Network Resilience Plan

CitiPower Pty Ltd, Powercor Australia Ltd
and United Energy Services Pty Ltd
PL-0002

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1. Executive Summary

Infrastructure such as electricity networks are exposed to weather-related risks. The loss of electricity infrastructure services can increase society's vulnerability, as communities lose connection to critical services and mobile phone towers, internet, water supplies and banking. In the coming decades, Australia will experience more frequent extreme weather events such as heatwaves, bushfires, floods, droughts and storms. Parts of Australia are also likely to be affected by long-term changes such as drought, sea level rise and coastal erosion.

CitiPower, Powercor, United Energy (CP/PAL/UE) and Australian Energy Operations (AEO) are committed to maintaining a resilient business by having a robust framework with supporting plans that protect our people, assets, facilities and systems to minimise the impact to our customers and communities.

This plan is a long-term approach to resilience that identifies programs to address risks of extreme weather, with the aim to reduce their impacts on our customers and ensure the long-term sustainability of our network and operations. Our goal is to develop a well-adapted, disaster-resilient future.

These weather events can damage assets; reduce asset life; increase asset failures and outages; increase operational and repair costs; reduce network capacity and increase demand. They pose risks to the continuous supply of electricity to communities and result in High Impact Low Probability (HILP) events which are challenging to plan for effectively.

Extreme events sometimes lead to negative network and customer impacts. In the coming decades, climate change is expected to magnify the frequency and severity of some weather-related risks. The higher impact climate variables are:

- **Bushfires** – likely to increase in frequency where it becomes hotter and drier. The number of high-risk bushfire days in 2070 is projected to increase by 10-20 fire days per year over current quantities.
- **Storms** – are likely to become more intense and increase in frequency. For southern and eastern Australia, the median results from ensemble modelling projected a 7% to 8% increased frequency in favourable conditions for severe convective winds.
- **Flooding** – an increase in the intensity of downpours will lead to an increase in surface water and river flooding. Increases in heavy rainfall days are projected to be greatest within the Barwon Southwest region, particularly, the Otway Ranges, Rosebud and Red Hill. Locations with more assets exposed include between Shepparton and Mulwala, Swan Hill to Bendigo, the Grampians and portions of Geelong, Colac, Elwood, Parkdale and Frankston.

These changing climate factors mean we need to make energy systems more reliable and resilient to ensure we minimise outages for our communities.

Considering climate change when making planning and investment decisions allows us to proactively build in resilience before disaster strikes. Our infrastructure operates for decades, and designs that were optimised for historical operating conditions may not be able to meet system needs in a future climate. We need to consider changes such as temperature or precipitation when making design, placement and upgrade decisions to increase resilience and reduce future damage.

This plan identifies increasing risks to electricity assets including distribution lines, underground cables, substations, poles and communications equipment from future climate conditions. Analysis and hazard mapping has been undertaken for both a moderate emissions scenario (RCP 4.5) and high emissions scenario (RCP 8.5). The results mainly focus on the exposure of assets under RCP 8.5 as it represents the higher risk scenario and is how global emissions are currently tracking. Results also primarily focus on exposure in 2070 in assessing impacts on long life assets.

Exposures under RCP 4.5 forecast for 2050 are also observed, reflecting a moderate risk scenario consistent with the approach taken by the AER in reviewing submissions made by NSW distributors in their 2024-2029 regulatory proposals, noting that projections for RCP 8.5 and RCP 4.5 substantially overlap up to 2050.

We are preparing for these risks and ensuring our assets continue to perform well in the long term. We are committed to understanding these climate risks and the exposure of our assets to inform the future planning, design, construction and maintenance of network infrastructure. To achieve this, we are looking at three key areas – preparation, adaptation, and customer resilience.

Preparation initiatives include programs focusing on hardening the most at-risk assets to the exposure of floodwaters, storms and bushfires. Hardening programs include:

- fire-proofing assets such as poles in at-risk locations.
- reducing the impact of floods on poles and zone substations.
- Alternate supply (feeder tie lines) to improve supply for customers most exposed to outages from strong winds.

An **adaptation** approach will ensure new assets are rated, designed and located according to these future climate risks. GIS systems are loaded with climate risks like flood plains to ensure future asset locations consider these risks.

While **customer resilience** programs will also play a critical role, it also includes microgrids where suitable sites are identified as well as deployable response tools such as muster trucks and community liaison officers.

This is a "live" document and will be updated to comply with legislative/regulatory changes and as new information, tools and technology become available.

2. Purpose and Scope

This plan's **purpose** is to describe how CPPAL, UE and AEO address risks of extreme weather events in the long term, with the aim to reduce customers' impacts under current and evolving conditions. It documents our approach in managing network assets, our operational response and community and customer engagement. The climate variables of most significance include wind, extreme temperature, extreme rainfall, flooding and bushfire.

The **scope** of this plan applies to the management of all network assets installed and operated by CPPAL, UE and AEO.

Aspects of community resilience, engagement and education are also **within scope** of this document where they relate to network resilience or where we can support local community needs together with other entities.

This plan **does not apply** to day-to-day CPPAL or UE reliability management which is found in Network Reliability Plans (CPPAL-PL-0002 & UE-PL-5010).

This plan **does not consider** compounding weather events, that is, the occurrence of multiple hazards simultaneously or in quick succession (i.e. extreme rainfall and wind simultaneously or fire followed by rainfall) as it was not modelled in the supporting Climate Change Study.

This plan **does not** consider business continuity disruptions as a result of IT and telecommunications hardware and software facilities, data corruption, acts of sabotage or terrorism, industrial action, loss of critical suppliers or service provider or pandemics. These are found in the Business Continuity Plan (JEQA4UJ443MT-154-417).

3. INMS Framework

CPPAL's and UE's Integrated Network Management System (STR-1440) represent an integrated approach to manage the safe design, construction, operation, maintenance and decommissioning of their electricity networks.

Its structure enables CPPAL and UE to efficiently fulfil the requirements of multiple Management System Standards (MSSs), namely *AS ISO 55001:2014 Asset Management – Management Systems* and *AS 5577: Electricity Network Safety Management Systems*. The INMS covers all the required elements to satisfy these MSSs. The entire INMS is underpinned by the Enterprise Risk Management Framework (13-10-CPPCUE0005).

AEO's ESMS AEO Electricity Safety Management Scheme (AEO-STR-0001) leverages documents that underpin the CPPAL and UE Integrated Network Management System.

4. Context

4.1 Background

Resilience has always been part of our DNA:

Our primary purpose is to deliver a safe and reliable network. Our focus on reliability does not suddenly stop when the network is overwhelmed.

Resilience has always been part of our planning, primarily focused on response with preparation and adaption activities being achieved through inspection, maintenance and community work.

Climate change is increasing the impacts and frequency of disruptive events.

However, as extreme weather conditions increase and threaten the reliable supply of electricity, our systems will need to become more resilient. Minimising outages during such extreme events is critical to ensure the well-being of our communities, especially as the consequences are often most severe for those more vulnerable community members.

4.2 Our Operating Environment is Changing

Infrastructure, including electricity networks, are exposed to weather-related risks. The failure of infrastructure services increases society's vulnerability. According to the Victorian Government Climate Change website, https://www.climatechange.vic.gov.au**,** Victoria will experience more frequent extreme weather events such as heatwaves, bushfires, floods, droughts and storms over the coming decades. Parts of Australia are also likely to be affected by long-term changes such as drought, sea level rise and coastal erosion.

Climate change is expected to impact electricity distribution networks through direct physical impacts such as changes to the operational performance of networks, increased risk of equipment failure, reduced asset life and reduced network capacity which in turn will increase operational, repair and maintenance costs. These pose risks to supply of electricity to households and businesses and could result in low probability events which are challenging to plan for effectively.

4.3 Customers are More Dependent on Electricity than ever Before

Customers are increasingly dependent on power in every aspect of their lives and so have less capacity to live through prolonged outages.

Almost every other essential service is impacted by the loss of electricity supply including communications, healthcare, transport, water and sewerage services, food production and storage. Electricity supply is also critical to community responses to disruptive events after extreme weather events. As dependence on electricity continues to increase, any power disruptions will become more consequential, with significant societal impacts and potentially deadly results.

The longer the outage, the more community impact and recovery from major emergencies and disasters can be delayed.

