfire<br>Power lines will have to be defended against bushfire<br>Difficult questions about who gets the electricity from the battery<br>Fixed in one location, so only one community may benefit, while all customers of the business pay | There will be a period without electricity from the network |

The Value of Network Resilience will lower the bar for electricity network businesses to invest in technical, higher capital solutions. The proposed positive obligation on electricity network businesses to consider resilience, along with the proposed expenditure factors for specific yet undefined investments in "resilience", will also support electricity network business' investment in capital solutions. In combination, the Victorian government rule change, the regulator's Value of Network Resilience and the established bias towards capital expenditure will result in increased electricity bills for consumers.

The focus on electricity network equipment for resilience results in a mismatch between the approach electricity network businesses and governments want to take to electricity resilience and what consumers say they need for electricity resilience.

The focus of industry and governments is on risk reduction by investing in the resilience of the equipment that delivers the electricity to customers. This includes requirements to undertake risk assessments on electricity network equipment[140] and to invest in solutions that might make the equipment more robust, such as stronger poles[141], or solutions that might provide a resilient source of electricity, such as batteries and microgrids[142,143].

Electricity consumers focus on a resilient supply of electricity, which can be delivered in many ways. During a prolonged outage, consumers want electricity network businesses to communicate well and be responsive to consumer needs. Consumers also expect electricity network businesses to support readiness before an event.

[138] https://www.aemc.gov.au/sites/default/files/2024-10/consultation_paper.pdf
[139] https://www.aer.gov.au/system/files/Fact%20sheet%20-%20Indexation%20of%20the%20regulatory%20asset%20base.pdf
[140] https://www.energy.vic.gov.au/__data/assets/pdf_file/0030/594930/network-resilience-review-final-recommendations-report.pdf
[141] https://www.energy.vic.gov.au/__data/assets/pdf_file/0014/715010/our-plan-for-victorias-electricity-future.pdf
[142] https://energyconsumersaustralia.com.au/wp-content/uploads/ECA-Connections-That-Matter-August-2021.pdf
[143] https://bsgip.com/wp-content/uploads/2024/05/Exploring-design-challenges-and-opportunities-for-microgrids-to-improve-resilience-in-the-Eurobodalla.pdf

The current focus nationally by governments, is on recovery[144]. Any approach taken to electricity resilience needs to focus on delivering expressed consumer preferences for readiness and response as there is no evidence that investment in risk reduction by electricity network businesses will reduce repair costs.

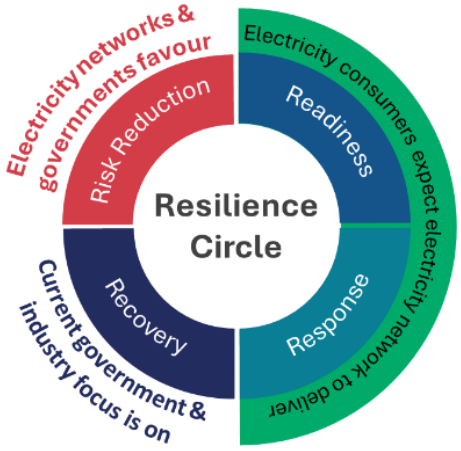


*Figure 7: The mismatch on resilience approaches between consumers, industry and governments*

*Current proposed changes to the framework*

The regulator is exploring a specific Value for Network Resilience[145] and, following the recent reviews by the Victorian government[146,147], the Victorian government has proposed a rule change that would place a responsibility on electricity network businesses and the regulator to consider expenditure on resilience approaches to reduce the risk of an event resulting in a prolonged outage.

The Victorian government suggest that investment in risk reduction will be less costly for consumers than repair costs after an event[148]. International work on risk reduction focuses on buildings[149] and on total GDP[150]. Work on critical infrastructure identifies the increasing costs of damage in the future but recommends focussing on risk assessment[151]. There is no work internationally that demonstrates that specific investment in risk reduction for electricity networks results in reductions in the costs of rebuilding electricity network equipment damaged by severe weather. Australian work[152] on *buildings* suggests that up to $10 is saved on recovery costs for every $1 spent on risk reduction, however, there is no evidence that this is the same for electricity network business pre-event investments.

The limitations of climate projections and climate modelling mean that very few of the severe weather events that impact electricity networks can be predicted with certainty to a specific location (see table 1). This means that electricity network business investment in a location-specific resilience solution, such as an islandable microgrid or a battery, is unlikely to be in the correct place to provide a resilient supply of electricity to consumers.

