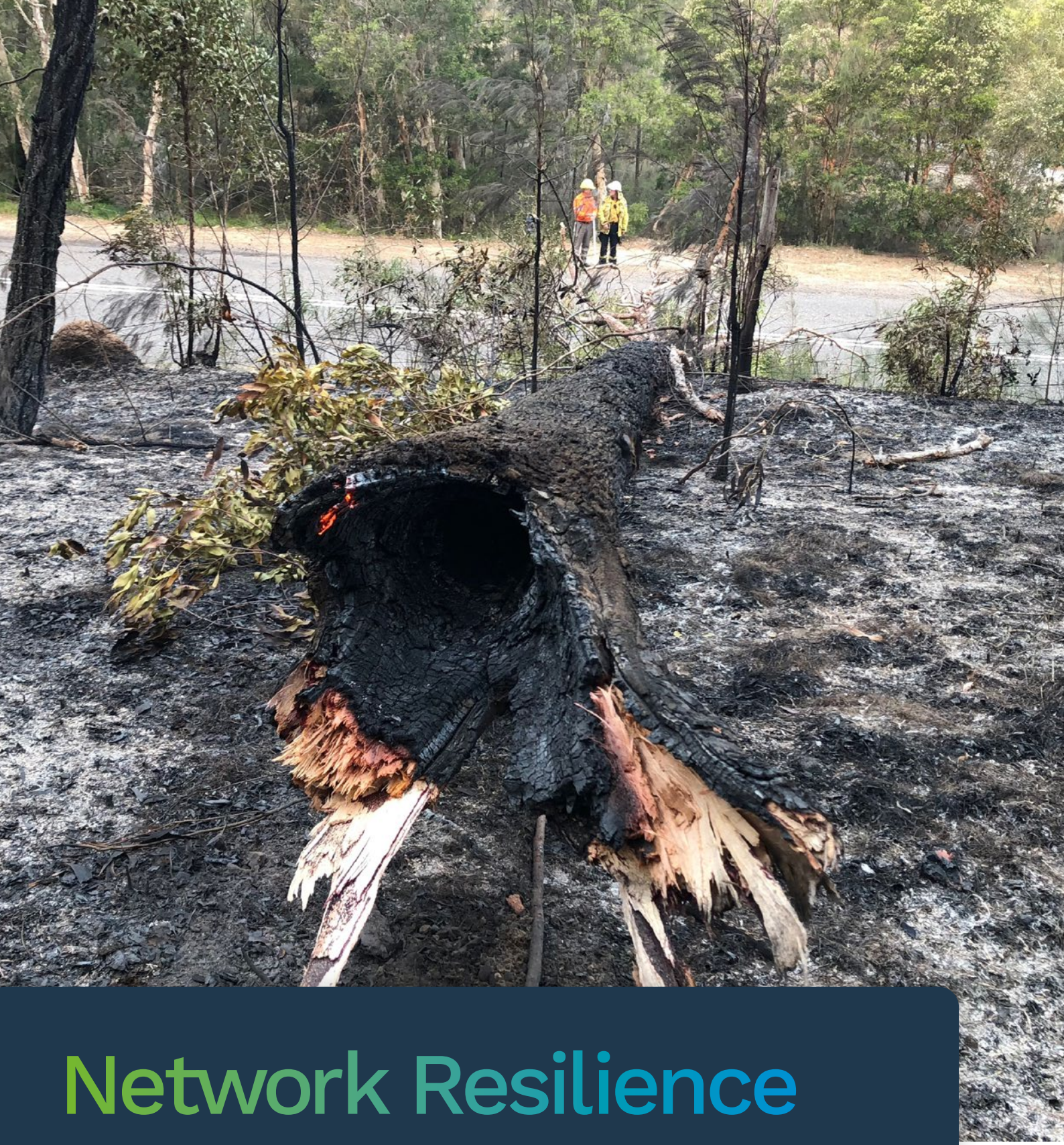


Network Resilience

2022 Collaboration Paper on Network Resilience

Ausgrid Endeavour Energy essential energy TasNetworks Delivering your power evoenergy PowerWater

Developed by NSW/ACT/TAS/NT Electricity Distributors

Introduction

For electricity distribution networks, stakeholder engagement is critical to meeting the needs of our customers and the development of regulatory proposals submitted to the Australian Energy Regulator (AER).

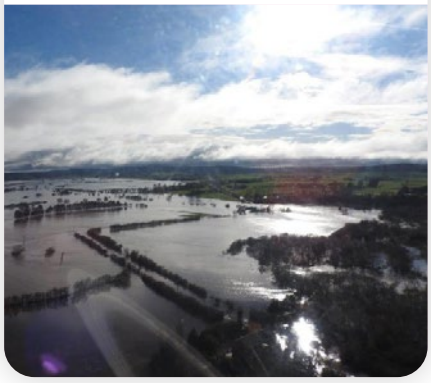
We understand that our stakeholders' time is valuable and would like, where possible, to engage with them on issues that are common across distribution networks through more streamlined processes, to minimise the burden of consultation. Ausgrid, Endeavour Energy, Essential Energy, Evoenergy, TasNetworks and NT Power & Water are all on the same regulatory cycle, with proposals for the upcoming 2024-29 regulatory control period due to be submitted to the AER in January 2023. In recognition of this, the six distribution network service providers (DNSPs) have collaborated in creating this document to learn from stakeholders, and to develop and align our responses to the AER about extreme and changing climatic conditions.

Following the release of this collaboration paper, we expect to run joint engagement processes, including a public forum about network resilience on February 8, 2022. We welcome feedback on the questions raised in this document, as well as suggestions on how we should approach joint engagement in the future.

The purpose of the consultation paper:

We are interested in hearing our stakeholders' views on the following key question:

Over the next 10 years, how can DNSPs best support the communities they serve in adapting to a changing climate?



This consultation paper forms part of a broader engagement on "Network Resilience", which seeks to understand how we, as DNSPs, can best support the communities we serve in adapting to a changing climate over the next 10 years and the increased community reliance on reliable electrical networks. To enable us to do this, we must understand how our customers expect us to respond to climate change, its impact on our network and ultimately, our customers. In addition, the knowledge gained from these engagements will be shared with our regulatory bodies, helping to shape the frameworks on which we will base our expenditure proposals. This will ensure the rules and regulations we are operating within are fit for purpose, enabling us to meet the needs and desires of our customers.

Specifically, this consultation document seeks to understand:

- The relationship between resilience and reliability and your view on our proposed definitions
- Your views on whether regulatory frameworks and objectives consider resilience
- Your view of Networks' role in community resilience and response

Given the breadth of this topic, and the timeframes available, this discussion paper is not intended to be a comprehensive list of climate resilience strategies. Other feedback and suggestions on this topic are welcome. The feedback from this paper will be considered along with that from our own customer and stakeholder groups and will set the framework on which we will base our upcoming regulatory reset submissions and our capital expenditure proposals.

How to have your say:

This consultation document is 'pre-reading' material for a stakeholder forum on February 8, 2022. In addition to (or in in lieu of) attending a stakeholder engagement session or forum, you are welcome to lodge submissions in response to the issues discussed in this consultation paper and "Network Resilience" more broadly, with the networks participating in this joint collaborative process by February 28, 2021. We will consider your feedback, both written, and at the stakeholder forum, as part of our regulatory submissions and our joint approach.

To provide written feedback, or if you have any questions about this paper, or the joint collaborative process, please contact your preferred distribution network operator:

- Kara Chan at kara.chan@ausgrid.com.au
- Samuel Morris at samuel.morris@endeavourenergy.com.au
- Natalie Lindsay at natalie.lindsay@essentialenergy.com.au
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- Brent McKillop at brent.mckillop@tasnetworks.com.au
- Brendon Crown at brendon.crown@powerwater.com.au

Contents

What is resilience?

The NSW/ACT/TAS/NT DNSPs have developed a definition of 'resilience'. We invite feedback on this definition so that, through stakeholder engagement, we have a common understanding of what resilience means in the context of our network infrastructure.

Resilience for an electricity network business is a feature of prudent energy system planning practices and an increasingly important topic both in Australia and globally. The concept of resilience is not a new one. In any industry, a resilient service can be considered one that is able to continue to provide its intended function in the face of an external shock, or if interrupted, can recover from that shock, and return to normal service in a timely manner. The joint DNSPs have agreed to a common definition of resilience in the context of their electrical networks. The words for the definition were chosen carefully to align with other relevant definitions in the public domain.

In the case of DNSPs, resilience is the ability to continue to provide *safe* and *reliable* supply in the face of a shock. *Resilience* encompasses the 'survivability' of network assets, but also the ability of staff and businesses processes within a utility, and more broadly the impacts to customers. As essential service providers, resilience can extend to the communities it serves. For the purposes of this paper, we will specifically be discussing natural hazard and extreme weather events, however, this could be applied to other shocks such as a cyber-attack. Electricity utilities have been investing, both in their assets and their operational capacity, to provide a resilient service for decades.

To help us engage with stakeholders on this topic, we aim to settle on a common understanding of resilience. Our initial position is to use the Resilience NSW Fire Inquiry definition, which has been adapted to acknowledge the objectives of electricity networks in relation to reliability, system security and safety.