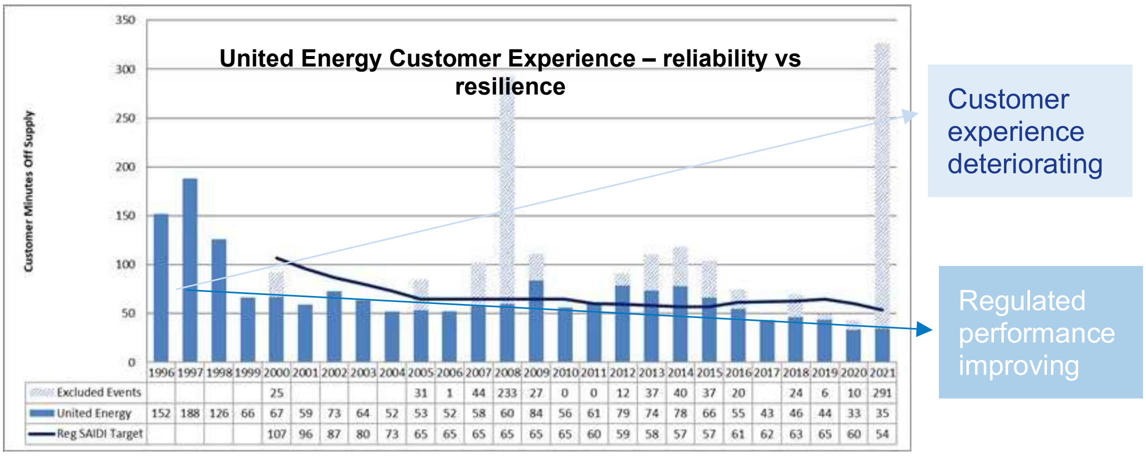
4.4 Frequency and Severity of Extreme Events is Forecast to Grow

Recent climatic events in Australia substantiate the reality of climate change and the need for network businesses to manage and adapt to these changing conditions. There will be changes in weather-related impacts, largely driven by the projected changes to temperature and precipitation. The variables of most interest are:

- Bushfires – likely to increase in frequency where it becomes hotter and drier.
- Storms – are likely to become more intense and increase in the frequency of storms in Victoria.
- Flooding – an increase in the intensity of downpours will lead to an increase in surface water and river flooding.

4.5 Despite Improving Regulated Performance, Customer Experience is Deteriorating due to Extreme Weather

The chart below highlights the customer experience problem. Figure 1 shows that while reported United Energy regulated unplanned SAIDI performance is improving over time (the dark blue bars), the customer experience is deteriorating when considering all events, including extreme weather events which are excluded from regulated performance reporting.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Excluded Events					25					31	1	44	233	27	0	0	12	37	40	37	20		24	6	10	291
United Energy	152	188	126	66	67	59	73	64	52	53	52	58	60	84	56	61	79	74	78	66	55	43	46	44	33	35
Reg SAIDI Target					107	96	87	80	73	65	65	65	65	65	65	60	59	58	57	57	61	62	63	65	60	54

Figure 1: United Energy Customer Experience compared with Regulated Performance

5. Definitions

5.1 What is Resilience?

Network resilience has been defined differently across Asset Management standards, industry bodies and legislation depending on the business context and lived experience. The most relevant include:

- Australian Energy Regulator (AER).[1]: the network's ability to continue to adequately provide network services and recover those services when subjected to disruptive events.

[1] Network resilience A note on key issues, April 2022

- Energy Networks Australia (ENA)[2]: the ability to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard.
- Institute of Asset Management (IAM)[3] : the ability of a system or organisation to withstand and recover from adversity.

We have adopted the following definition, based on our interpretation of these references:

Network resilience is the ability to withstand and recover from the effects of a natural hazard or disaster.

The focus of network resilience is on low probability Widespread and Long Duration Outages (WALDO) resulting from disruptive extreme weather events such as bushfires, floods, storms, heatwaves, earthquakes, tsunamis to:

- **Withstand** weather events by **preparing** and **adapting** the network assets for the new future "climate normal".
- **Recover** through the traditional operational response to events, including customer resilience support.

5.2 Reliability vs Resilience

Reliability and resiliency might go hand-in-hand but are very different.

Reliability is about continuous adequate supply of electricity. It is focused on average network performance and seeks to minimise outage time during normal conditions. It is typically measured by normalised outages per customer, or normalised average outage duration per customer (SAIFI, MAIFIe and SAIDI), excluding "major events".

Resilience is about planning for, operating through and recovering from a major event, including not only extreme weather events but also risk of cyberattacks and is much more difficult to achieve. It seeks to minimise outages during major events and is typically measured on an event basis in un-normalised outages or outage duration per customer.

6. Requirements

6.1 Our obligations

Our networks operate under a combination of national and state legislation. While electricity safety legislation is set within each jurisdiction, every Major Electricity Company (MEC) also operates under the *National Electricity Law* (NEL) and within the *National Electricity Rules* (NER). The applicable laws are briefly described below.

6.1.1 National Electricity Rules

Network businesses operate under the NEL within which sit the NER. The NEL and NER set out the regulatory framework for electricity networks. Network resilience is not explicitly mentioned in the NER.

The AER requires Distribution Network Service Providers (DNSPs) to forecast, in each regulatory period, both operational (NER, S6.5.6) and capital (NER, S6.5.7) expenditure. The expenditure is required to achieve the following capital and operating expenditure objectives which focus on the service level outcomes that the network provides:

- Maintain the quality, reliability and security of supply.
- Maintain the reliability and security of the distribution system.
- Maintain the safety of the distribution system.

These objectives apply both on a "normal" day and during extreme weather events.

Sections 6.5.6(a)(2) and 6.5.7(a)(2) of the NER also stipulate that the forecast expenditure is to "comply with all applicable regulatory obligations or requirements", which include the jurisdictional legislation listed below in Section 6.1.2.

6.1.1.1 STPIS Scheme

According to the AER[4], "*STPIS is not designed to incentivise improvements in managing the impact of unforeseen extreme weather events. It is designed to incentivise reliability improvements under standard conditions.*"

[2] Network Resilience 2022 -collaboration paper on Network Resilience

[3] Subject Specific Guidance 32 – Contingency Planning & Resilience Analysis

[4] Network resilience A note on key issues, April 2022

6.1.2 Security of Critical Infrastructure Act 2018

Our networks are considered as critical electricity assets as defined by the Federal Department of Home Affairs. As such we must have and comply with a Risk Management Program which identifies, and as far as is reasonably practicable, minimises or eliminates material risks that could impact the asset. These risks could come from any hazard, including cyber, personnel, natural disasters and supply chain.

6.1.3 Victorian Legislation

UE's and CPPAL's licences to distribute electricity in Victoria are governed by the *Electricity Industry Act* (EIA). The *Electricity Distribution Code of Practice*, prescribed in the EIA provides network operations standards. Under the code "A distributer must use best endeavours to meet targets required by the Price Determination and targets of clause 5.1 and otherwise meet **reasonable customer expectations of reliability of supply**." including during extreme weather events.

The *Energy Legislation Amendment (Electricity Outage Emergency Response and Other Matters) Bill 2023* provides the Department of Energy, Environment and Climate Action (DEECA) Secretary powers to direct DNSPs to support those impacted by an electricity outage emergency, focused on three principal areas:

1. Directing networks to provide relevant information such as likely restoration dates.
2. Directing networks to attend specified places to provide specified information to affected customers such as supply restoration details and providing logistical support and assistance to providers of emergency relief programs.
3. Directing networks to administer the Prolonged Power Outage Payment (PPOP) – which we have done since October 2021. This will still be funded by DEECA.

6.2 Our Stakeholder Requirements

There is a growing expectation from communities for businesses to respond to a changing climate. Our internal stakeholders include employees, contractors and shareholders. External stakeholders include customers and regulators.

6.2.1 Employees and Contractors

We need a culture where everyone understands the impact of climate risks to optimise planning, response and design.

6.2.2 Shareholders

Economic losses from extreme climate events are already substantial, and on the rise. Such events force the insurance industry to respond with higher costs. We need to optimise investments to minimise this risk to escalating costs.

6.2.3 Customers

Customers require a reliable supply at a reasonable price. They consider resilience a vital element of the energy system and expect us to minimise the likelihood and impact of network outages due to extreme weather events. Our networks must therefore be more resilient to weather extremes as climate change is projected to result in more onerous conditions.

Customers expect us to work with communities to better prepare for extreme weather events and support them during emergencies. Communities expect us to play a critical role in proactive and reactive disaster management and develop prudent plans tailored to communities' needs. Further, customers want transparent communication and education, especially during crises, to stay informed about outage causes, recovery times and preparedness measures.

6.2.4 Regulators

In April 2022, the AER published *Network Resilience - A note on key issues* to discuss how resilience-related funding would be treated under the NER. The AER's focus is on how network resilience seeks to achieve service levels outcomes (maintenance of reliability, safety, network security), as these outcomes align with the long-term interest of consumers. The AER expects DNSPs to demonstrate that:

1. There is a causal relationship between expenditure and the expected increase in the extreme weather events.
2. The expenditure is required to maintain service levels and achieve the greatest net benefit of the options considered.
3. Consumers have been fully informed of options, including implications, and they are supportive of the expenditure.

In July 2024, the AER released *Draft Decision - Value of Network Resilience 2024*. Their proposed approach is to value the first 12 hours of a prolonged outage applying the standard VCR and then adopting various multiples of the standard VCR applying for periods beyond 12 hours.

6.2.5 Victorian State Government

Following extreme storm events in 2021, the Victorian State Government engaged an expert panel to undertake an Electricity Distribution Network Resilience Review[5]. The outcomes from this review made clear Government's expectation that we reduce both the likelihood and impact of prolonged power outages by making investments in resilience.