The way consumers fund an electricity network business means that all the customers of that business pay the same for the delivery of electricity regardless of whether it might cost more, for instance it costs more to deliver electricity to consumers in rural areas, but a rural consumer pays the same as an

[144] https://www.pc.gov.au/inquiries/completed/disaster-funding/report
[145] https://www.aer.gov.au/system/files/2024-07/23072024%20-%20Draft%20Decision%20-%20Value%20of%20Network%20Resilience%202024.pdf
[146] https://www.energy.vic.gov.au/__data/assets/pdf_file/0030/594930/network-resilience-review-final-recommendations-report.pdf
[147] https://www.energy.vic.gov.au/__data/assets/pdf_file/0035/717749/network-outage-review-report.pdf
[148] https://www.aemc.gov.au/sites/default/files/2024-08/rule_change_request.pdf
[149] https://www.undrr.org/our-work/our-impact
[150] https://www.uschamber.com/assets/documents/USCC_2024_Allstate_Climate_Resiliency_Report.pdf
[151] https://www.undrr.org/media/48327/download#:~:text=The%20resilience%20and%20sustainability%20of,and%20climate%20change%20impact%20considerations.
[152] https://www.csiro.au/en/news/all/articles/2016/april/building-disaster-resilience-systematically-australia-save-billions

urban consumer. This means that regardless of location, every consumer pays the same for using the electricity network.

Electricity network business investments in resilience are likely to be in capital equipment[153] that will be in a specific location, such as a battery or islandable microgrid (where an unreliable and expensive to maintain powerline is retained, as well as installing a battery and generation), delivering resilience to that location. This results in an equity issue because all consumers will pay for a location-specific resilience solution, but only the consumers or community at that location will potentially benefit from the resilience solution. This is no different to how consumers pay today for standard reliable electricity networks.

However, there are electricity network resilience solutions that electricity network businesses can invest in, that either benefit all consumers or maximise the number of consumers that benefit. These include Stand-Alone Power Systems (SAPS) where an unreliable power line, which is expensive to maintain, is removed completely and customers are provided with local generation to meet their electricity needs[154]. This reduces costs to all consumers because the unreliable powerline is removed and improves the outcomes for the consumers connected to the Stand-Alone Power System[155]. Solutions also include agile and responsive approaches, such as Mobile Emergency Response Vehicles (MERVs)[156] that can be sent to locations that impacted by prolonged outages.

Reliability is important to electricity consumers. Some electricity consumers rely heavily on electricity and invest in their own resilience solutions. This includes businesses that have process that are critically supported by electricity and cannot be interrupted.

Some consumers, particularly rural consumers, who already experience poor reliability[157] or have experienced prolonged outages in the past, have invested in their own electricity resilience solutions[158].

Giving the electricity network businesses the opportunity to invest in resilience through a Value of Network Resilience[159], or new expenditure factors plus a positive obligation to address network vulnerabilities[160], will result in electricity consumers paying multiple times for electricity resilience.

Consumers will:

1. Fund routine electricity network business operation
   Consumers already fund routine electricity network business operation, which includes investment for reliability and routine asset maintenance that are likely to improve resilience.

2. Fund electricity network business investment in a (location) specific resilience solution
   If there is a requirement or opportunity for an electricity network business to invest in "resilience" it is likely to do so to increase its asset base and revenue, but this investment may not deliver the resilience benefits consumers want.

3. Fund repairs following an event
   When severe weather damages electricity network equipment, consumers pay for the repair of that damage. It is likely that severe weather may damage specific electricity network business

[153] https://www.aemc.gov.au/sites/default/files/2024-10/consultation_paper.pdf
[154] https://www.aemc.gov.au/news-centre/media-releases/new-rules-allow-distributors-roll-out-stand-alone-power-systems-nem
[155] https://www.westernpower.com.au/resources-education/our-network-the-grid/grid-technology/stand-alone-power-system/
[156] https://www.instagram.com/citipowerpowercor/p/C3tXq72yziY/
[157] https://www.aer.gov.au/system/files/2023-Electricity-network-performance-report.pdf
[158] https://energyconsumersaustralia.com.au/wp-content/uploads/ECA-Connections-That-Matter-August-2021.pdf
[159] https://www.aer.gov.au/industry/registers/resources/reviews/value-network-resilience-2024
[160] https://www.aemc.gov.au/sites/default/files/2024-08/rule_change_request.pdf

resilience solutions, since some solutions, like a microgrid, are dependent on poles and wires remaining undamaged.