Our definition of resilience

The ability to resist, absorb, accommodate, adapt to, transform and recover[1] from the effects of a hazard

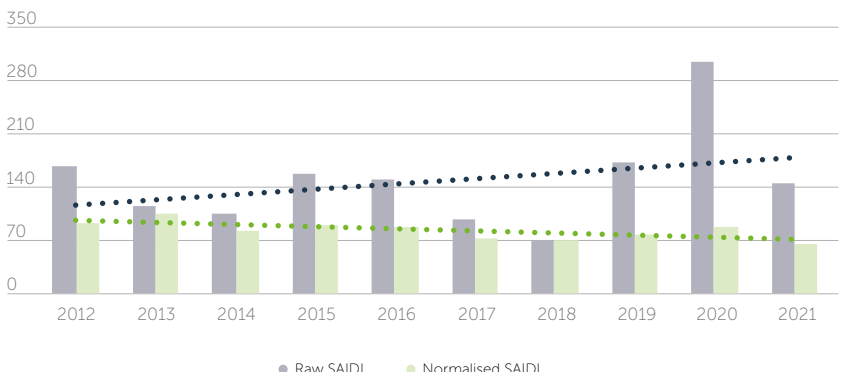
Resist	Building our capability to **withstand** impacts or **avoid** network destruction
Absorb/ Accommodate	Minimising **disruptions** to networks and customers and **supporting communities** during these events
Adapt/ Transform	Use **learnings** to identify **opportunities** or **anticipate** hazards to ensure the lived experience is acceptable to customers
Recover	Ensuring plans and processes provide energy **supply restoration** as **quickly** as possible
Hazard	Major disruptive event or chronic risk such as extreme weather events, cyber-attacks, or losses in power supply from fluctuations in intermmittent energy sources outisde of normal operating parameteres.

What is the relationship between resilience, reliability and safety?

Resilience encompasses the concepts of quality, reliability, security of supply, and safety - but it does so in the context of how these objectives are achieved in the face of natural hazard and extreme weather events. The relationship between resilience and reliability has been observed by the CSIRO. It noted that 'reliability is focused on the average network performance and seeks to minimise outage time during normal conditions as well as planned outages'[2] whereas 'resilience looks specifically at the 'bad days' and a network's ability to withstand them'. The CSIRO, importantly, concluded that 'this inherently implies that resilience will in effect increase reliability, but the reverse is not true; a network could dramatically increase its reliability and that would have little to no effect on its resilience'.

Data on the service levels DNSPs have offered to customers in recent years supports the CSIRO's observations. While many DNSPs have improved average network performance (SAIDI) there is an increasing trend in the number and scale of major event days (MEDs) that are excluded from reported reliability performance. Take, for example, Endeavour Energy's performance trends over the last decade. This trend is applicable to all electricity networks as demonstrated in the AER's Electricity Network Performance Report 2021[3] and does not account for customers lived experiences of prolonged outages.

Endeavour Energy
Raw vs Normalised reliability Performance (min/customer)



1. https://www.publish.csiro.au/rs/pdf/RS19005
2. https://www.publish.csiro.au/rs/pdf/RS19005
3. https://www.aer.gov.au/system/files/AER - Electricity network performance report 2021 - September 2021 - v1.1.pdf

The difference between the reliability performance and overlay of MEDs illustrates the difference between network reliability and resilience. Investment in resilience to match an increasingly volatile climate has the potential to reduce the difference between raw and normalised SAIDI and maintain the overall lived experience of customers.

Natural hazard and extreme weather events can also directly impact safety, especially where electricity infrastructure is involved. Transitioning networks to minimise safety risks prudently and efficiently to both the public and network staff before, during and after these disruptive events is also important.

With the probability of major climate events increasing (as demonstrated in section 3), the disconnect between 'reliability' and 'resilience' is expected to persist, and most likely widen. This will likely lead to increased safety risks, so it is important for networks to begin transitioning their asset management approaches in collaboration with customers and communities in high-risk locations. While an understanding of these concepts from an asset management and regulatory perspective is important, it may be less important to customers, who are already experiencing the impacts of climate change and its effect on reliability, whether excluded or not for reporting purposes.

What are networks required to do?

Under the National Electricity Law (NEL) framework, distributors are regulated to advance the National Electricity Objective (NEO).

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

- ***price, quality, safety and reliability and security of supply of electricity***
- ***the reliability, safety and security of the national electricity system"***

This requires DNSPs, amongst other things, to develop investment plans in accordance with expenditure objectives that the AER assess against the National Electricity Rules (NER). The expenditure objectives involve meeting or managing the expected demand for network services, complying with obligations and (in the absence of obligations) maintaining the quality, reliability and security of supply and the distribution system.

It should be noted that the AER must evaluate expenditure against the NER and the NEO, however, it can be difficult in accounting for emerging risks to the network.

The NEO variables of price, quality, safety, security, and reliability do not explicitly include resilience. Instead, it is the impacts of managing resilience on these variables that makes it relevant to advancing the NEO in the interests of customers. As the AEMC recently notes (emphasis added):

The NEO and NERO include a specific set of variables – price, quality, safety, reliability and security of supply – which must be objectively considered when assessing a rule change or a review. We must base our decision on how the outcome of a particular decision would impact on these variables, where relevant, and these variables alone. That said, other variables may be relevant to the extent they affect the price, quality, safety, reliability and security of supply. The impacts of climate change, and climate change mitigation and adaptation risk, on the price and reliability of electricity is an example of this.

In practice, to advance the NEO and meet the expenditure objectives, a network needs to consider resilience in developing its investment plans. A resilient network considers the evolving nature of the environment to which we operate. A key consideration to balanced and prudent network investment are the decision-making factors including probability, consequence, and cost. The key question is whether / how climate change should change how we quantify these factors going forward.

In addition to the NEO and the expenditure objectives in the NER, DNSPs are obligated to consider and address natural hazards and extreme weather events through legislative requirements relating to their Electricity Network Safety Management Systems (ENSMS). For example, the NSW Electricity Supply Safety Regulation 2014 part 7 (1) (a) requires the network operators to have an ENSMS in accordance with *AS 5577:2013 Electricity Network Safety Management Systems*. This Australian Standard requires a horizon scanning of hazards to the network and effective risk assessments (Formal Safety Assessments) as well as treatment plans. Whilst the ENSMS and AS 5577 fall under safety legislation, the assessments and plans must include consideration of risks to the environment, property, supply loss.

Additionally, the Department of Home Affairs is currently developing the Critical Infrastructure Bill which places obligations on electricity networks to minimise or eliminate natural hazards. As currently drafted, it requires that:

Responsible entities for critical electricity assets must, within 12 months of the commencement of this rule, ensure that their risk management program sets out how the entity will, so far as is reasonably possible, minimise or eliminate any material risk and mitigate the relevant impact from a natural hazard or disaster on the asset, including but not limited to bushfires, floods, cyclones, storms, heatwaves, earthquakes, tsunamis and health hazards such as pandemics.

The Department of Home Affairs has delayed parts of the Bill so that it can consult further on whether DNSPs should be required to eliminate risks so far as reasonably 'possible' or 'practicable'. If passed, this Bill would impose an additional and direct obligation on networks to manage climate risks.

In addition to the growing risk of climate change to DNSPs and the broader electricity market is also undergoing a substantial transformation, moving from a centralised system to an increasingly distributed system with a growing mix of renewable generation. This transformation includes increasing adoption of solar photovoltaic systems, electric vehicles and both utility scale and home batteries that create opportunities for customers to interact more dynamically with the electricity network. They may also create risks and opportunities to the resilience of the electrical grid. To facilitate these opportunities, new regulatory arrangements will be required to allow DNSPs to innovatively deliver a more resilient grid.

General principles for responding to resilience

We have developed a set of general principles for how we develop our investment plans for resilience, in accordance with the regulatory framework administered by the AER and our obligations under Australian Standards via the ENSMS (and, potentially, the draft Critical Infrastructure legislation). All DNSPs which have contributed to this consultation paper have agreed to these general principles, although there may be differences between how we apply them in practice. Our intention therefore is to consult jointly on the general principles below but then separately consult, via our respective customer forums, on how these principles should be applied.

Principle	Overview	Alignment with other investments
Targeted	Resilience investments will be targeted at the assets and areas most at risk (e.g. bushfire prone areas)	●
Customer benefits	Decisions to invest, or not invest, will be based on what unlocks the most net economic benefits	●
Risk based approach	Economic benefits will be calculated by comparing forecast costs and the monetised value of risk	●
Evidence based	Probability of events driving resilience investments will be informed by evidence	●
Time horizon	Costs and benefits associated with an investment will be assessed over the life of the asset (40 or more years)	●

Questions:

What does resilience mean to you?

What do you see as the role of electricity networks in responding to climate change?

What are your views on the set of general principles we have developed for considering resilience investments?