This review has since been followed by a Network Outage Review[6] into the more recent 2024 storm event. The more recent review has not been finalised, but has focused on outage readiness, communication and on-the-ground support.

6.2.6 Other Essential Services

Almost every other essential service is impacted by the loss of electricity supply including communications, healthcare, transport, water and sewerage services, heating and air-conditioning, food production and storage. Just like other customers, they need our networks to be resilient to weather extremes and accurate restoration times.

Further, they need to be engaged as more of a partnership to jointly plan and respond to such events.

7. Our Method of Approach

CPPAL, UE and AEO maintain an Enterprise Risk Register that includes key risks, drivers, potential impacts and mitigating controls relating to management of electricity assets. It identifies the resilience-related risk as follows:

> ***Inability to meet customers' electricity supply needs for a protracted period caused by adverse weather or a natural disaster (e.g.: bushfires, flood, storm, lightning, earthquakes).***

This plan presents an approach to the risks from the future climate and uses modelling of projected climate changes.

While resilience management traditionally relies on response activities, this plan focuses more on preparation through an approach that includes how we design, construct, operate, maintain and decommission our networks and is based on relevant Representative Concentration Pathways (RCPs), timeframes, climate hazards and the best available datasets.

The steps that underpin our approach are described below.

7.1 Identify and Analyse Historic Climate Hazards and Impacts

- Review historic data to understand the current impact of major climate events on system performance.
- Identify relevant climate hazards and variables.
- Identify impacts on network and customers.

7.2 Determine Future Climate Hazards

- Develop emission-scenario-based modelling of future climate.
- Undertake a thorough assessment of climate change risks – identify relevant variables and timeframes based on:
  - Identify relevant climate hazards and variables.
  - Identify potential impacts on network and customers.

7.3 Assess Network Vulnerability Exposure

- Determine which risks are regarded as tolerable by the organisation and the community, or critical and require adaptation approaches - based on the principle of minimising harm to the community:
  - Assess relative exposure of assets to future climate hazards across the network.
- Identify priority risks and failure thresholds (for equipment and hazard).

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[5] Electricity Distribution Network Resilience Review (energy.vic.gov.au)

[6] Network Outage Review (energy.vic.gov.au)

7.4 Treat Future Climate Risks

- Identify potential risk mitigants, that either reduce the likelihood or consequence of future climate hazards.
  - Identify potential adaptation options for priority risks.
- Undertake a cost-benefit and sensitivity analysis in accordance with investment methods.

8. Traditional Reliability Planning

As set out in the Network Reliability Plans (CPPAL-PL-0002 & UE-PL-5010), network management for reliability focusses on several activities which can be categorised in the following four ways: -

By **preventing** outages from occurring:

- Asset replacement occurs as assets approach their end of life to prevent risk of failure and outages.
- Faults caused by vegetation are managed through our Electrical Line Clearance Management Plans.

By **minimising** the number of customers affected by each outage event:

- The number of customers affected by a fault can be reduced by breaking a feeder up into smaller sections through the installation of remote-control switches or reclosers.

By **restoring** supply as quickly as possible:

- CPPAL and UE use an automatic fault restoration application to quickly reconnect customers following a fault.
- Improvements in the Network Management System leverage the advanced features of the system to provide fault location and power flow analysis to better target operational response.

By improving individual **customer experience:**

- A reactive program of localised solutions improves the experience of the network's worst served customers.

However, when networks are overwhelmed by the impacts of a natural hazard or disaster, these reliability initiatives do little to improve the customer experience.

- During storms, vegetation faults are often caused from tree debris being blown from well outside the clearance space that our Electrical Line Clearance Management Plans can not readily address.
- While automatic fault restoration and the application of smaller switching zones can ensure fewer customers are impacted initially, it does not assist in supply restoration for those within the faulted section of line where access issues might remain for days and manual repair work is required, especially for storms, floods and bushfires.
- Local solutions can only do so much for the customer experience, especially if the upstream network is not available.

Therefore, resilience planning needs to adopt a different approach to reliability planning to effectively complement day-to-day reliability programs focused on the current impact of natural hazards and the future impacts of climate change.

9. Resilience Planning

Resilience planning is not new. In 2009, all Victorian distributors reviewed future climate risks and impacts as part of their 2011-2015 economic regulatory submissions. In 2014, UE undertook a Tier 1 assessment (a qualitative assessment to identify key climate risks and impacts) based on ENA's *Guidance Manual on Climate Risk and Resilience*.

- More recently in 2023, CPPAL and UE undertook a climate risk assessment based on *ISO14091 – Adaptation to Climate Change – Guidelines on vulnerability, impacts and risk assessment*. While AEO was not part of this assessment, similar impacts to PAL are forecast due to the commonality of their asset locations. The assessment identified 66 climate risks to manage, related to climate impacts such as bushfire, flood, wind, and heatwave and forms the basis of this document.

There is predicted to be changes in weather-related network impacts. Those of most impact are:

- Bushfires – likely to substantially increase in frequency where it becomes hotter and drier.
- Storms – likely to increase in frequency and intensity of storms in Victoria.
- Floods – an increase in the intensity of downpours will lead to an increase in surface water and flooding.

The diagram below was produced by the Department of Environment, Land, Water and Planning in 2021. Victoria's Climate Change Strategy summarises how Victoria's climate is likely to change by 2050.

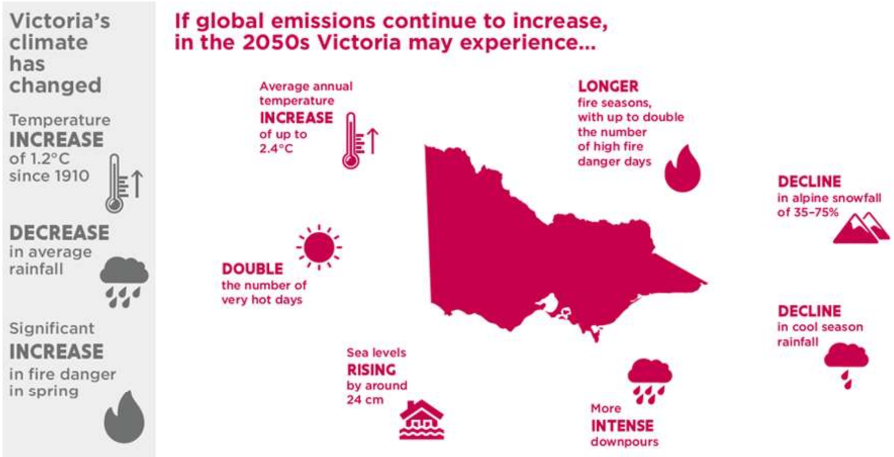

Figure 2: How is Victoria's Climate Changing

Action can be taken to minimise the risk climate change represents, including long term changes to standards such as the redesign of structures, strengthening parts of a network or even rebuilding parts of the network underground but it also includes short term measures such as improved emergency response to repair and restore supply quickly.

Plans to address risk are determined from detailed analysis. We continuously scour opportunities to further reduce risks where costs are justified and are not disproportionate to the benefits.

Managing climate change risk involves both pre-emptive and post-outage actions. Balancing between these, promotes the networks to adopt alternate network solutions that might otherwise not be competitive with traditional options.

Preparation and adaptation – measures that provide protection from a risk, enable assets to operate under a range of conditions or enables the availability of backup installations or spare capacity.

Activities to prepare for outages include system and asset design, asset configuration, network hardening and damage prevention, undergrounding, vegetation management, emergency exercises, microgrids and mobile generation fleet.

Response - measures to facilitate a fast effective response to and recovery from disruptive events.

Activities include incident management, spare equipment, mutual assistance, despatch of back-up generators and communication of situational awareness.

9.1 Future Climate Variables

9.1.1 Greenhouse Gas Concentration Scenarios

The Intergovernmental Panel on Climate Change (IPCC) has outlined four scenarios to explore potential future concentrations of greenhouse gases in the atmosphere, referred to as Representative Concentration Pathways (RCPs). These range from high concentrations (RCP 8.5) to very low concentrations (RCP 2.6). Each is based on assumptions of combinations of potential future economic, technological, demographic, policy, and institutional trajectories.

This document is based on a high emission scenario (RCP 8.5) and a moderate emission (RCP 4.5) scenario to provide contrasting possible climate futures. It is generally recommended that both RCP 8.5 and RCP 4.5 be used to identify the exposure of assets to climate change, including by the *Electricity Sector Climate Information (ESCI) Project* and the *Victorian Climate Projections 2019* (VCP19) guidance.

The use of RCP 8.5 allows for the identification of hotspots that may be exposed to more significant climate risks. It is also important to consider RCP 8.5, particularly for near-term climate projections as using a lower emissions scenario (e.g. RCP 4.5) assumes a level of mitigation over the last 15 years that did not occur.