4. Fund compensation for long outages (Guaranteed Service Level requirements)
   The regulator has allowed electricity network businesses to recover the compensation paid to consumer following a prolonged outage (GSL) as part of funding repair costs.

5. Consumers' own investment in electricity resilience (the regulator's "rational alternative")
   Where consumers already have poor reliability, have experienced a prolonged outage, or have a high dependency on electricity, they may invest in solutions that ensure a resilient supply of electricity, such as solar PV and batteries and generators.

*Can the frameworks currently deliver what consumers expect?*

The current frameworks that govern electricity network businesses and the regulator do not deliver what consumers expect during a prolonged outage.

It is unlikely that the proposed rule change[161] and the Value of Network Resilience work[162] will deliver what consumers expect if both are progressed as proposed.

Further, the previous note from the regulator on resilience defined the criteria that should be met for expenditure on resilience[163]. These criteria are reasonable, but the definition of resilience needs to be consumer-focused, not network equipment or network operation focused.

The rule change and the Value of Network Resilience focus on risk reduction investment, and this is likely to increase costs for all electricity consumers of the investing electricity network business while only potentially delivering benefits to a specific group of consumers.

For most of the severe weather events (74%) that impact the electricity network equipment, it is not possible to identify a specific location on investment timescales. Most severe weather events can only be predicted with certainty on weather forecasting timescales of 5-10 days. While it is possible to say with certainty that, over the longer term (the typical lifetime of network equipment), electricity network equipment will be exposed to increasingly intense weather events that will result in damage that will cause a prolonged outage, it is not possible to say when and where this damage will occur.

As part of routine annual planning and asset maintenance, electricity network businesses should identify equipment that is vulnerable to severe weather. This "climate resilience plan[164]" would build on the risk assessment already required by governments. Vulnerable equipment can be replaced and/or repaired as part of planned routine asset management, based on vulnerability and age of equipment (e.g. pole replacement).

Where significant network equipment is identified as being vulnerable, such as a substation on a flood plain, then the cost could be supported by governments[165,166], rather than fully funded by electricity consumers.

In terms of resilience, consumers are clear that they want more responsiveness, including better communication, from electricity network businesses.

[161] https://www.aemc.gov.au/rule-changes/including-distribution-network-resilience-national-electricity-rules
[162] https://www.aer.gov.au/industry/registers/resources/reviews/value-network-resilience-2024
[163] https://www.aer.gov.au/documents/aer-note-key-issues-network-resilience-april-2022
[164] https://www.ofgem.gov.uk/sites/default/files/2021-09/ED2%20Business%20Plan%20Guidance%20-%20September%202021_1.pdf
[165] https://assets.publishing.service.gov.uk/media/61012a83e90e0703b09ac4ac/Flood_coastal_erosion_investment_plan_2021.pdf
[166] https://www.premier.vic.gov.au/reducing-powerline-bushfire-risk-communities

Electricity network businesses need to focus on communicating effectively with consumers before and during outages related to severe weather events. This may require investment in communication approaches and shared resources should be the focus (e.g. the UK's single number for outages[167]), allowing unaffected businesses to provide communications support to impacted businesses.

Electricity network businesses need to get smarter at identifying the location of damage and outages. This could be through network monitoring devices, while smart meters also offer an opportunity to show, at the connection point, where a problem is located. This is particularly true in Victoria with near 100% coverage of smart meters. The accelerated rollout of smart meters[168] should ensure that the benefits of identifying outages, particularly in regional and rural areas, is accommodated in replacement meter plans[169]. Internationally, "pinging" smart meters has helped to map outages[170] and applications that allow consumers to take a geo-located image of network damage could also accelerate recovery[171].

*Incentivising consumer electricity resilience*

The current framework does not support responsiveness or recovery during prolonged outages. Once an outage has exceeded the Major Event Day threshold, the outage is excluded from the reliability incentive scheme (STPIS), meaning that the minutes related to that outage don't count towards assessing an electricity network business' performance.