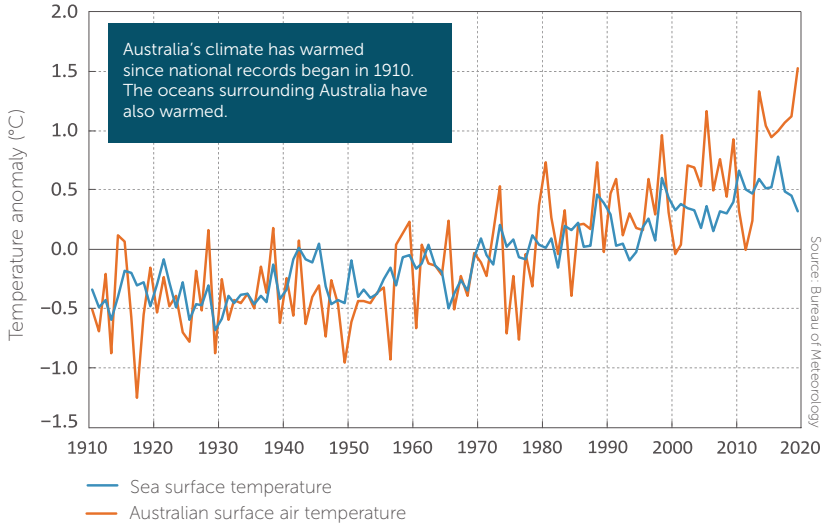
What has changed

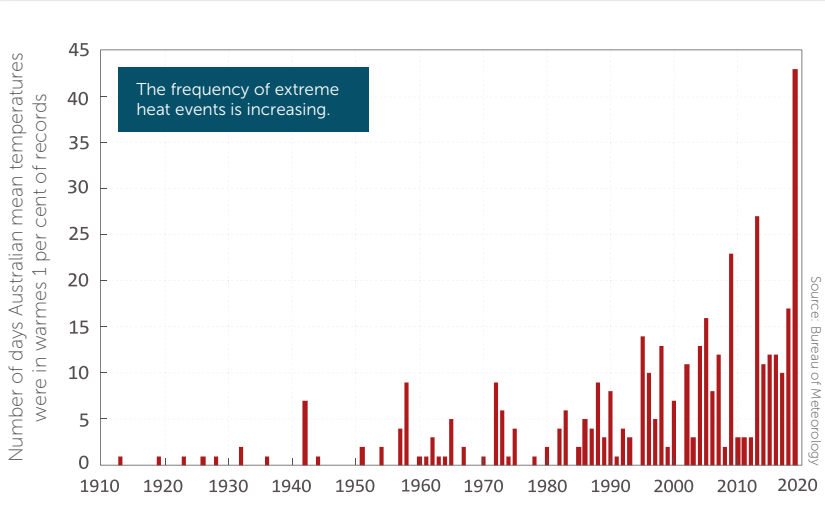
Australians have generally enjoyed the benefits of a highly resilient, secure, and reliable energy system. However, there are several escalating challenges that present an increasing risk to the resilience of electricity networks into the future. With global mean temperatures increasing, there is an increase in more natural hazards and extreme weather events and therefore an increased likelihood or probability of events that will impact the network.

Globally, it has been confirmed by climate scientists that human influence has unequivocally warmed the atmosphere and oceans. Human-induced climate change is already affecting many weather and climate patterns across the planet.[1] In 2019 Australia experienced its warmest year on record, warming is projected to continue under all likely emissions scenarios[2]. In recent years, along with the rise in temperature, Australians are seeing increasing numbers of events. In 2019-2020, Australia experienced a series of natural hazards and extreme weather events resulting in bushfires, floods, droughts, sea level rise and east coast low-pressure storms.

The cost of natural hazard events in Australia has more than doubled since the 1970s and totalled $35 billion over the past decade[3]. The frequency and magnitude of these events are increasing due to climate change and will affect future generations more profoundly. It is estimated that the total financial cost of natural hazards will average $73-94 billion per year by 2060 without significant investment in resilience and mitigation[4].

We are now starting to see observable impacts to communities and businesses. Natural hazards and extreme weather events increasing frequency reveal the vulnerability of Australian communities and infrastructure, including the electricity grid. To address the current climate crisis, Australian state and territory governments, and most recently the Federal government, have committed to achieving Net Zero emissions by 2050.





(source: http://www.bom.gov.au/state-of-the-climate/index.shtml and http://www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml)

1. Intergovernmental Panel on Climate Change – Climate Change 2021 The Physical Science Basis
2. Temperature Change (climatechangeinaustralia.gov.au)
3. https://www.climatecouncil.org.au/resources/hitting-home-compounding-costs-climate-inaction
4. Australian Business Roundtable for Disaster Resilience & Safer Communities 2021

Without accounting for climate change impacts when making network investments, there is risk of locking in higher costs and greater risk for the customers being served by that network over its 50-year life. As it stands now, the resilience of the assets that provide our current electricity supply is dictated by the decisions and design principles adopted by those that built the network at the time of installation (mainly in the 1970's and 1980's). Likewise, those people being supplied by the electricity network in 2065 will be living with the risk and cost implications of the investment decisions we make today. It is therefore critical that electricity networks, and regulatory authorities, consider how our climate might change over the next 40-50 years, not just the next 5-10 years.

Why is network resilience important?

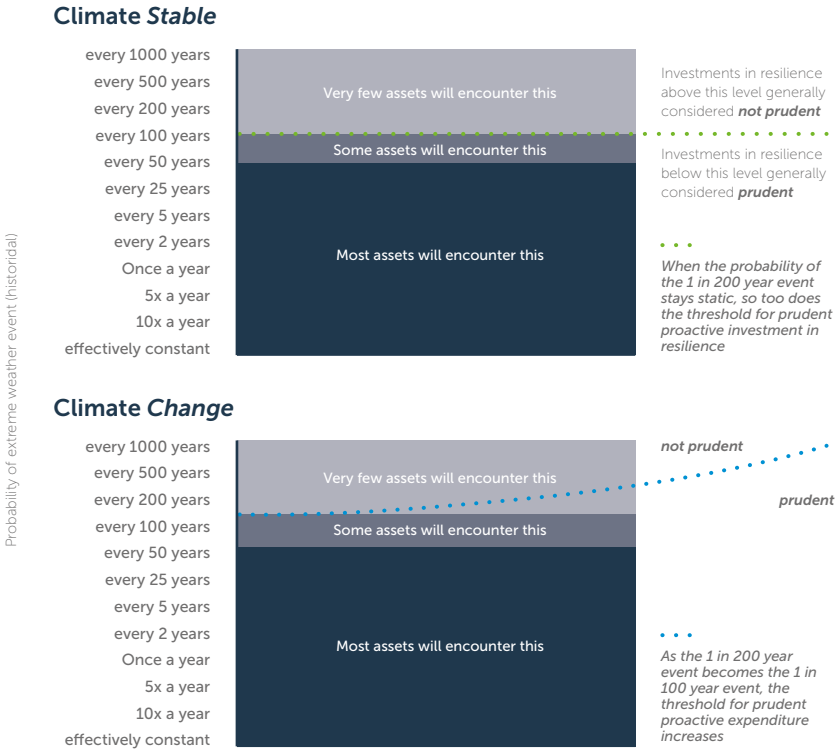
Natural hazard events can affect electricity network infrastructure in a number of ways as CutlerMerz identified in a report for Energy Networks Australia:

- Strong winds may directly bring down overhead lines and poles, while falling trees and tree debris may also cause significant damage to overhead lines and lift underground cables.
- Flooding may inundate substations and underground assets, rendering them unusable. Flooding can also cause accessibility issues, resulting in extended restoration timeframes after an event.
- Bushfires not only burn through above-ground network assets, but electricity networks are a common source of ignition for bushfires, particularly on extreme fire weather days.

These impacts have the potential to lead to long duration outages for customers and can affect communities' ability to absorb and recover from natural hazard events. The costs of natural disasters comprise the following[1]:

As a provider of an essential service, damage to our assets triggers broader impacts at both a *widescale* (many communities serviced) and *local community* scale. Electricity is central to the delivery of numerous widespread essential services, as shown in the following diagram.

Hypothesis:
a changing climate means the threshold beyond which investment in resilience is no longer economic is shifting lower



Quantified economic and social costs of natural disasters in Australia

Asset Damage	Financial costs	Social costs
Residential damage	Public asset damage	Family Violence
Commercial damage	Clean up costs	High risk alcohol consumption
	Reduced economic activity from agriculture	Injuries
	Emergency response costs	Fatalities
	Temprorary housing costs	Exacerbated chronic illness
	Evacuation costs	Mental health impacts

(source: Deloitte Access Economics 2021)

1. https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-abr-natural-disasters-061021.pdf

WIDESCALE Interconnection Dependencies

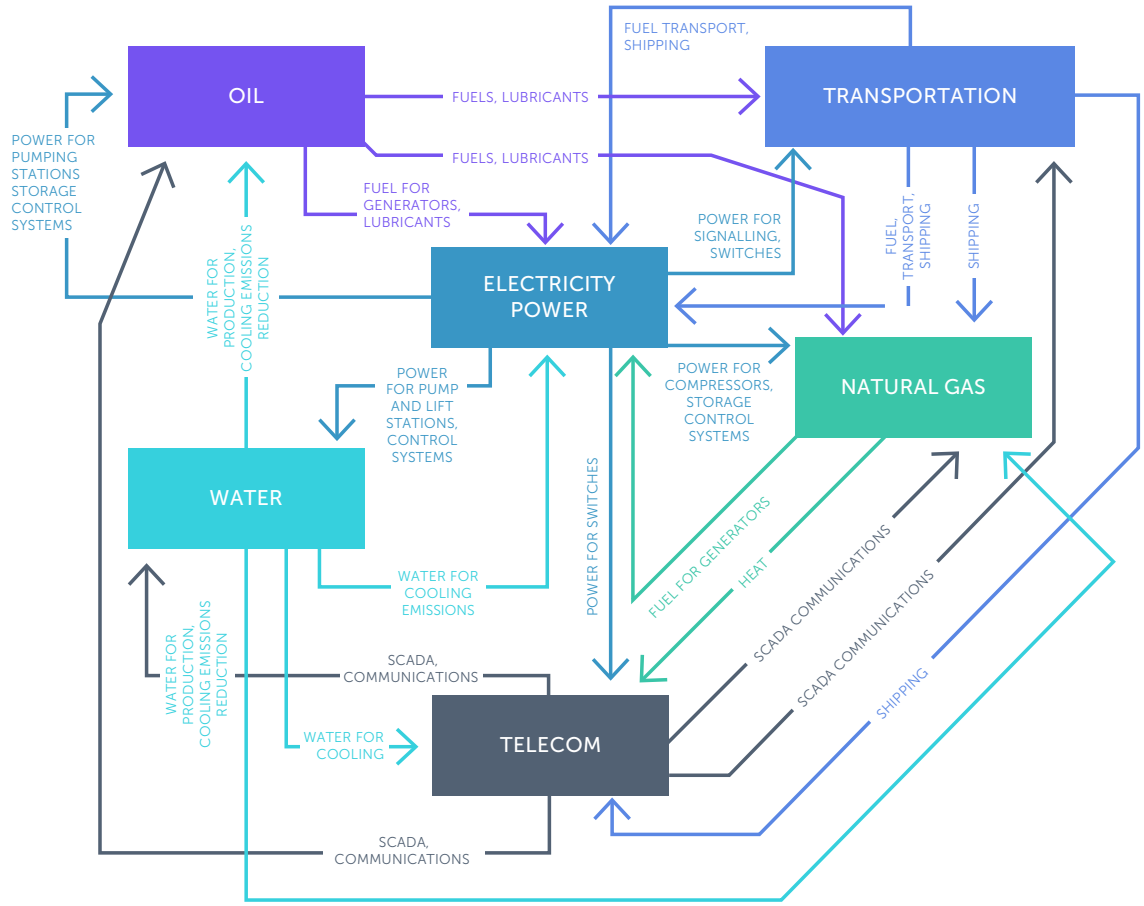


Figure 1: Examples of infrastructure interdependencies for selected critical infrastructure systems. Critical Infrastructure Resilience Strategy — Emergency Management Victoria (2015)