While some literature suggests that we are tracking more closely to RCP 4.5, RCP 6.0 is also plausible as emissions would need to peak in 2040 and then decline rapidly to stay in line with RCP 4.5. However, downscaled Victorian climate projections are not available for RCP 6.0. RCP 2.6 was not selected as it requires emissions to peak in 2020 and decline through 2100, this scenario is considered to be unlikely.

Projections for RCP 8.5 and RCP 4.5 substantially overlap up to 2050 and beyond as shown below (Source: IPCC 2013).

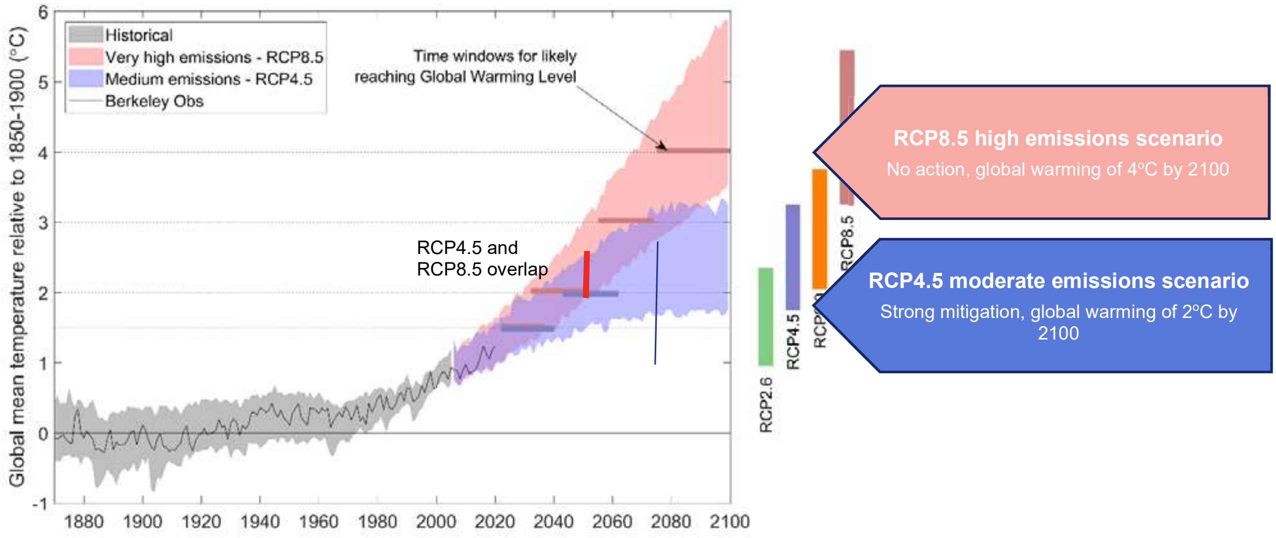

Figure 3: IPCC Temperature Projections relative to 1986-2005

9.1.2 Planning Timeframes

Multiple time horizons are considered within this assessment. Projections for 2030, 2050 and 2070 have been used to assess climate impacts over multiple time periods to understand how risks may change over time.

It is particularly important to consider long-term timeframes when assessing long life assets (i.e. poles and transformers have asset life > 55 years). The 2030 timeframe provides for near-term risks that are more immediate. The 2070 timeframe was selected recognising the longer lifespan of many assets and is relevant for future planning.

9.2 Decision and Evaluation Criteria

The decision and evaluation criteria used for the selection of appropriate actions are directly related to the corporate vision, strategic pillars and our established core values. The key criteria or principles are as follows:

- Maturity and accuracy of the modelling for credible forecasting.
- Causal relationship between proposal and expected customer impact.
- There is customer support for the resilience proposals.
- Technology maturity and effectiveness.
- The long-term benefit of the resilience-related proposal outweighs the costs of the investment.
- The proposal is required to maintain service levels and likely achieves the greatest net benefit of the feasible options.
- Compliance with legislative and regulatory requirements.

9.3 Some Common Aspects of our Resilience Adaptation

While each climate variable is unique in its impact on network assets and our customers, some approaches are common. Accounting for climate change in planning and investment decisions can proactively ensure resilience before disaster strikes while reducing future damage costs. Our infrastructure operates for decades, and designs that were optimised for historical operating conditions may not meet system needs under a future climate.

Examples of actions which can be applied regardless of the specific weather variable include:

- Incorporating climate change considerations in all business decision making processes and business cases.
- Revising equipment specifications for new assets – for heat, wind, fire resilience.
- Revising design standards for new construction (i.e. higher-rated assets for future climate wind, temperature, fire).
- **Building Back Better** adopting non-like-for-like replacement at asset end-of-life.
- Ensuring strategic spare and material stocks are reviewed and mobile plant such as generators are maintained.
- Ensuring contingency and resourcing plans are reviewed and updated as are resource deployment / work options.
- Ensuring the Control Centres have UPS support and standby back up generation as well as back up control rooms to relocate the function to in the event of issues at the primary Control Centres.

10. Bushfires

Bushfires, supported by hot and windy conditions, can significantly damage or destroy exposed overhead assets including communications equipment, overhead distribution lines, poles and substations resulting in multiple outages and substantially delayed response efforts.

Bushfires also create prolonged smoky conditions, limiting solar production impacting local network demand.

10.1 Historic Exposure

Victoria is one of the most fire-prone regions in the world. Bushfires regularly cause damage or destroy assets.

- The 2019-2020 bushfire season significantly impacted Victoria's electricity distribution network. The fires were ignited by lightning strikes and destroyed more than 5,000 poles across Victoria and NSW, with entire sections of the network needing to be rebuilt. They also resulted in 420 houses lost and five fatalities.
- The 2009 Black Saturday bushfires killed 173 people affecting almost 80 communities and towns. The fires burned more than 2,000 properties and 61 businesses.

10.2 Future Exposure

Climate change is projected to increase the frequency of severe fire danger days, however the extent or locations at risk of fire are largely determined by the terrain and vegetation. Under RCP8.5, the number of high-risk bushfire days in 2070 is projected to increase by 10-20 fire days per year depending on the territory.

Figure 4 shows the increase in Total Fire Ban Days across Western Victorian that already exists over the past 40 years.

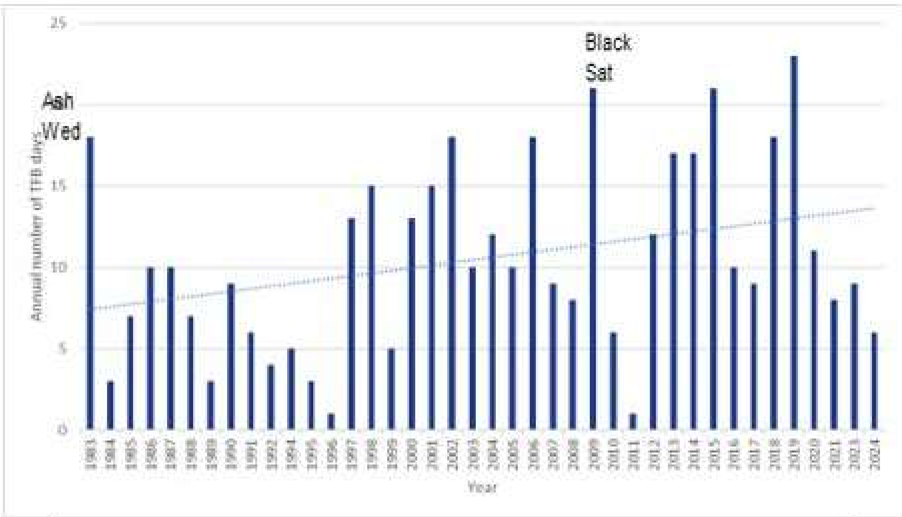

Figure 4: Historical Days of Total Fire Ban in Powercor Network area [7]

10.3 Future Impacts

- Severe Forest Fire Danger Index (FFDI) days represent conditions conducive to sustaining and spreading bushfires.
- An increasing number of severe FFDI days will result in more likely and expansive bushfires impacting our networks.

Projected increases in the frequency of severe fire weather days increases the risk of fire damage to assets and the likelihood of network supply interruptions occurring. This is likely to increase insurance costs, post-event litigation, and health impacts to outdoor workers (i.e. heat stress and breathing difficulties associated with poor air quality).

[7] Country Fire Authority https://www.cfa.vic.gov.au/warnings-restrictions/total-fire-bans-fire-danger-ratings/history-of-tfbs

CitiPower

- No CitiPower assets are exposed to this risk as the distribution area is not within any bushfire management overlays.

Powercor

- High risk areas as indicated by the bushfire management overlay include the Loddon Mallee and Grampians regions and areas in the Barwon Southwest region under RCP 8.5 climate scenario by 2070. Locations with a larger portion of assets exposed include Bendigo, Ballarat, Stawell, the Otway Ranges, north of Portland and south of Red Cliffs.
- Between 10% and 12% of Powercor lines (voltage dependant) intersect with bushfire management overlays.

United Energy

- High risk areas as indicated by the bushfire management overlay include much of the Mornington Peninsula region, from Frankston down to Red Hill and Rosebud. The more urbanised areas near greater Melbourne are less exposed to this risk and are not within any bushfire management overlays.
- Between 7% and 11% of United Energy lines (voltage dependant) intersect with bushfire management overlays.