There are a variety of (complex) metrics that could be used to develop an incentive scheme to support rapid recovery from prolonged outages. None of the metrics are ideal as they are dependent on feeder density, are limited by a specific outage duration, do not incorporate consumer energy resources (CER) or recognise consumer investment in resilience, and do not appropriately account for the true impact of a prolonged outage on consumers[172,173]. Any metric for electricity resilience needs to be simple to understand and based on the impact of the prolonged outage on consumers, not the system or equipment (as reliability metrics do).

Metrics used to monitor prolonged outages

CAIDI is the ratio of SAIDI to SAIFI monitoring the Customer Average Interruption Duration Index and gives an indication of the average time to restore power.

SAIDI is the System Average Interruption Duration Index and provides insights on the number of minutes consumers are without electricity. SAIFI is the System Average Interruption Frequency Index and provides insights on the number of outages that consumers experience. Both are scaled by the number of consumers on impacted power lines[174] and both are routinely reported by electricity network businesses[175].

CELID-X monitors Customers Experiencing Long (more than X hours) Interruption Durations over the course of a year. CELID-X is defined in the same standard used for the metrics that Australian electricity network businesses use to monitor reliability[176]. Like the reliability metrics SAIDI and SAIFI, CELID is dependent on feeder density by including the number of customers connected to (served by) the damaged power line:

$$\text{CELID-X} = \frac{\text{number of customers experiencing outages greater that X hours in a year}}{\text{total number of customers served}}$$

CR-XX is the Customer Restoration time to reconnect XX percent of the total number of customers served by the electricity network business. It is not scaled by the number of customers on a damaged power line and is simple to understand.

[167] https://www.powercut105.com/en/
[168] https://www.aemc.gov.au/rule-changes/accelerating-smart-meter-deployment
[169] https://www.aemc.gov.au/sites/default/files/2024-04/draft_rule_determination_-_accelerating_smart_meter_deployment.pdf
[170] https://www.palmbeachpost.com/story/business/2013/05/11/how-smart-meters-are-changing/6842189007/
[171] https://www.snapsendsolve.com/
[172] https://link.springer.com/content/pdf/10.1007/s40518-023-00227-0.pdf
[173] https://eta-publications.lbl.gov/sites/default/files/ee_reliability_resilience_2022_11_10.pdf
[174] https://media.powercor.com.au/wp-content/uploads/2024/10/03182336/Net-Zero-2045-Regional-and-Rural-Roadmap.pdf
[175] https://www.aer.gov.au/publications/reports?search=regulatory%20information%20notice&f%5B0%5D=type%3A130&page=0
[176] https://ieeexplore.ieee.org/document/6209381

The Guaranteed Service Level (GSL) payments that provide compensation to consumers for some, but not all, prolonged outages, are set in each state by the government and relevant statutory body. These payments are often capped regardless of the length or number of prolonged outages a consumer experience. The GSL payment can be recovered by the electricity network business through their applications to the regulator to fund repair costs[177,178]. As a result, the customers of the electricity network business fund GSL payments, not the network business, so the GSL requirements provide no incentive to the electricity network business to minimise prolonged outages.

The Major Event Day threshold is well-established and clearly identifies when a loss of electricity falls outside the reliability framework. This threshold, rather than arbitrary times without electricity, should be used to identify when approaches to resilience are needed. Any electricity network business approach to the need for resilience must focus on delivering the outcomes that consumers seek, such as responsiveness and readiness to severe weather events[179]. It may also be appropriate to explore whether "restoration of electricity supply" includes temporary generation and not just restoration of electricity supplied via the network equipment.

*International approaches to prolonged outages*

In the United States of America, several electricity network businesses are using metrics to incentivise rapid recovery from prolonged outages[180] and many state regulators require the electricity businesses to report on recovery times outside of an incentive scheme using established metrics such as CELID-X and CR-XX[181,182].

In Sweden, all outages are covered by the reliability incentive scheme, but compensation varies by the length of outage. Outages longer than 12 hours are compensated by refunding impacted customers the network charge plus a base payment of approximately $6,000 (AUD). Outages greater than 24 hours are illegal, and the electricity network business incurs a civil penalty and is required to compensate consumers up to a maximum of 300 % of the network use charge[183].

In the UK, the Guaranteed Service Level (GSL) compensation is based on three pre-determined thresholds, based on the impact of the outage, for each electricity network business dependent on the impact on consumers. A 12-hour outage attracts a payment of approximately $580 (AUD) and $1,400 (AUD) for each additional 12-hour period without electricity, up to a maximum of 5 days[184].