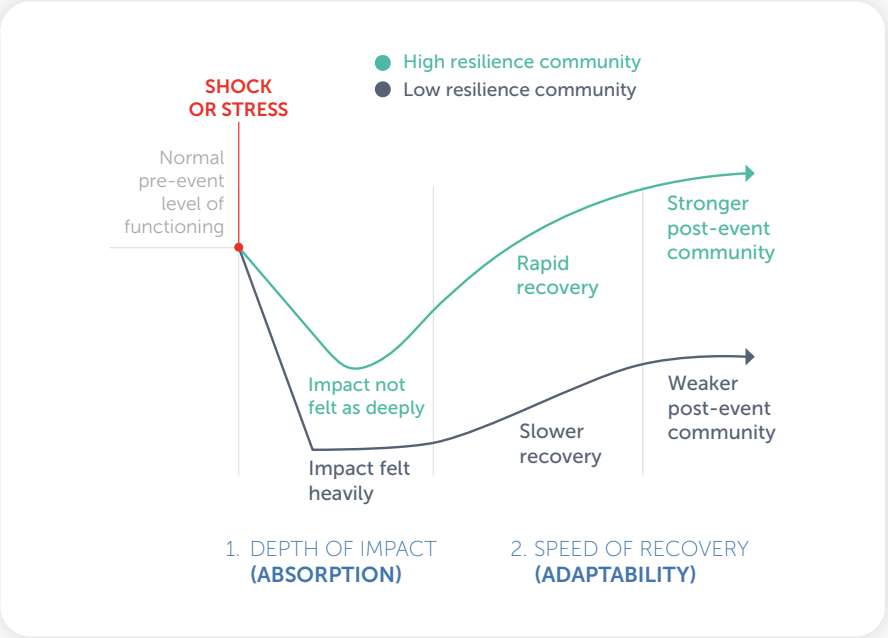
To be effective when thinking about network resilience, we need to acknowledge the complexities and interconnections that increasing digitisation has created for the delivery of essential services at all levels across society. As digitisation continues to increase, the degree to which our communities rely on the reliable supply of critical services such as water, wastewater, and health (and the electricity supply that underpins them) also increases. An extended electricity outage has a higher consequence today because of this increased reliance on telecommunications, than it did just 25 years ago. A similar shift is likely to occur as society transitions to electrified transportation, highlighting the importance of a resilient electricity network. The resilience of the electricity network is increasingly a key determinant of its reliability.

In addition to the wide-scale community dependencies on electricity there are many local community dependencies. The following are examples of the services which support communities generally but are also important to how well they respond and recover from major disruptive events:

- Petrol stations
- Local health services - hospitals, medical centres, pharmacies, etc.
- Aged care and Disability care facilities
- Supermarkets
- Emergency service hubs (Fire, Ambulance, State Emergency Services, Incident Operation Centres and Emergency Operating Centres).
- Council services
- Places of community refuge and support (food banks, etc.)
- Schools
- Veterinary services
- Local water and waste treatment plants
- Accommodation providers (particularly to support emergency response)

These are examples of services which communities rely upon every day and even more so in a post major event recovery phase. All these services have a high dependency on having a power supply available to continue functioning effectively in a crisis. This necessity must be incorporated into resilience plans at a state, community, local business, and network service provider level, and highlights the broad economic and community impact of extreme weather. It is important for DNSP's to proactively engage and collaborate prior to natural hazards with other critical infrastructure partners, government, and local communities to improve resilience before any major events occur.

Electricity supply vulnerability needs to be communicated, understood, and accommodated in resilience plans to reduce the impact of extreme weather events and support rapid recovery. Learnings from past events highlight that community resilience and recovery from events is dependent on continued access to essential goods and services, particularly those services that are crucial to assisting the vulnerable during and after disruptive events.



(Source: National Disaster Resilience Strategy ANHMC Conference 2019)

How is network resilience changing?

While climate action aims to mitigate future greenhouse gas emissions, climate resilience is targeted at prudently responding to the negative impacts of climate change, such as extreme weather events. Climate resilience within the context of electricity networks aims to make cost effective decisions within the context of a changing climate. It also may explore things such as collaboration with other resilience organisations about providing communities with the strategies, tools and learnings required to recover from these events with as minimal impact as possible.

Natural hazards and extreme weather events such as temperature, precipitation, sea-level rise, lighting and storms, wind, compound extremes, snow and ice, hail, humidity, and solar radiation all expose the electricity network to climate-related risks. When the probability of extreme weather events changes, so too does the likelihood of individual network assets being damaged or needing to be replaced before they reach the end of their economic life. The objective of network investment is to maintain the quality, reliability, security, and safety of the distribution system, so any change to the probability of extreme weather events inherently changes the decision about what gets built. Overall, the changing probability of these events increases the risk of failing to meet regulatory requirements and customer expectations and exposes vulnerable customers to even higher risks.

Electricity network resilience is an emerging theme in our customer research and engagement activities which is unsurprising following several natural disaster events during 2019-20. This sentiment is captured by a report commissioned by Energy Consumers Australia (ECA) in relation to the East Gippsland Community following the 2019-20 Bushfires – The Connections That Matter.

This ECA report provides a valuable insight to the experience and priorities of a community recovering from a natural hazard or extreme weather event. It highlights the growing importance of network resilience, and where improvements can be made to better meet the expectations of customers. Some key insights include:

ECA report disaster recovery insights

Network resilience is increasingly important and customers want to know more about it	*The crisis experience increased the perceived importance of energy security and meant that many people were looking for greater communication with their energy network, particularly about what is being done to minimise disruptions to the network*
Quick restoration of supply is valued but not at the expense of future-proofing assets	*One such source of frustration has been the tension between quickly rebuilding assets to get electricity supply back online and taking the time to make sure the rebuilding process leaves residents and business owners better prepared to withstand future crisis events.....* *.....The initial focused response to the re-establishment of critical infrastructure was welcomed. However the rebuild of the network infrastructure was also viewed as a missed opportunity to establish a new, better and ultimately more flexible and resilient energy system.*
Customers are interested in options they can explore to improve resilience	*It also became apparent that the crisis experience had for many people heightened their desire to secure a self-sufficient energy source. This desire was not only an effort to safeguard the technologies (mobile phones, emergency service apps) that underpin access to critical information in the midst of an emergency but also provide a sense of security and self-sufficiency in the event of other crises, such as network infrastructure failure.*
Innovative network options need to be considered	*When participants were asked what energy companies could do better in terms of energy provision, participants were often looking for new solutions whether community-wide backup battery programs or other stand-alone systems that would, in their minds, deliver greater reliability....* *....What was clear is that there is a strong interest in different energy technologies, and people are thinking about how the local 'system', including everything from rooftop solar PV, batteries and small portable generators, to the traditional 'grid' infrastructure, works together to provide the secure and reliable services the community needs, particularly in the advent of a crisis.*
It is a shared responsibility	*This proactive, very practical and flexible local response seen across the different East Gippsland communities is suggestive of an intrinsic community mindedness and ability to draw closer together in a crisis that should be seen as core to the concept of energy resilience. In this light, there appears to be a need for energy service providers, governments and energy sector institutions to undertake further research, planning and policy work about the aspects of resilience which go to empowerment at an individual business, household and community level.*

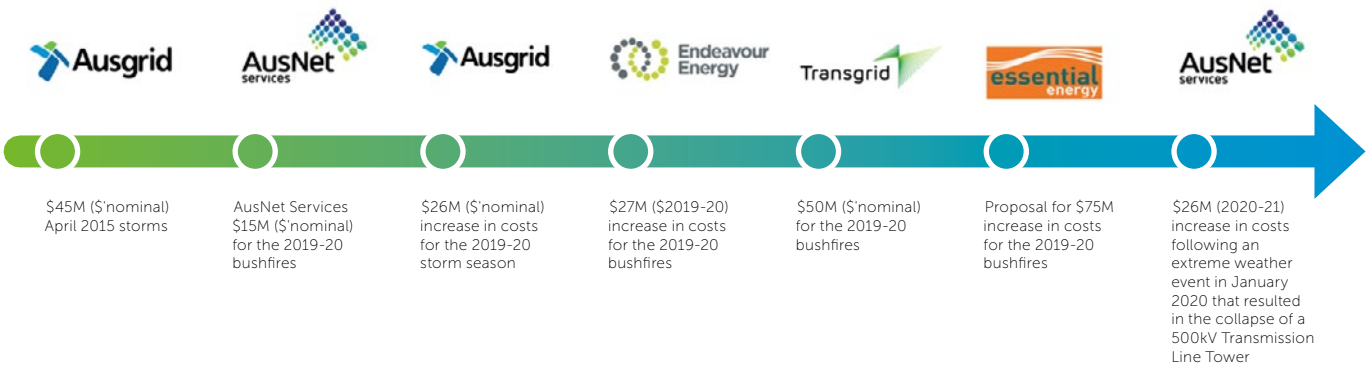
Managing resilience in the regulatory framework

In responding to these climate risks, the emergence of DER and our regulatory and legislative obligations, DNSPs must demonstrate that any associated expenditure is both prudent and efficient. Managing network resilience involves proactive and preventative measures, as well as reactive measures, including:

- Capital expenditure programs targeted at redesigning or reconfiguring grid assets or strengthening more fragile parts of the network. These investments will be led by cost effective planning and would require detailed business cases to be consulted on with customers and approval from regulators.
- Operating expenditure to reflect:
  - known changes in regulatory obligations such as the impacts of the Critical Infrastructure Bill on ICT spend.
  - known changes for factors outside of a networks control such as increasing insurance premiums following a tightening in global insurance markets and increasing guaranteed service level payments and other support measures.
  - efficient trade-offs between network solutions such as, the decision to incur increased maintenance, inspection and/or emergency response costs, or to invest in network upgrades or reconfiguration.
- Cost pass-throughs and contingent projects to manage uncertainty in operating and capital plans respectively. The regulatory framework recognises that it may be more efficient to manage low probability, high consequence events of uncertain timing or cost via ex-post adjustments to revenue.