Australian Energy Operations

- No AEO assets are considered to be exposed to this risk as Ararat and Elaine Terminal Stations are surrounded by reduced adjacent fuel zones with removed vegetation and combustibles.

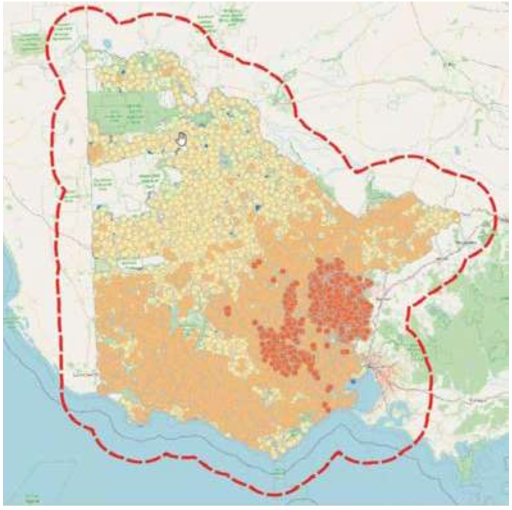

Figure 5: HV and Subtransmission poles exposed to higher bushfire risk and customer consequences[8]

10.4 Prepare and Adapt for Bushfires

We consider over 20 critical controls for bushfire mitigation focused on the risk of our assets being the source of fires. They do little for the resilience of network assets to the impact of fires. Therefore, our bushfire resilience program must prepare our assets to withstand the impacts of bushfires from all sources.

It is **cost effective** to:

- Revise specifications for assets in highest fire-risk areas to be more fire resilient:
  - at their end-of-life, replace wooden poles in high fire consequence areas with non-combustible poles.
- explore fire treatment products for applying to remaining wooden poles before their end-of-life.
- Protect at-risk key assets like zone substations with local fire protection options such as reducing adjacent fuel zones by removing all vegetation and combustibles, additional mitigations may be required such as fire walls[9].
- Implement catastrophic bushfire mapping for adopting undergrounding or covered conductor for localised asset risk.

It is **NOT cost effective** to:

- Proactively underground or relocate assets based on future fire danger forecasts.

[8] CSIRO assessment of inverse bushfire modelling

[9] Appendix F of CIGRE TB 886 – Guidelines for Fire Risk Management in Substations provides case studies for wildfire mitigation

11. Windstorms

Storms cause debris including trees to damage exposed assets or can exert structural loads on components that exceed the safe design limits, causing outages and increasing the risk of public safety or bushfires.

11.1 Historic Exposure

On 13 February 2024, a significant thunderstorm crossed Victoria causing heavy rainfall and damaging winds as high as 150km/hr. The event caused considerable damage to trees, buildings and infrastructure including electricity networks. Over 1 million customers lost power across the event with over 531,000 customers off power at the peak of the event. About 90 per cent of customers were restored in the first 72 hours, but for the hardest hit communities it took several weeks to get the power back on, including Mirboo North, Emerald, Cockatoo, Gembrook, and Monbulk.

On 29 October 2022, heavy rainfall and wind gusts more than 100 km/h were recorded (146 km/h at Wilsons Promontory, 143 km/h at Mt William, and 119 km/h at Melbourne Airport). This led to widespread damage to overhead lines across the southwest of Victoria (Geelong, Bellarine and Surf Coast) and metropolitan areas.

The October 2021 storm resulted in a network outage for more than 230,000 customers with the storm damaging assets, with trees and debris hitting powerlines. Winds reached gusts of 120 km/h in alpine areas.

In June 2021, storms across Victoria involving heavy rainfall followed by extreme winds led to extended outages. Crews were unable to access the worst affected areas for several weeks due to fallen trees. Customers in the Dandenong Ranges were left without power for over a month.

In June 2020, destructive winds and severe thunderstorms toppled six transmission towers in Cressy. The storm knocked down trees and damaged powerlines primarily around Frankston but also in Geelong, Horsham, and Bendigo.

11.2 Future Exposure

Projected changes in extreme wind speed for Victoria are generally small with low agreement on the strength or the direction of the change. However, there is low confidence in the projections associated with extreme wind speed events.

Calibrated model projections indicate a range of positive and negative changes in the frequency of days with favourable conditions for severe convective winds. For southern Australia and eastern Australia, the median results from the ensemble modelling projected a 7% to 8% increased frequency in favourable conditions for severe convective winds.

Exposure of assets to extreme wind related risks are either from risks associated with tree contact or windblown debris damaging assets or from days with maximum wind gusts of over 100km/h. This threshold was selected as the design threshold for older poles across Victoria with much higher thresholds recently adopted.

11.3 Future Impacts

Wind speeds greater than 60kmh correlate with deteriorated customer reliability predominantly from vegetation blow ins from outside the clearance space and other debris. According to AECOM Climate Change Study for Victorian Electricity Distribution Businesses - Phase 1, 2023, impacts by distribution area, include:

CitiPower

- Areas of higher exposure from vegetation include along the Yarra River between Abbotsford and Richmond and Merri Creek north of Abbotsford. The number of days with extreme winds over 100km/h is projected to be uniform.
- Between 4% and 5% of distribution lines (depending on voltage) intersect with the vegetation overlay.

Powercor

- Areas of higher exposure indicated by the vegetation overlay and the concentration of assets include the region surrounding Ballarat, Gisborne and Castlemaine, and the Otways. Assets near Gisborne, between Ballarat and Geelong and along the coast are likely to be more exposed to extreme wind risk than other parts of Powercor’s area.
- Approximately 5% of the distribution lines intersect with the vegetation overlay across the distribution area.

United Energy

- Areas of higher vegetation exposure to asset concentrations include the Mornington Peninsula, south of Frankston. The projections for number of days with extreme winds suggest that assets located within the Frankston and Mornington Peninsula region are likely to be more exposed than other parts of the distribution area.
- Between 8% and 9% of distribution lines (depending on voltage) intersect with the vegetation overlay.

Australian Energy Operations

- Areas of higher vegetation exposure are not relevant for AEO assets as AEO is responsible for vegetation management within close proximity to its network assets, minimising risk, through its vegetation management contractor.

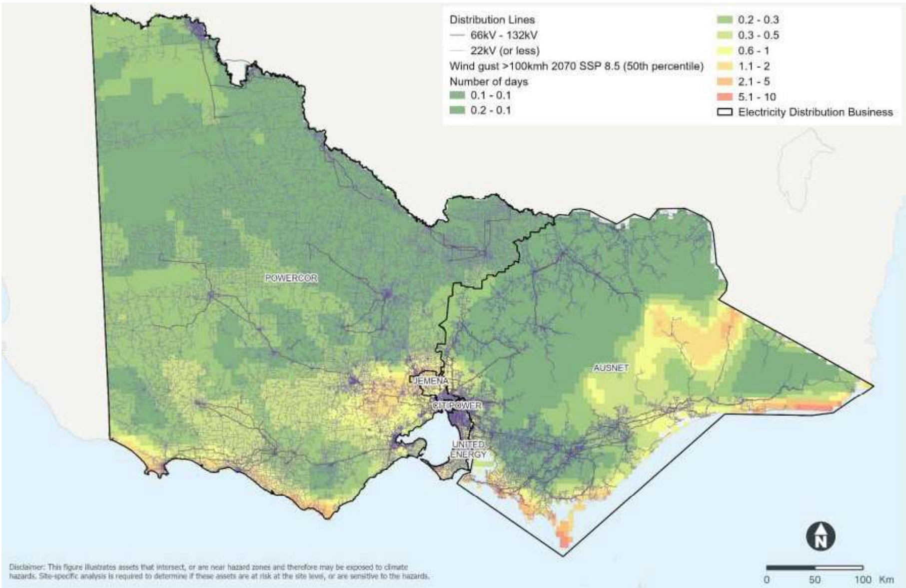

Figure 6: Distribution Lines exposed to days with maximum wind gust above 100 km/h in 2070 (RCP 8.5).[10]

11.4 Prepare and Adapt for Wind

Windstorms climate forecasts are less well defined than some other climate variables such as fire and flood. Therefore, identifying locations for preparation projects is quite problematic. Our approach to windstorm resilience therefore is focused on adapting the network assets to be more able to cope with future climate conditions under a build back better regime with improved standards adopted for new equipment. Current preparations underway for windstorms include:

- Revising design standards for new construction to *AS7000 2016: Overhead Line Design* to allow for greater clearances between wires to address high wind conditions to reduce HV line clashing.
- Applying *AS7000 2016: Overhead Line Design* to existing HV lines to reduce HV line clashing. At-risk sites identified through LiDAR assessment are addressed predominantly through the application of HV spreaders to maintain clearances during intense winds.
- Ongoing LiDAR review to ensure maintenance of line clearances.
- Improved resource planning during times of forecast severe weather may be improved by improved weather forecasting and resourcing models complemented by access to better local weather data through more weather stations.
- Enhance climate modelling to better forecast consequence and causality of extreme weather events.