The UK has also embedded exploring resilience to climate change in the current 5-year regulatory period (commenced April 2023), with a focus on ensuring that electricity network businesses undertaking scenario planning to assess for vulnerabilities and are actively pursuing resilience approaches in the following 5-year period (April 2029)[185]. A metric to monitor resilience performance is still under development.

## Roles and responsibilities for consumer electricity resilience

Consumer electricity resilience is a shared responsibility encompassing many entities, from governments, the electricity industry regulator, the electricity network business to consumers and

[177] https://www.aer.gov.au/system/files/AusNet%20Services%20-%202020-21%20Storms%20disaster%20event%20cost%20pass%20through%20-%20Application%20-%20November%202021.pdf
[178] https://www.aer.gov.au/system/files/AER%20Determination%20-%20AusNet%20Services%20-%20June%202021%20storms%20cost%20pass%20through%20-%20March%202022.pdf
[179] https://engage.vic.gov.au/download/document/35884
[180] https://icc.illinois.gov/downloads/public/informal-processes/ICC_Metric_Report_12-01%20Final.pdf
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[183] https://www.ltu.se/cms_fs/1.156688!/file/Carl-Johan%20Wallnerstr%C3%B6m%20-%20Full%20text.pdf, see table 2 for details of calculations
[184] https://www.legislation.gov.uk/uksi/2015/699/pdfs/uksi_20150699_en.pdf
[185] https://www.ofgem.gov.uk/sites/default/files/2024-07/RIIO_3_SSMD_Overview.pdf

communities[186]. There are many options and solutions today, many behind-the-meter[187], that can deliver consumer electricity resilience, which are not appropriate for the electricity business to deliver. Consumer electricity resilience can only be delivered through collaboration, and it is not just the responsibility of the electricity network business because it is "electricity".

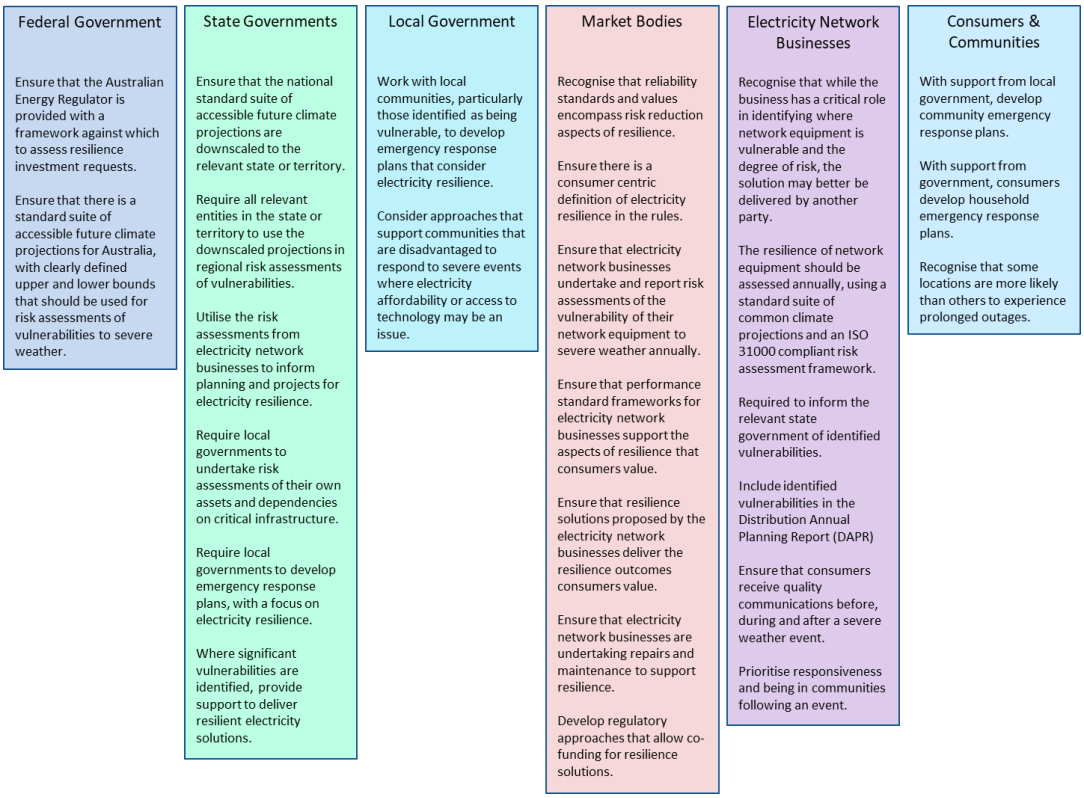
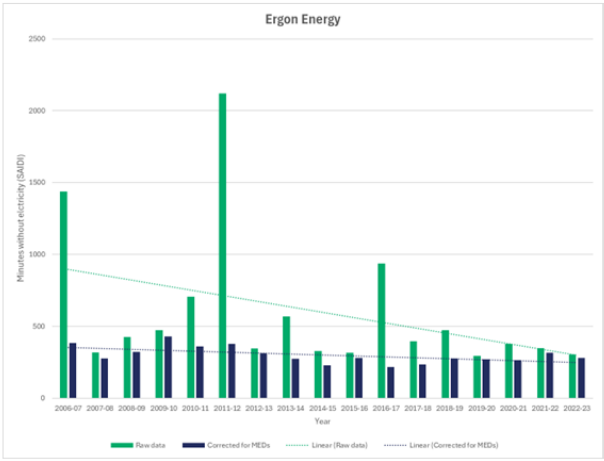