To date, cost pass-throughs have been the primary means by which electricity networks have managed the impacts of natural hazard events. Cost pass-throughs involve specifying a list of possible events that may trigger the re-opening of a revenue determination for positive or negative adjustments. A natural hazard event is one of several cost pass-through events that is available to networks.

Cost pass-throughs are based on the principle that customers should not pay for investments that may not be required, instead, the AER can decide on the revenue required to fund these costs only where a certain event occurs. The alternative is for networks to invest more upfront to reduce the impact of any natural hazards that might occur. Eight pass-throughs for natural hazard events have been approved or submitted in the last several years including:



There are advantages and disadvantages to the proactive and reactive options available to networks. A reactive approach only recovers costs from customers where they are an incurred. However, if the frequency and severity of natural hazards continues to increase this could result in large, unexpected increases to network revenues and bill shocks. While proactive investment in resilience does not necessarily eliminate the risk of impacts to the network from natural hazards, it provides an opportunity for a lower or optimised investment programs relative to reactive asset replacement.

We are interested in stakeholders' views as to the appropriate balance for managing network resilience. Networks use a combination of strategies when investing in their assets.

We consider the upcoming 2024-29 regulatory period is the appropriate time to embed the potential impact of climate change systematically in our investment decision-making. This will ensure that climate resilience is significantly improved, not within one regulatory period or even two, but rather incrementally over the next 40– 70 years (and beyond) as assets are retired, fail, or are otherwise destroyed and possibly replaced with a more resilient solution

Given affordability is a key issue for customers and growing reliance on electricity networks, a balanced approached to providing a resilient service is important. Networks must consult on the appropriate response to these challenges and whether the current balance between proactive and reactive measures remains appropriate.

What is our initial view?

In complying with our obligations and meeting the expectations of our customers, we believe a steady move to a more proactive and considered approach to minimise the risk and impacts of natural disasters on the grid is now required. We are increasingly recognising that the past is no longer an appropriate predictor of the future, and that a changing climate is a reality that we must adapt to.

At the NEM level, AEMO has set out several improvements and further considerations that can be made to improve the resilience of Australia's energy system:

1. Improve risk analysis and risk evaluation – better capture and quantify climate and other risks in integrated market modelling and project benefits assessments. Increase the use of natural hazards, extreme weather, and power system case studies to explore integrated resilience risks that cannot be fully quantified, yet likely yield unacceptable outcomes for society.
2. Improve planning standards – better capture climate and resilience considerations and the appropriate level of consumer risk aversion in the process of energy system design and technology planning. Ensure proposed solutions that enhance the resilience of the system are built to high standards with fit for purpose asset and system specifications.
3. Improve operator flexibility and procedures – provide additional operator flexibility to manage system resilience and security in the presence of increasing and coincident hazards. Improve forecasts of near-term extreme weather and natural hazard events.
4. Improve cybersecurity risk management – improve the cyber maturity of all energy market participants to understand where there are vulnerabilities, and ensure regulatory procedures are sufficient to deal with any potential cyber incidents in the NEM. Strengthen cyber security incident response and recovery arrangements at a jurisdictional and national level to enable the coordinated and swift management of incidents to reduce impacts and maintain community confidence.

At a distribution network level our immediate priority is to better understand and predict future scenarios so we can begin to mitigate the adverse effects of natural hazards and extreme weather events on our systems and communities. This will be achieved using evidence-based analysis and modelling, a focus on new technologies and mitigation strategies, along with robust customer and stakeholder consultation to shape the future of our networks.

Achieving a resilient electricity grid that supports resilient communities is going to require multiple adaptation strategies. Our goal is to continue providing an affordable, resilient, and flexible electricity network. We want to ensure that our customers can be confident that, even in a changing climate, that DNSPs are working on maintaining electricity supply they are used too and will continue to have power day to day at their home or business.

Questions:

Do the current measures of reliability within the regulatory framework (average duration and frequency of outages) reflect what customers value today in terms of service outcomes?

Should networks be more proactive in responding to the impacts of climate change?

What factors should be considered in making these decisions?

Community resilience

Research shows that Australians are not often adequately prepared for natural hazard events, even when they live in disaster-prone areas[1]. Although each event and situation can be different, communities and networks can work together to mitigate the effects through preparedness. The ECA's study on the East Gippsland Community following the 2019-20 Bushfires found that[2]:

A major finding from this study was that resilience was as much about the individual and community relationships and networks, and trust-based engagement with local service providers, as it is about the 'hard' infrastructure or the official emergency response and recovery efforts.

In many cases it was the local community that self-organised to dispose of spoiled food from fridges and freezers without power, or to open-up their own homes (particularly those with 'off-grid' power supplies) to help their neighbours charge their phones and stay connected to the outside world.

That is why it is critical for DNSPs to not just focus on the actions it can take in improving network resilience but to also understand our role within the community and how we can support community efforts to manage these risks.

The bushfires of 2019-20 are an example of the requirement for effective community preparedness and resilience. These bushfires were unprecedented and caused extensive damage to electricity networks across Victoria and New South Wales. Due to the extensive damage, and the safety hazards associated with obtaining access to damaged assets, many communities were left without power for days, even weeks. Communication systems were also affected meaning these communities had limited information regarding when power would be restored. Many of these communities were remote and as such access was cut off meaning limited access to other energy sources such as fuel, and other essential supplies such as food and even water.

Following the 2019-20 bushfire season, the NSW Government initiated a Bushfire Inquiry to make recommendations for future improvements. The Final Report made specific recommendations relating to increasing the resilience of electricity networks. Specifically, it recommended that the NSW Government work directly, or together with other Australian governments and/or their relevant power and telecommunications regulatory, policy and market bodies, to:

- *ensure there are sufficient redundancy options available (e.g. backup diesel generators, deployed temporary telecommunications facilities, etc.) to supply power to essential telecommunication infrastructure or alternative telecommunications infrastructure.*
- *ensure that the telecommunication entities' and electricity network providers' Bush Fire Risk Management Plans are updated annually and reported on in the NSW RFS Commissioner's annual statement to Parliament on the upcoming bush fire season and include details of all actions taken to mitigate those risks including maintenance of APZs and access roads.*
- *ensure there is appropriate auditing of distributors' preparedness for risks arising from network assets being affected by bush fire, as well as the risk of networks initiating a bush fire*[3].

These findings and recommendations emphasise the importance of a continuous energy supply in mitigating the risk and impact of natural hazard events by creating resilience in the electricity network. The issues identified are likely to be amplified over time as bushfire risks and their severity increase due to climate change.

In the sections below we provide an initial view of the support we can provide in addition to how we plan, manage, and operate the network itself and the steps individuals can take. It is important for networks and communities to engage outside of natural hazard periods so that expectations and opportunities in this area can be explored. As part of this paper, we would like your feedback on how DNSP's can aid communities to become more prepared for the increasing number of events.

Training and Education

Electricity network providers licence conditions oblige them to undertake public awareness campaigns, however, more could be invested, in conjunction with state and territory government emergency services, to help communities and their leaders become more resilient to extreme climate or natural hazard events.

In the Northern Territory, Power and Water Corporation is a vital team member in the Northern Territory's emergency response during extreme weather events, natural hazard events or other major incidents. It works closely with SecureNT, along with other government agencies and emergency services to ensure essential services are restored quickly and safely. Through its "Protect What's Precious" campaigns, Power and Water provide information on how customers can plan for damaging weather events, prepare their home to be resilient, and protect themselves during dangerous weather events.

Providing community preparedness education, training, and overall scale in the context of more recent extreme weather events up is not currently budgeted for by NSW, ACT, or Tasmanian electricity distributors.

1. https://knowledge.aidr.org.au/resources/ajem-apr-2017-emergency-preparedness-through-community-sector-engagement-in-the-blue-mountains/
2. https://energyconsumersaustralia.com.au/wp-content/uploads/ECA-Connections-That-Matter-August-2021.pdf
3. Final Report of the NSW Bushfire Inquiry, Recommendation 30, July 2020, pg xii

A key part of preparedness is providing the right training for community leaders. Leaders and other designated personnel need to know their roles and responsibilities during events so that they can successfully lead during extreme weather events. Training should also span across different community organisations and emergency response teams. It is important that there is a focus on scaling-up of set response plans, so that leaders can respond quickly in a coordinated approach. This requires training which can include running drills and conducting disaster exercises so that when a real disaster hits, communities have leaders who are well prepared.

Networks already undertake a level of public education around electrical safety through several approaches such as attending schools or providing teachers with curriculum materials, attendance at community events and advertising through newspaper, radio or social media. With customer, stakeholder, and regulator support, this could be extended to include training courses on the basics of how electricity behaves, how to spot electrical hazards, keeping a safe distance from downed powerlines, what to do with a downed power line, what to do if equipment has come into contact with a power line, and how to move people out of areas energised by a downed power line[1].