It is **NOT cost effective** to:

- Proactively replace or underground assets based on future wind forecasts.
- Proactively remove vegetation well outside the clearance space based on future wind forecasts.

[10] AECOM Climate Change Study for Victorian Electricity Distribution Businesses - Phase 1, 2023

12. Floods

Heavy and sustained precipitation causes major flooding, including flash or **surface flooding,** which can damage exposed assets like substations and poles, plus reduce clearance and access to overhead powerlines.

12.1 Historic Exposure

Extreme rainfall events have previously caused network outages and damage to electricity assets. In June 2021, storms involving heavy rainfall followed by extreme winds led to extended periods without power.

12.2 Future Exposure

Much of Victoria is projected to experience more frequent and intense extreme rainfall events in 2070 under both a moderate and high emissions scenario. However, the frequency of heavy rainfall events will vary across the state.

12.3 Future Impacts

The increased intensity and frequency of extreme rainfall presents risks to overhead distribution lines, poles, substations, and communications equipment.

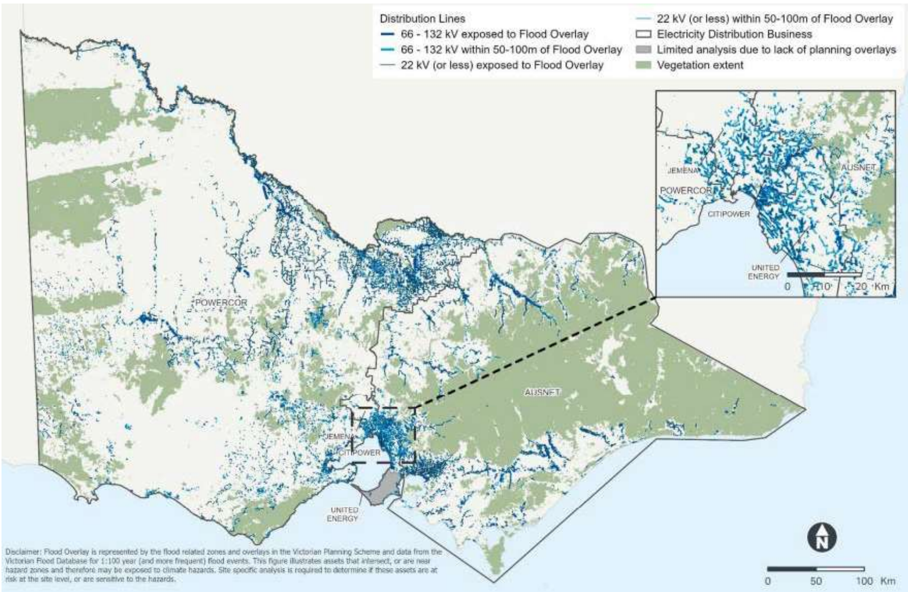

Figure 7: Distribution Lines Exposed to Flood Hazard Overlay [11]

Extreme rainfall related flooding can cause the destabilisation of the foundations of towers, overhead lines, poles, and substations resulting in damage to the assets. Flooding can limit access to assets including substations and overhead lines, limiting the ability to undertake repair works and prolonging network disruptions. Furthermore, extreme rainfall related flooding can cause communications equipment and substations to be inundated, damaging low-lying assets.

Our infrastructure resilience to flooding can be improved to a level that is acceptable to customers. The location and severity of flooding is considered predictable, enabling treatment measures to be more reliably identified. According to Australian Institute for Disaster Resilience [12], "Impacts of flooding on infrastructure are managed by using design standards that limit their vulnerability to flooding." This is the basis for our approach in treating flood risk.

Zone substations are single points of failure, so flooding can result in a high impact event. This can result in a secondary public safety risk as communities are without power, which can impact other essential services such as communications,

[11] AECOM Climate Change Study for Victorian Electricity Distribution Businesses - Phase 1, 2023

[12] Australian Disaster Resilience Handbook 7, Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia, chapter 1.2.3

life support equipment and water treatment. Target levels of local flood protection are set for zone substations where the greatest risks occur.

Sub-transmission and high voltage overhead powerlines over flood waters are de-energised if safe approach distances are breached for moving watercraft through flooded areas. It can also result in secondary safety risks as communities are left without power, impacting essential services. Assets may also be damaged by debris carried in the floodwaters. Target levels of line clearance are set for locations where the greatest public safety risks can occur.

Distribution substations and low voltage powerlines are not in scope as the customers they serve are normally also flooded. However, they may be considered if they supply critical infrastructure such as sewage or water treatment.

According to AECOM[13], impacts by distribution area, include:

CitiPower

- The projections for extreme rainfall are relatively uniform across the area and less severe than for other parts of Victoria. Locations with larger portion of assets exposed include Albert Park, St Kilda East, Prahran, and Fitzroy.
- Between 9% and 20% of distribution lines (depending on voltage), 15% of distribution substations, and 18% of zone substations intersect with flood overlays.

Powercor

- Increases in heavy rainfall days are projected to be greatest within the Barwon Southwest region. The Otway Ranges are projected to have more severe rainfall than other parts of the state. Locations with larger portion of assets exposed include between Shepparton and Mulwala, Swan Hill to Bendigo, north and east of the Grampians as well as portions of Geelong and Colac.
- Between 12% and 13% of distribution lines (depending on voltage), 12% of distribution substations and 13% of zone substations intersect with flood overlays.

United Energy

- Increases in heavy rainfall days are projected to be greatest around Rosebud and Red Hill. Locations with a larger portion of assets exposed include in and around Elwood, Parkdale, McKinnon, and Frankston. In addition, assets across much of the Mornington Peninsula are in areas identified as Flood Prone Areas - subject to review.
- Between 7% and 9% of distribution lines (depending on voltage) and 6% of distribution substations intersect with flood overlays.

Australian Energy Operations

- Neither Ararat Terminal Station nor Elaine Terminal Station intersect with flood overlays. A futures site at Gnarwarre is also free of flood overlays.

12.4 Prepare and Adapt for Floods

While flood behaviour is becoming less predictable, flood plains are well defined and so identifying locations for preparation projects is relatively straightforward.

The main preparation for future floods is to review vulnerabilities of assets to floods and take remedial actions on a location-by-location basis. Where assets are likely to be materially impacted by floods, we implement works including:

- Adding relevant overlays to our GIS systems to raise awareness of the future climate risks when selecting future asset sites and ensuring design standards specifically include checking for flood plains.
- Remediate zone substation sites with existing flooding risks focused initially on 1-in-100-year flood plain exposure.
- Remediate zone substation sites with potential future flooding issues opportunistically when undertaking other material projects such as control room rebuilds.
- Assess and remediate HV and sub-transmission line crossings of flood zones to ensure that limits of approach can be maintained for rescue watercraft or that contingency triggers for safety shut offs are documented.
- Enhance climate modelling to better forecast consequence and causality of extreme weather events.
  - Improve flood modelling to ensure historic 1-in-100-year flood plains remain relevant in the face of climate change.

It is **NOT cost effective** to relocate zone substations or other key assets or proactively underground assets based on future flood forecasts.

[13] Climate Change Study for Victorian Electricity Distribution Businesses - Phase 1, 2023

13. Heat Waves

Heat waves stress the grid, increase demand for air-conditioning, accelerate asset deterioration, increase sag on overhead conductors, which makes derating necessary and increase the risk of bushfires. Sustained extreme temperatures in combination with high overnight temperatures cause asset failures and network outages and impacts electronics such as communications and protection equipment. It also affects our ability to operate, disrupting planned field work and directly impacting crews.

13.1 Historic Exposure

In January 2018, prolonged high temperatures recorded in Victoria overwhelmed networks and led to power outages.

Events in other states also provide insights. In January 2019, Adelaide experienced its hottest day on record where 25,000 people lost power and South Australian Government diesel generators were turned on for the first time.

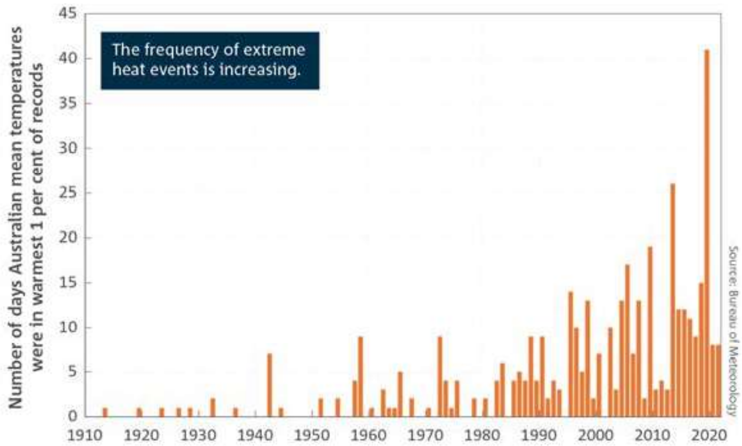

Figure 8: Number of Days in the Warmest 1% of Records in Australia .[14]

13.2 Future Exposure

Average temperatures across Victoria are projected to rise by 2°C to 4°C depending on the emissions scenario. The northern parts of the state including Loddon Mallee and Grampians regions are projected to have more frequent and intense periods of extreme heat than other parts of the state.