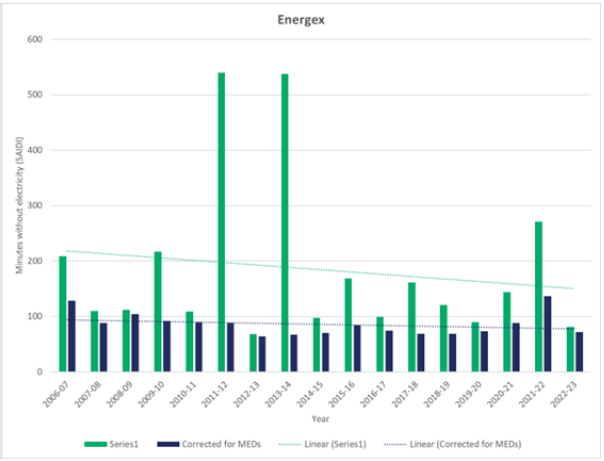

*Figure 8: Responsibilities for delivering consumer electricity resilience (based on [188])*

[186] https://thriving.org.au/publicassets/dc593035-8f30-ec11-9443-005056be13b5/Disaster%20Planning%20and%20Recovery%20Collaborative%20Research%20Project%20Phase%202%20Report.pdf
[187] https://assets.nationbuilder.com/boomerangalliance/pages/295/attachments/original/1657688880/TEC_Autonomous_Resilience_20220630_final_clean_sm.pdf?1657688880
[188] https://lnkd.in/gykUnCMy

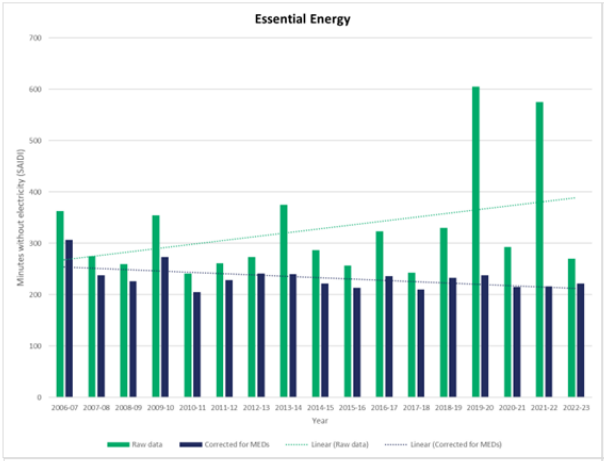
**Appendix A: Raw and corrected SAIDI data each electricity network business**