Households

Community resilience can further be achieved by individual households being prepared. Household preparedness includes developing emergency preparedness kits that have a family communication and evacuation plan, at least three days' worth of non-perishable food for your family members, 3.5 litres of water per person per day, flashlights, battery powered radios and extra batteries, first aid kits, blankets, copies of personal documents, and other items that households may need such as medication, extra cash, and personal hygiene items[2].

This level of preparedness may not be widely known to many households and communities, and this is an area of education where DNSP's could extend their services to partner with local councils or government emergency services to help broaden knowledge on this topic.

Community infrastructure, collaboration, communication, and expectations

Communities can become more resilient by also building responses to (relevant) natural hazards as part of their community planning. Community planners should have designated community facilities that can double as emergency shelters and areas of refuge for people who may not have essential service or may need to be evacuated. Communities should also investigate options for these facilities to be self-sufficient in times of natural hazard events, for example being equipped with fuel tanks, solar panels and battery set-ups and a generator.

Communications is a key area that can be critical to community resilience and setting expectations. There are emergency notification systems that communities can have in place to alert their residents of disaster such as mobile phone notification systems, outdoor warning sirens, and satellite phones in community halls. As DNSP's it is our role to work closely with communities, local governments and first responders to continuously improve the way we operate. There are ways to improve communicating outages, including investigating ways to provide updates in-language to culturally and diverse communities.

The Energy industry and signatories of the Energy Charter are currently collaborating on the #Bettertogether Resilience working group with the aim to support customers before, during and after a disaster event. Industry is developing a Disaster Response Playbook for the energy sector with clearly defined roles, processes and use of emergency response agency information – enabling a more coordinated and process driven approach to customer support.

As network providers, we could also play a role in aiding community planners to preparing critical facilities. We could assist with considerations of things such as more secure connections, backup batteries, Stand Alone Power Systems (SAPS), or investing in a fleet of mobile diesel generators.

Other practical considerations for communities during prolonged outages, such as hot meals, showers, laundry services, and backup generators for houses or community gathering areas fall under the remit of government emergency services, but networks could assist in this area through the provision of portable generators for power and could explore other innovative ideas.

Following the bushfires of 2019-20 and the associated impact these had on communities, in particular the community of Mallacoota where power was out for multiple weeks, Energy Consumers Australia commissioned a study to understand the experience of energy customers during these bushfires and identify lessons learned about ensuring a more resilient network[3]. Key findings from this study include:

- the importance of energy security, and the need for customers to secure their own energy supply (e.g., mobile diesel generators) instead of relying only on the electricity network.
- that many other essential services rely on the electricity network and prolonged outages significantly impact the ability to stay informed, communicate with others and safely evacuate an area.
- that the network was largely rebuilt as it was (except concrete poles were used instead of timber poles) and this was a missed opportunity to engage with the community regarding the use of new and emerging technologies, such as community batteries, SAPS or a microgrid, to deliver a more reliable electricity solution for the future.

The study highlighted the need for networks to engage further with their customers to better understand their expectations around network resilience. This engagement should occur as part of preparing for natural hazard response rather than when responding to natural hazard due to the urgency to restore supply.

Questions:

Should electricity networks play a role beyond education and communication to help communities prepare for extreme weather events and possible disruptions of power? If so, how?

The Network providers have played a role in helping communities respond to extreme weather events to varying degrees. What do you expect from your provider in this situation?

1. https://www.bchydro.com/safety-outages/electrical-safety/worker-training/first-responders.html
   https://www.energynetworks.com.au/resources/reports/national-research-priorities-for-natural-hazards-emergency-management/
2. https://www.redcross.org/get-help/how-to-prepare-for-emergencies/survival-kit-supplies.html
3. https://energyconsumersaustralia.com.au/publications/resilient-system-resilient-communities-the-connections-that-matter

Network resilience

Risk assessment framework

Historic planning practices have delivered networks that provide a high level of reliability and are resilient to the typical historical climate conditions experienced by those networks. However, these practices and key assumptions need to be challenged and reviewed given the changing nature and severity of extreme weather events and natural hazards. Networks must ensure that their prudent planning practices today produce affordable investment plans that will maintain a reliable and safe network for the decades to come.

To be able to assess, measure, respond and adapt to climate risks, many DNSPs are undertaking the development of a common risk assessment framework. The development of a framework will allow DNSPs:

- to identify risks and vulnerabilities in each network.
- to identify opportunities for investment to improve resilience in the face of increased likelihood of major events.
- to have oversight and governance into the businesses.

The framework will impact on and inform network operations, asset management and investment, network planning, emergency response, planning, and risk quantification decisions based off a cost benefit analysis. The framework will align with the requirements of the international standard for risk management ISO 31000.

To assess the risk with the climate hazards, the likelihood of the event occurring, the potential impact of the hazard on the network, and the likelihood and consequence of that impact occurring needs to be assessed. To achieve this, the following high-level process will be undertaken by each DNSP:

1 Identification of Hazards	– Review past hazard events (scale/impact, frequency, duration, type) by individual DINSPs and in the industry – Using climate models, determine the likelihood of future climate events inshort. medium and long term cycles. – Quantifying consequences of events in terns of network operations, asset survivability and customer behaviour pattems.
2 Network Vulnerability Assessment	– Using SMEs to assess critical network components to identified climate hazards based on impactand severity and treatment options – Determine areas of network vulnerability
3 Development of Potential Opportunities	– Workshop potential opportunities (network investment, maintenance strategies, network planning, emergency response initiatives, collaboration opportunities), comparing to local and international industry – Comparison of opportunities based on cost, effectivness and community benefit
4 Development of Pathway	– Develop transition pathway, identifying barriers and potential pitfallsto achieve success – Set targets and track progress against targets
5 Continual Review / Consultation	– Consultation with various industry (CSIRO and BOM) bodies and customer engagement groups – Review risks/treatments/opportunities on a regular basis, to ensure effective and efficient

(A similar alternative to the above framework is the Climate Risk Assessment Framework contained in ENA's Climate Risk & Resilience Industry Guidance Manual).

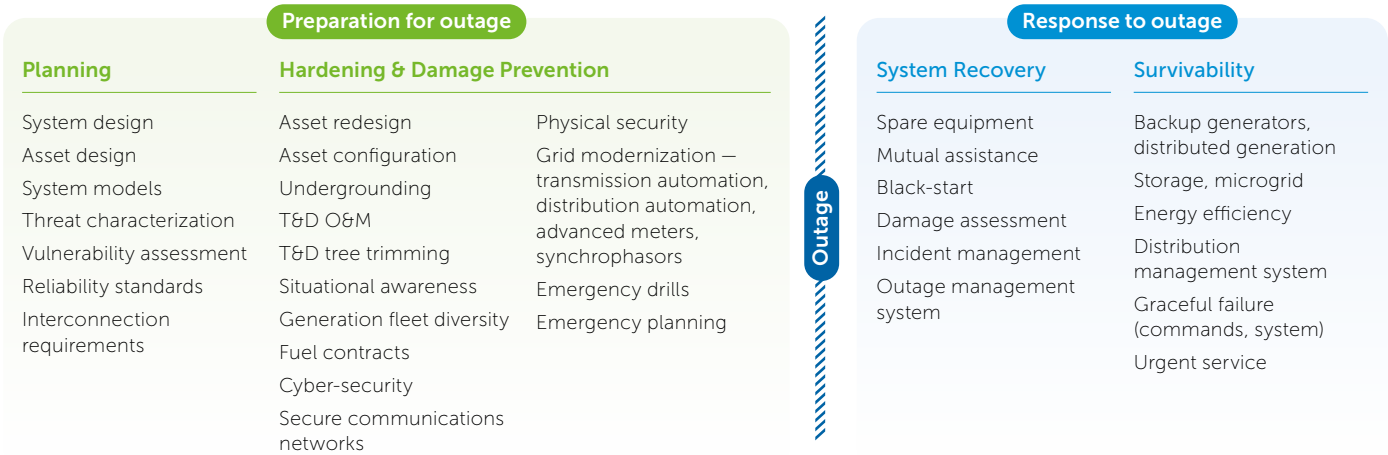
The risk assessment process will be undertaken in alignment with the AER's industry practice application note for asset replacement planning (Jan 2019), which outlines the principles and approaches when undertaking investment analysis and input assumptions such as the value of customer reliability. It is important that the latter is fully informed by the increasing hazards to ensure customers continue to receive a desired level of reliability.

Valuing network resilience

As noted earlier, DNSPs are vulnerable to risks from the impacts of climate change. The increasing frequency and severity of extreme weather events can result in damage to or from the network, which in turn can lead to broader economic and societal impacts. Managing these risks can involve both pre-emptive and post-outage actions[1]. It is important that networks strike an appropriate balance between options to develop a value of network resilience mitigation solutions. This balance may promote the adoption of alternate network solutions that would otherwise not be competitive with traditional options or ensure the appropriate sizing of them.

1. https://gridprogress.files.wordpress.com/2018/05/customer-focused-resilience-final-050118.pdf

Smart meter data and visibility of the low voltage network underpins resilience efforts



Findings from the National Institute of Building Science in the United States indicates that the cost savings from investing in risk mitigation could result in savings amounting to a ratio of 1:4[1]. From an DNSP perspective there have been several attempts to develop models for quantifying and valuing network resilience.

Currently reliability is relatively straight-forward to quantify and monetise by using the Value of Customer Reliability (VCR) measure. However, while the current VCR measure is appropriate for valuing localised, short duration outages (up to 12 hours), it does not allow for large scale societal impacts that occur from highly disruptive low probability events. This sort of valuation was previously reviewed by the AER; however, consensus was unable to be reached on an appropriate approach to valuing the impacts of large scale events. From a DNSP perspective, there may still be value in developing a way to monetise the value of large-scale major events. This may be further refinement of the current VCR, or it may involve broadening the costs associated with standard VCR as noted by the AER[2].