- Under RCP8.5, Mildura is projected to have 23 days >40°C in 2070 compared to a historic 12 days per year.
- Under RCP8.5, Horsham is projected to have 11 days >40°C in 2070 compared to a historic 2 days per year.

13.3 Future Impacts

Increases in temperature will add stress to infrastructure and may lead to thermal degradation of substations and underground cables and may mean that the derating of lines is required more frequently leading to network disruptions.

According to **AECOM Climate Change Study for Victorian Electricity Distribution Businesses - Phase 1, 2023**, impacts by distribution area include:

CitiPower

- The frequency and severity of extreme heat events is projected to be relatively uniform.
- The projections do not consider the potential for higher ambient temperatures due to the urban heat island effect.

Powercor

- Assets located north of Horsham and northwest of Kerang are likely to be the most exposed to risks associated with extreme heat with projections for extreme heat days in these regions being higher than for other areas.

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[14] AECOM Climate Change Study for Victorian Electricity Distribution Businesses - Phase 1, 2023

United Energy

- Assets located within Greater Melbourne and Frankston region are likely to be more exposed to risks associated with extreme heat as these areas are expected to have more frequent and intense extreme heat days than other areas.
- The projections do not consider the potential for higher ambient temperatures due to the urban heat island effect.

Australian Energy Operations

- The frequency and severity of extreme heat events is projected to be relatively uniform.

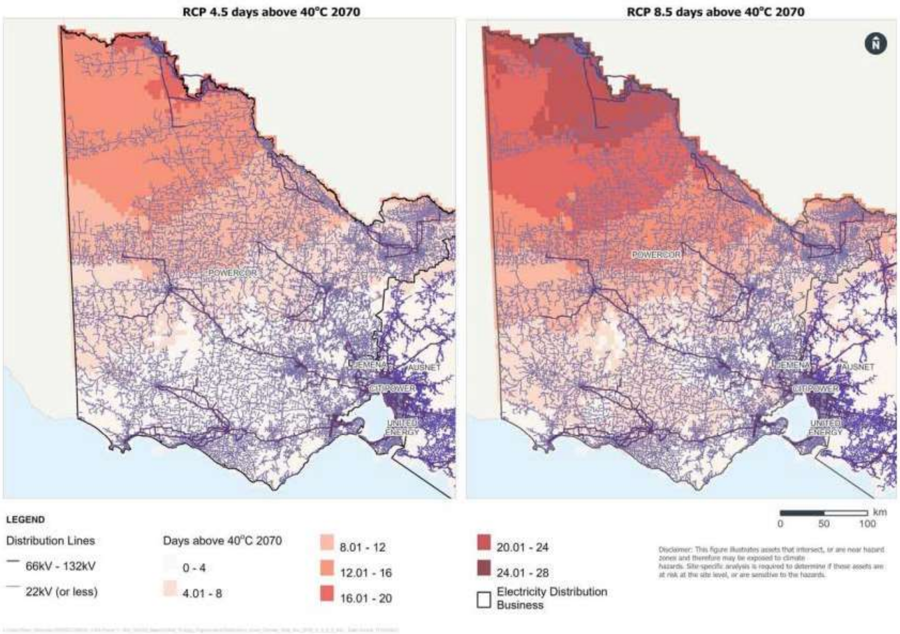

Figure 9: Distribution Lines Exposed to Extreme Heat – days over 40ºC in 2070 .[15]

13.4 Prepare and Adapt for Heatwaves

Most network assets are designed to operate up to 40^{0}C ambient temperature. With forecasts of a substantive increase in days more than this operating threshold, we will prepare by undertaking the following:

- Review equipment ratings for thermally limited equipment for higher ambient operating temperatures or de-rate equipment as required.
- Revise equipment procurement standards for higher temperatures for new equipment.
- Review zone substation design to manage control room temperatures e.g. insulation, ventilation or energy efficiencies for both electronic equipment and staff.
- Preparations for summer heat wave weather are put in place through Spring and include:
  - Ensure asset health and availability leading into Summer: complete maintenance, defects, and construction.
  - Ensure stocks are reviewed, generators are maintained, and Contingency/Resourcing Plans are updated.
- Install temperature monitoring devices on limited select assets and equipment.
- Enhance climate modelling to better forecast consequence and causality of extreme weather events.

It is **NOT cost effective** to proactively replace assets based on future heat forecasts.

[15] AECOM Climate Change Study for Victorian Electricity Distribution Businesses - Phase 1, 2023

14. Droughts

Dry ground leads to change in soil conditions, destabilisation of foundations, erosion and movement which damages underground assets, higher thermal resistivity of cables and a build-up of dust and pollutants that lead to dry band arcing in combination with light rain or humidity causing pole fires.

14.1 Historic Exposure

Droughts in Victoria have caused damage to underground infrastructure assets. In 2008, the Millennium drought caused soil movement that caused damage to cables, and pipeline failures increases for Melbourne Water and Multinet Gas.

14.2 Future Exposure

Severe droughts are expected to become more frequent under both the moderate and high emissions scenario. Some regional projections are far more severe, with Greater Melbourne, Ovens Murray, Barwon and the Great South Coast projected for a higher number of 'extreme dry' periods (when the Standard Precipitation Index (SPI) is below –2).

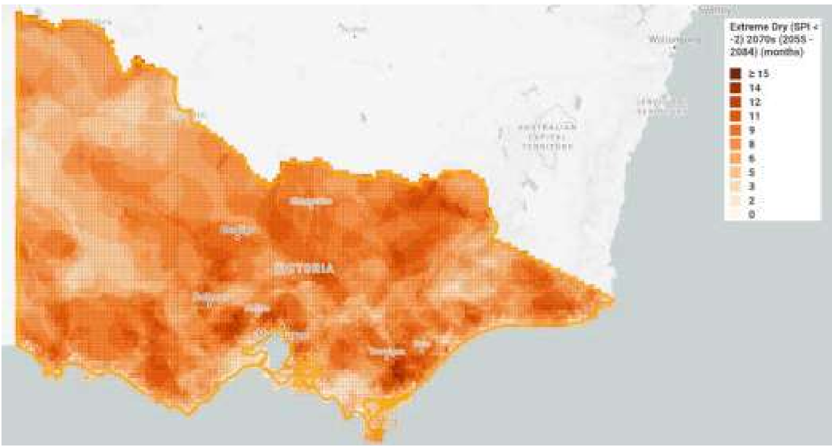

Figure 10: Projected Number of Months under 'extreme dry' conditions under RCP 8.5 in 2070.[16]

14.3 Future Impacts

CitiPower

- CitiPower is less exposed to the risks associated with this hazard than other parts of the state. However, droughts are projected to become both more frequent and severe across CitiPower's distribution area.

Powercor

- Powercor's distribution area is more exposed to drought than other parts of the state. The Great South Coast region, particularly around Meredith, Colac, and Camperdown is projected to be more exposed to severe droughts.

United Energy

- Frankston and the Mornington Peninsula are projected to have far more frequent and longer periods of drought.

Australian Energy Operations

- Both Ararat and Elaine Terminal Stations are projected to experience more frequent and longer periods of drought.

14.4 Prepare and Adapt for Drought

While there have been few impacts on our networks, it remains prudent to explore options based on others' experiences. Therefore, the main preparation for future droughts is to review construction standards for buried assets to improve soil conditions during droughts using engineering soils and to ensure we inspect earth assets, especially in Zone Substations. Where earth assets are materially impacted by drought, we could further improve earth effectiveness such as Common Multiple Earth Neutral (CMEN) systems or water drip system reticulation around the perimeter of ZSS earth grids.