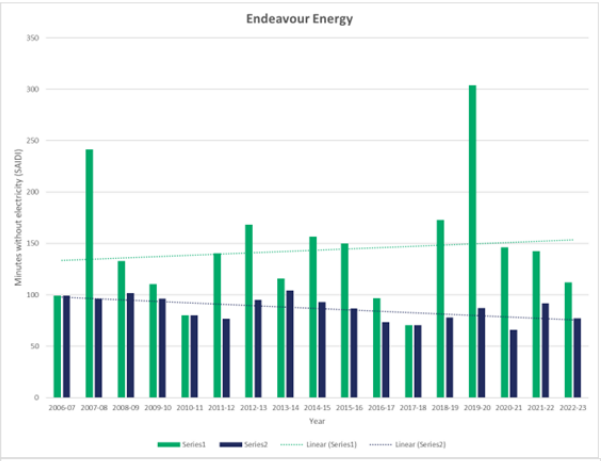
## Queensland

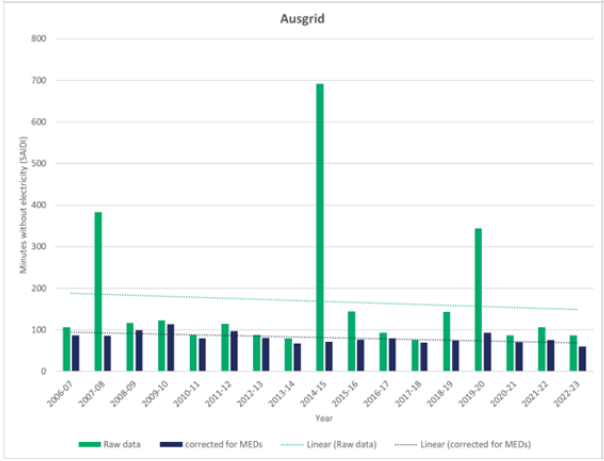


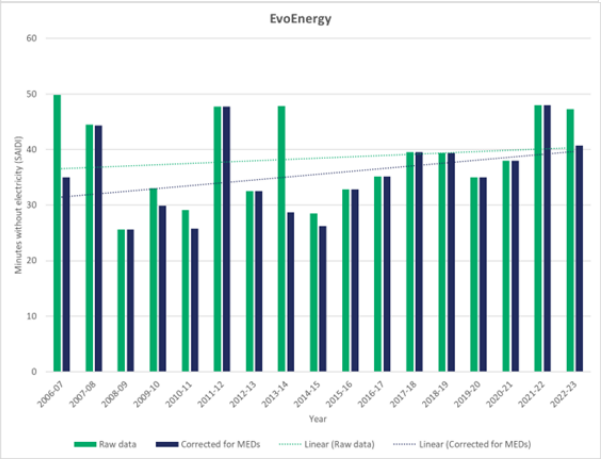




## New South Wales and the Australian Capital Territory

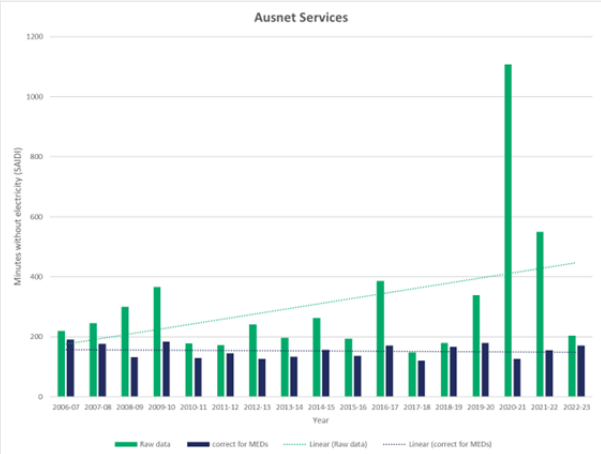


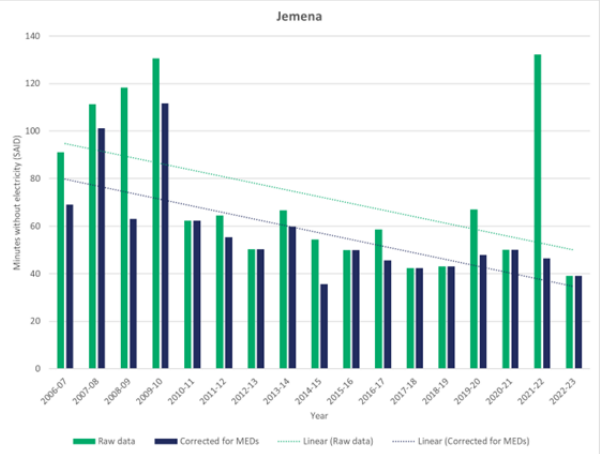



# Victoria


Ausnet Services
Minutes without electricity (SAIDI)
Year
Raw data
correct for MEDs
Linear (Raw data)
Linear (correct for MEDs)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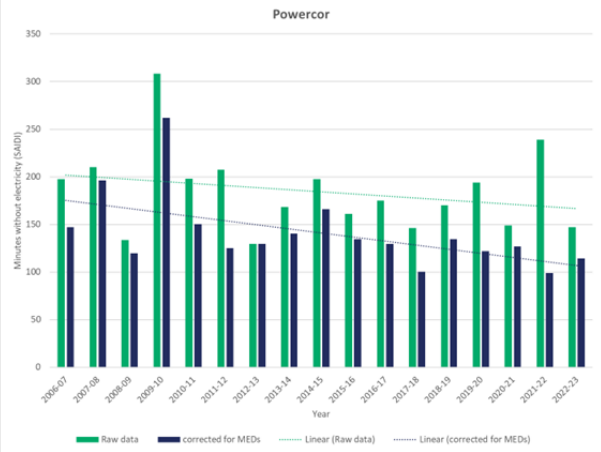