Large scale outages can also lead to lead to health and safety impacts. For example, the 2020 Royal Commission in National Natural Disaster Arrangements (RCNNDA) found that the loss of electricity supply immediately before, during and after natural disasters negatively impacted on the function of dependent services, resulting in health and safety impacts to people that rely upon those dependent services and delaying disaster response and recovery efforts. Safety and health impacts can be monetised using the Value of Statistical Life (VoSL) and Value of Statistical Life Year (VoSLY)[3]. As with the VCR measure, there may be a need to define alternative VoSL or VoSLY measures for use in the context of large-scale events. This reflects existing practice in safety risk management, where multiple incidents involving only single or low numbers of injuries or fatalities are treated differently than a single incident involving multiple injuries or fatalities.

As a result of the above factors, there is not currently a prescribed or common value methodology that can be used by networks to value and assess network resilience investments. We suspect a pre-emptive approach to adapting to these changing circumstances may become more efficient and prudent in dealing with the increasingly frequent and severe consequences. As noted by Deloitte[4]:

The Australian economy is facing $1.2 trillion in cumulative costs of natural disasters over the next 40 years even under a low emissions scenario. This shows there is the potential for large economic gains from investments to improve Australia's resilience to natural disasters. Targeted investments in both physical (such as infrastructure) and community (such as preparedness programs) resilience measures are predicted to significantly reduce the increasing costs of natural disasters. Investments in disaster resilience can be effective in lowering these costs, particularly if investments are maintained over a number of years.

However, it will be incumbent upon each network to engage with their customers and the AER to measure and value network resilience related investments to demonstrate their efficiency and prudency. It is worth noting that there may also be other mechanisms to address climate change risks through partnerships with other parties. We will actively seek opportunities to collaborate with other energy networks, government, councils, and other resilience-based organisations may be undertaken.

In the following sections, we provide an overview of the types of solutions and actions networks can take in response to various climate related risks. This is to understand initial expectations and views of stakeholders which will help inform our efforts to quantify and refine our plans. We appreciate that these views will be subject to a full and transparent account of the ultimate cost and bill impacts of these initiatives.

Mitigative measures

An electricity network does not need to be fully resilient towards major events. More importantly, customers would likely be unwilling to pay for such an outcome. Rather, network resilience is about making customer supported, prudent, incremental changes in investment decisions to 'harden' the network. This will most likely be:

- in locations where the network provides infrastructure that is identified as critical to nearby customers and communities.
- to reduce the vulnerability of remote communities.
- in locations where there are accessibility issues.

1. https://www.fema.gov/sites/default/files/2020-07/fema_ms2_interim_report_2017.pdf
2. https://www.aer.gov.au/system/files/AER%20-%20Values%20of%20Customer%20Reliability%20-%20Widespread%20and%20long%20duration%20outages%20-%20Final%20conclusions%20-%20September%202020.pdf – pg 21
3. https://obpr.pmc.gov.au/resources/guidance-assessing-impacts/value-statistical-life
4. https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-abr-natural-disasters-061021.pdf

Data is imperative in times of crisis

During major events and natural hazards, networks are constantly asked for up-to-date data from a range of stakeholders. A lack of data was the single most significant stakeholder management issue for Essential Energy during the 2019-20 bushfires.

With only 20 percent smart meter penetration* and limited access to smart meter data, the business could not provide accurate details as to the number of life support customers without power, or the total number of customers without power.

Visibility of the low voltage network is also imperative if networks are to be able to more easily pinpoint non-functioning areas of the network and provide communities and governments with a much clearer indication of likely restoration times

*In states outside of Victoria

Identifying and addressing network and community vulnerabilities will be an ongoing process, but approaches to harden a network can include:

- strengthening poles to withstand extreme winds or floodwaters
- using underground cables instead of overhead lines
- raising or moving equipment out of flood prone areas
- accessing the full suite of smart meter data
- improving visibility of the low voltage network
- building additional distribution lines to enhance reliability and resilience
- modernising aging equipment to help digitise and improve reliability and resilience
- improving communications channels to customers for more accurate information about restoration times
- deploying new technology to speed up emergency response, such as the use of drones to identify the specific location of an outage; and
- investing in SAPS or microgrids to reduce outage times for customers and communities and reducing risk of fires in bushfire prone areas.

How Standalone Power Systems (SAPS) and microgrids can help improve resilience

SAPS are off grid electricity systems, generally comprised of solar photovoltaic arrays, energy storage and backup diesel generators. A SAPS may serve one customer, or it may serve multiple customers in what is known as a microgrid. A microgrid may be completely disconnected from the electricity network or it can be connected to the main electricity network with the ability to deenergise the main line for network maintenance or an impending extreme weather event. Technological developments and the falling cost of renewable generation and batteries have made SAPS and microgrids potentially viable energy solutions that can improve resilience among other things.

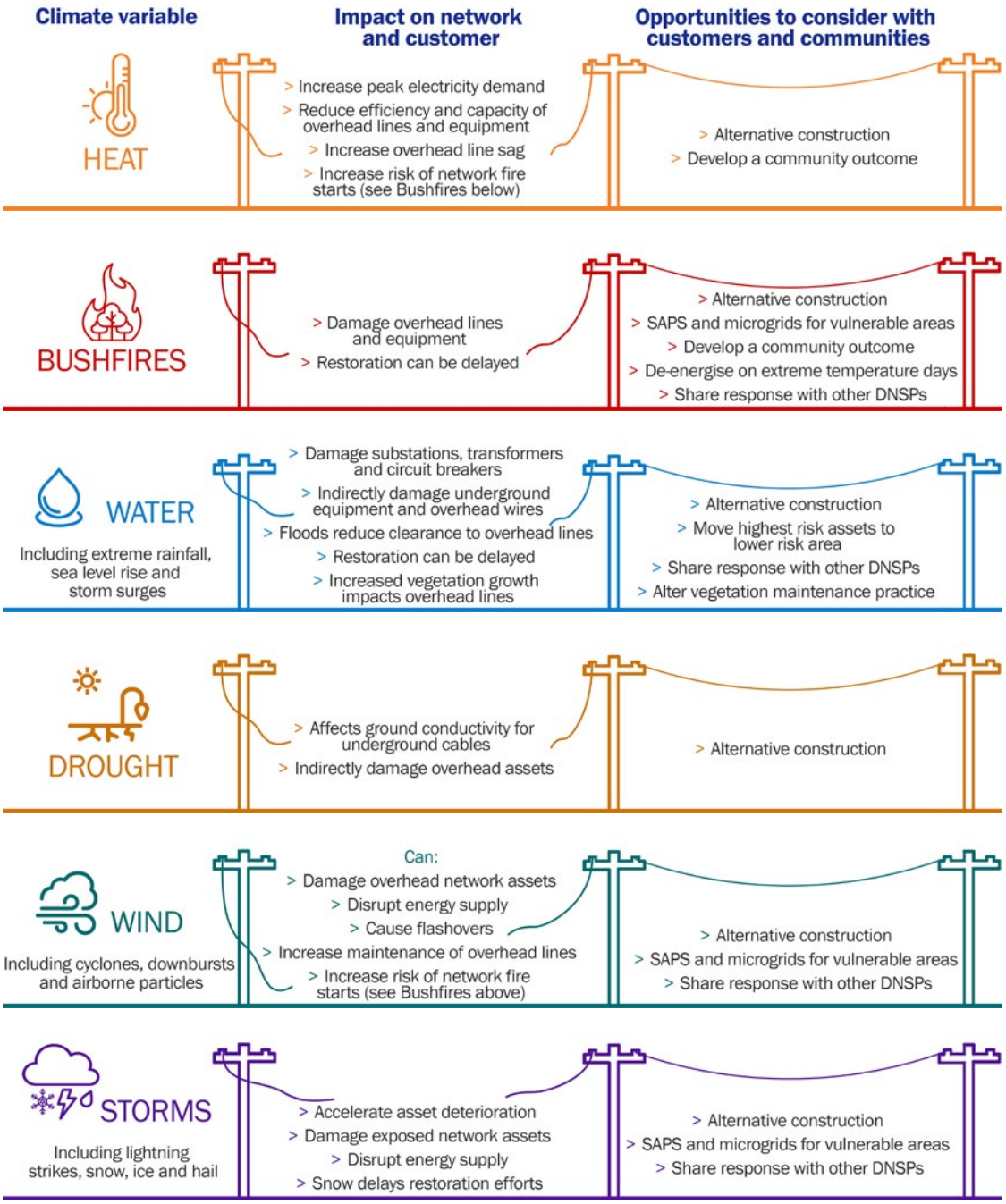
SAPS and microgrids reduce bushfire risk as electricity infrastructure, that could potentially spark igniting a bushfire, is either no longer energised or removed. They can also be used by electricity networks as practical solutions to make communities more resilient to extreme weather events and natural disasters as they enable a customer or community to isolate and remain energised in an emergency. Having customers in bushfire prone areas supplied by SAPS means that even if a fire event does occur, fewer customers will be left without power, less network repairs will be required and the cost of responding to the event will be lower. This is particularly important for keeping telecommunication towers and fire-fighting equipment (water pumps) operational. It is expected that the cost to supply customers in high bushfire risk areas will fall if DNSPs provide SAPS on a permanent basis, leading to a reduction in network charges for the entire customer base.

As distribution network's experience more natural disasters such as bushfires, storm events and floods, SAPS can also utilised in emergency and asset replacement events allowing utilities to effectively provide the updated power solutions for our customers rather than replacing assets like for like.

As SAPS can come in several different sizes and levels of service capacity, mobile and fixed, and they can also function as a backup power supply for remote communities to ensure that their local emergency facilities have power during extreme events.