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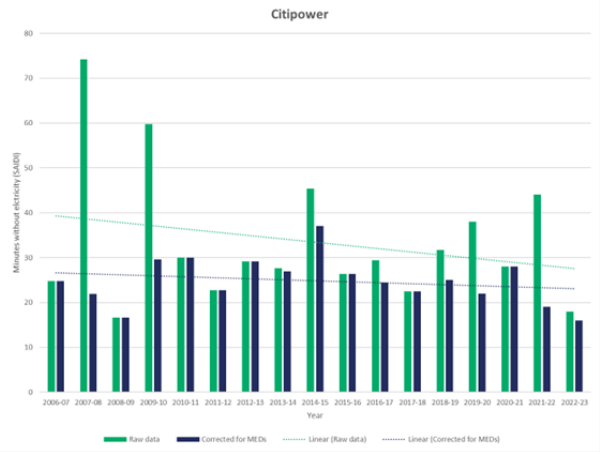
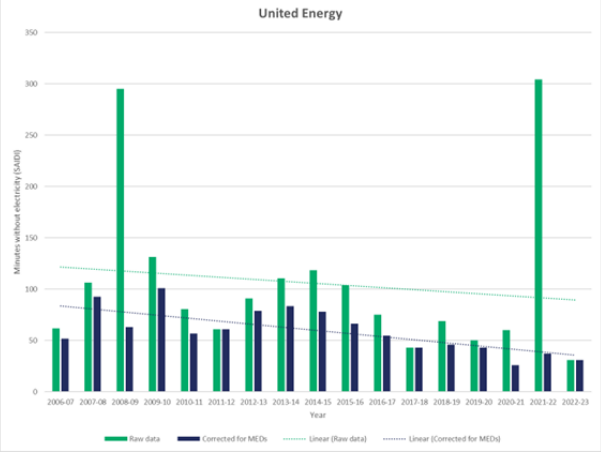
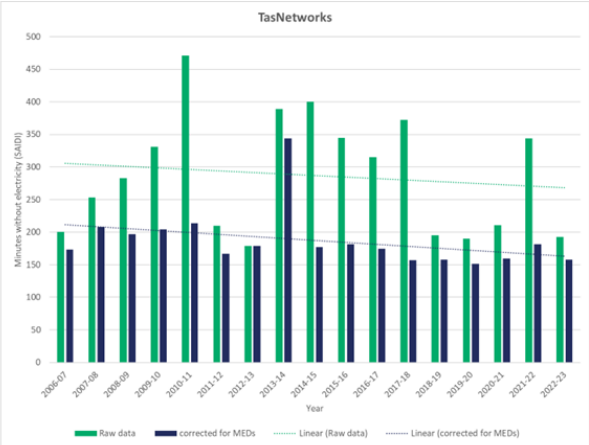
Raw data
corrected for MEDs
Linear (Raw data)
Linear (corrected for MEDs)


Citipower
Minutes without electricity (SAIDI)
Year
Raw data
Corrected for MEDs
Linear (Raw data)
Linear (Corrected for MEDs)


United Energy
Minutes without electricity (SAIDI)
Year
Raw data
Corrected for MEDs
Linear (Raw data)
Linear (Corrected for MEDs)

## Tasmania




## South Australia