*Recent AER Ringfencing Guideline review can be found here: Electricity ring-fencing guideline review | Australian Energy Regulator (aer.gov.au)

Common climate risks and network opportunities



Questions:

Are there any critical steps or other elements missing from the risk assessment and solutions process and framework?

Is there benefit in developing a way to value large-scale major events in network investment decisions?

Should DNSPs have a common framework for valuing the risk of large-scale major events?

Appendix: Examples of natural hazard or extreme weather events on electricity networks

Ausgrid

In April 2015 and February 2020, Ausgrid experienced East Coast Low events that were among the worst storms to impact Ausgrid's network in terms of customer interruptions, network hazards, and restoration costs.

East coast lows are intense low-pressure systems of destructive wind and torrential rain, that will often get more intense over a period of 12-24 hours making them one of the more dangerous weather systems to affect the eastern coast.

Ausgrid's storm response costs to those two events alone were in excess of $71m (nominal), required cost pass through applications, and put approximately 350,000 customers out of power for nearly two days, with a significant number of customers out of power for longer than 6 days. Although East coast lows can occur throughout the year, traditionally they are most likely to occur in June, however, Ausgrid's storm related overtime records over an 11-year period indicate a potential trend both in the frequency and severity of storms in warmer months.

Endeavour Energy

The 2019-2020 bushfire season was the worst bushfire season in NSW history. A number of factors including a prolonged period of hot weather without significant rainfall (with 98% of NSW being drought affected at the time) provided the catalyst for an unprecedented level of bushfire activity across the state. The NSW Rural Fire Service reported that 11,264 bush and grass fires burnt 5.5 million hectares or 6.2% of the state, destroyed 2,448 homes and claimed 25 lives over this period. The area burnt in NSW was three times larger than in any other bushfire season.

The bushfires ultimately burnt through approximately 11,000 km^2 or 44% of the network area. The fires either damaged or destroyed 840 homes and businesses connected to the network and interrupted supply to over 55,000 customers. Approximately 20,000 customers were without power at the peak of the bushfires during the New Year period, mostly in communities in the Shoalhaven and NSW South Coast.

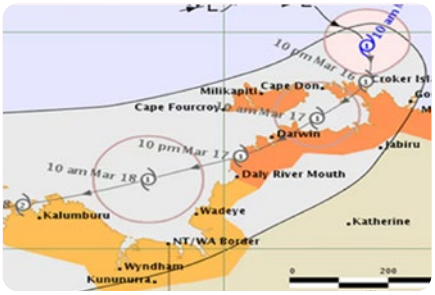
The worst affected areas saw some customers without power for more than 10 days as Endeavour Energy crews worked through challenging conditions to rebuild large sections of the network. Managing the multiple bushfire threats required a sustained, whole-of-organisation response and collaboration with several authorities led by the RFS. At all times during the response, our priority was to maintain the safety of our workforce and the communities we serve. The total cost of the damage from the fires to the network totalled $27 million.

Essential Energy

The 2019-20 bushfire crisis saw multiple and concurrent bushfire events across the Essential Energy network area. Over 3,200 power poles were damaged, leaving more than 104,000 customers affected by power outages, including 4,700 life support customers.

Essential Energy staff played a critical role during and after the bushfires. At one point, more than 540 staff were involved in the bushfire response. Priority was given to restoring power supplies for critical services in bushfire-affected areas, including communications infrastructure, water and sewerage pumping stations, hospitals, nursing homes and petrol stations. Essential Energy worked collaboratively with the Rural Fire Service and other authorities to provide alternative power generation to emergency centres and critical infrastructure, which was crucial to assist the community during the emergencies.

Significant parts of the affected network were in remote areas with difficult terrain, with long lengths of line connecting a small number of customers. In instances, some firegrounds could not be accessed safely for up to three weeks. Essential Energy conducted inspections of hazardous trees immediately after the bushfires. The initial inspections resulted in the removal, trimming and debris removal of more than 23,000 trees. Given the severity of the fires, it was impossible to determine if some trees would regenerate at the time of the initial inspection. As a result, a second inspection was carried out six months later that that led to the additional removal of more than 4,000 hazardous trees. Essential Energy put in a cost through application totalling $75 million.



Evoenergy

On 3 January 2022, the districts of Belconnen and Gungahlin in north and north-west Canberra were hit with one of the most intense and damaging thunderstorms in the last 5 years. Unique synoptic conditions developed quickly to create a 'supercell' thunderstorm event that resulted in strong winds, heavy rainfall and large hail stones. Within a period of approximately 10 minutes the thunderstorm caused the worst damage to electrical infrastructure in the ACT in 5 years, with repair works requiring the replacement of around 11 poles, 50 powerlines, 190 service lines and associated assets such as cross arms and spacers.

At the peak of the storm, this resulted in 21,672 homes and businesses losing supply with 308 separate faults reported and attended by Evoenergy. On-Call Crews and System Control worked through the first night to make safe and restored more than 16,000 customers with additional staff either re-called or volunteering to respond to the event. Supply was restored to 85% of customers within 24 hours with 100% restoration completed within 6 days. Additional support crews from Endeavour Energy arrived mid-week to assist in restoration efforts with Evoenergy crews continuing network repairs in the following weeks.

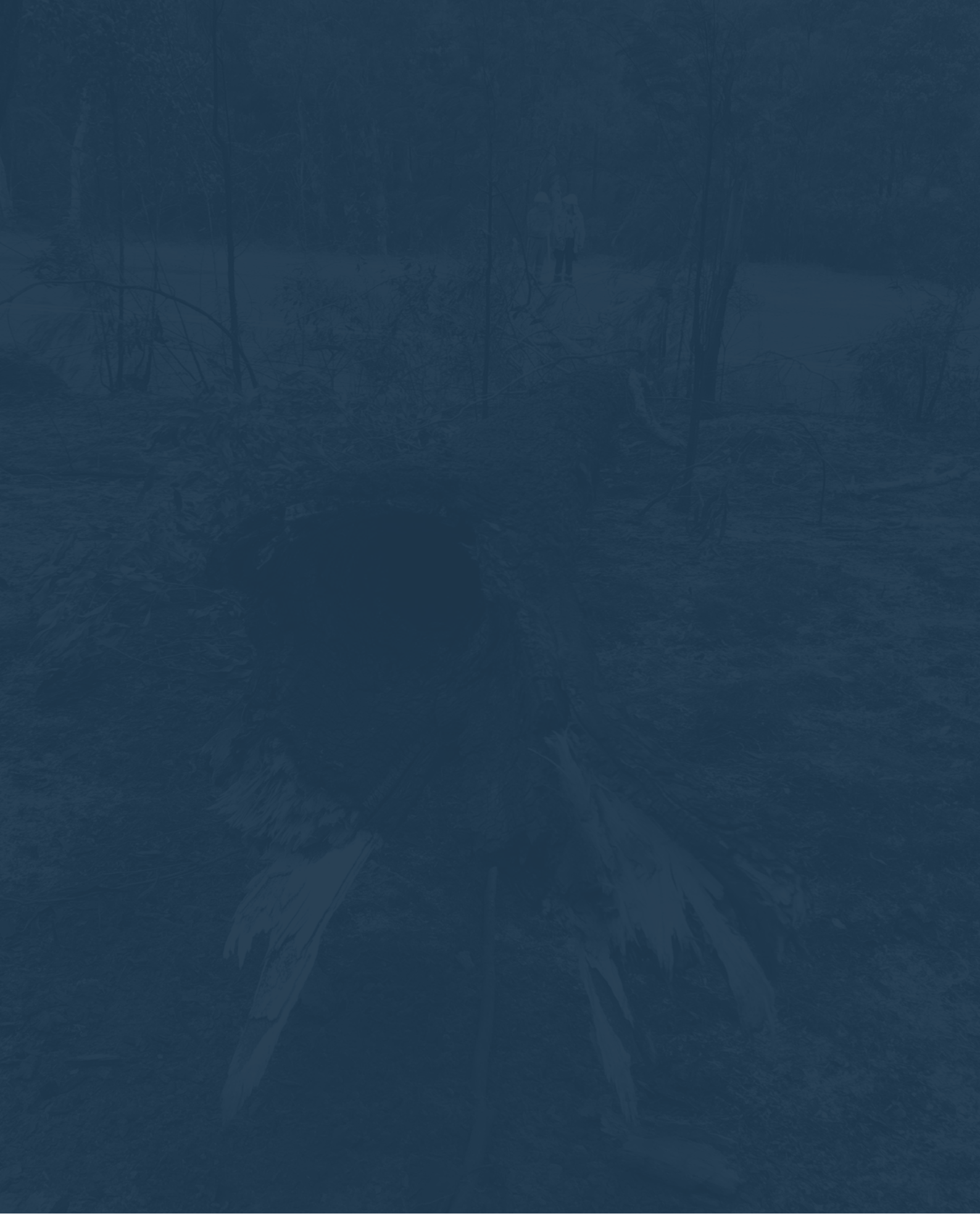
Almost all outages were caused by falling trees onto and damaging the network. Fallen trees also contributed to access issues with many road closures and restrictions on accessing large portions of the LV network located in customers backyards.

Power and Water Corp.

On 17 March 2018, tropical cyclone Marcus crossed over Darwin with reported sustained winds of 95km/ph and gusts greater than 130 km/ph. The extent of damage caused was significant and second only to tropical cyclone Tracy, in comparison around 30% of customers in the Darwin region were without power after the cyclone passed. Half of these customers were restored within 2 days, with 90% of affected customers restored within 3 days. Restoration costs were in the order of $3 million in capital expenditure and $2 million operating expenditure.

TasNetworks

In August 2014 an extreme rainfall event occurred in the north and north-west of Tasmania that resulted in flooding damage to the distribution overhead network, and supply outages peaking to 22,000 customers over a three day period. Restoration costs were in the order of $1 million.



Ausgrid Endeavour Energy essential energy TasNetworks Delivering your power evoenergy PowerWater