[16] Source: Victoria's Future Climate Tool

15. Earthquakes

Earthquakes occur due to the build-up of stress along fault plains. Although most losses from earthquakes derive from damage to urban housing, economic impact arises from damage to critical infrastructure such as energy and utilities and the knock-on effects of disruption to their functionality. The NSHA18 hazard map below indicates the mean PGA (expressed as a proportion of the acceleration due to gravity, g) for 10% probability of exceedance in 50-years on *AS1170.4 Structural design actions Part 4: Earthquake actions in Australia.*

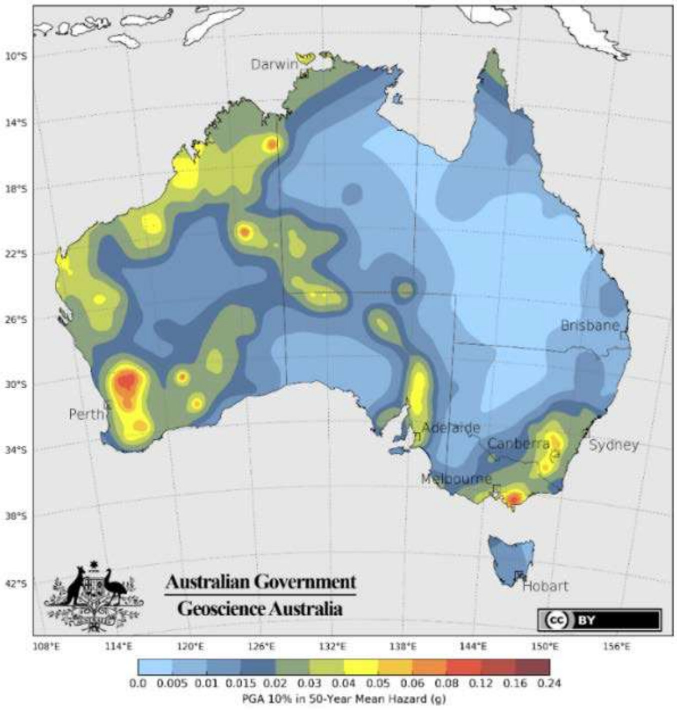

Figure 11: National Seismic Hazard Assessment – Peak Ground Acceleration (PGA) probability

Consistent with *AS1170.4 Structural Design Actions – Earthquake actions in Australia*, the SES Victoria, has identified fault plains in Victoria in their document Earthquakes in Victoria below, including the Strzelecki Ranges, Mornington Peninsula and the Otway Ranges. Most exposure, however, is in the east of the state, supplied by AusNet.

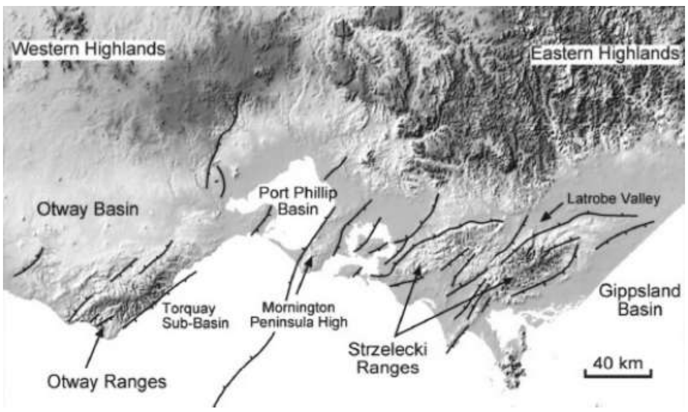

Figure 12: Known Victoria Fault Plains

15.1 Historic Exposure

Victoria is an extremely low seismic hazard area. Since 1900, Victoria has had few earthquakes above magnitude 5.0. Anecdotally, the impact of earthquakes on our assets has been minimal. Buchholz relay operations from vibrations have occasionally been reported in Powercor (Swan Hill) and in Ausgrid’s territory around Newcastle.

15.2 Future Exposure

It is expected that the future exposure to earthquakes will remain the same as it is today.

15.3 Future Impacts

It is expected that the impact of earthquakes will remain the same as it is today.

15.4 Prepare and Adapt for Earthquakes

While there have been very few events on our networks, it is prudent to explore options based on others' experiences. Therefore, the main preparation for future earthquakes is to prioritise Buchholz relay replacement in the high-risk areas towards the Otway Ranges identified in *AS1170.4*: *Structural Design Actions – Earthquake actions in Australia*.

16. Tsunami, Coastal Erosion from Sea Level Rise or Storm Surge

Coastal inundation leads to site erosion, corrosion of metal assets, flooding of waterways and low-lying areas.

16.1 Historic Exposure

There is no known record on our networks of tsunamis, coastal erosion, sea level rise or storm surge materially impacting customer service.

16.2 Future Exposure

Sea levels around the Australian coastline are rising at an increasing rate with an average annual increase of 2.1 mm/year between 1966 and 2009 and 3.1 mm/year between 1993 to 2009.

Under a high emissions scenario, sea levels across Victoria's coast are projected to rise approximately 24 cm by the 2050s and could be as much as 54 cm by 2070.

16.3 Future Impacts

The Victorian Government has developed the following inundation maps showing areas at risk of storm surge related flooding in 2040 (20 cm sea level rise) and 2070 (40 cm sea level rise).

Figure 13: Distribution Lines Exposed to Sea Level Rise

CitiPower

- Some assets in Port Melbourne, Southbank, Docklands and Albert Park are exposed.
- Approximately 1% of distribution lines and 2% of zone substations intersect with areas that are projected to be inundated by 2040and between 1% and 2% of distribution lines (depending on voltage) by 2070.

Powercor

- Some assets in Point Lonsdale, Great Otway National Park, Port Campbell, Peterborough and Portland are exposed.
- Less than 1% of lines (depending on voltage) and substations are projected to be inundated by 2040 and 2070.

United Energy

- Some assets in coastal suburbs of St Kilda, Elwood, Brighton, Sandringham, Beaumaris, Mordialloc, Aspendale and Carrum are exposed. Some assets on the Mornington Peninsula are exposed including Frankston and Mt Martha.
- Less than 1% of lines (depending on voltage) and substations are projected to be inundated by 2040 and 2070.

Australian Energy Operations

- No assets are exposed.

16.4 Prepare and Adapt for Coastal Inundation

There are no records on our networks of tsunamis, coastal erosion, sea level rise or storm surge materially impacting customer service. It remains prudent to explore options based on others' experiences.

GIS overlays are available to raise awareness of the future climate risks when selecting asset sites. This can also be used for considering relocating existing lines at end of life. However, there is expected to be limited ability to do much while we continue to provide supply to customers who are also located in areas at risk of coastal inundation. Such issues are a broader societal issue and so are a joint responsibility with local councils.

17. Geomagnetic Storms - Solar Flares

Conditions in space can affect conditions on earth. Rare solar super storms can cause detrimental effects to the electricity grid, satellites, avionics and signals from satellite navigation systems and mobile telephones. A major geomagnetic storm could be catastrophic to electrical networks, generating induced currents, which can exceed 100 amps and damage transformers, relays and sensors, leading to large scale outages.

17.1 Historic Exposure

There is no known record in the CPPAL, UE or AEO networks of solar flares materially impacting customer service.

17.2 Future Exposure

It is assumed that the future exposure to solar flares will remain the same as it is today.

17.3 Future Impacts

It is assumed that the future impact of solar flares will remain the same as it is today.

17.4 Prepare and Adapt for Solar Flares

While there have been no recorded events on our networks, it remains prudent to explore options based on others' experiences. Therefore, we are reviewing our transformer specifications against *CIGRE Technical Bulletin TB 780 Understanding of geomagnetic storm environment for high voltage power grids*.

18. Lightning Storms

Surges from lightning cause asset deterioration, thermal damage and/or network outages. Lightning striking trees may fall onto power lines and cause outages.

18.1 Historic Exposure

Victoria is one of the lower lightning intensity areas in Australia, therefore, lightning storms infrequently cause material outages. However, in recent times, surge arrester operations on REFCL supplied networks in the Powercor area have impacted more customers than on non-REFCL networks.

18.2 Future Exposure

As lightning cannot easily be modelled it is assumed that the climate future will remain the same as it is today.

18.3 Future Impacts

It is assumed that the impact of climate futures will remain the same as it is today.

18.4 Prepare and Adapt for Lightning Storms

Industry practice is to install surge arresters on major plant items to protect them from lightning strikes. The application of surge arresters varies between businesses depending on risk appetite, lightning exposure, location and value of assets.

Surge arrester application is regularly reviewed as experience with lightning activity and new products continue to be developed. This is likely to be especially focused on REFCL supplied networks in the Powercor area where surge arrester operations can impact more customers than on non-REFCL networks.

AEO network assets have been designed to mitigate lightning strikes impacting its assets via appropriate lightning protection systems, such as aerial earth wires and surge arrestors.

19. Respond

Ensuring we respond quickly remains critical for our customers and will always be key in our resilience plan. Response activities are broadly agnostic to the event cause and include response planning, emergency management, mutual aid, spare equipment, generator despatch and communication of situational awareness.

19.1 Emergency Response

Emergency response includes pre-event preparation meetings when weather forecast triggers are reached. Field resources are provided advanced notice of an impending event and additional resources are committed.

The availability of resources such as fault crews, fleet, equipment including through insourced or outsourced service providers is therefore a prime business focus throughout the year, especially so leading into peak storm activity season.

Once an event is triggered, the emergency manager develops a forward view of the duration ensuring that resources are managed for fatigue guidelines and there is continuous resource coverage (e.g. for overnight).

UE has an external service provider, so additional resources can be requested from the Network Services Agreement Service Provider (Zinfra) and major projects panel contractors (such as BEON, Downer, Service Stream and UGL).

We produce several emergency planning documents. Those dealing with resilience include:

- Business Resilience Framework (JEQA4UJ443MT-154-402)
- Crisis Management Plan (JEQA4UJ443MT-154-386)
- Business Continuity Plan (JEQA4UJ443MT-154-417)
- Event Command Organisation Manual – Emergency Management Plan (JEQA4UJ443MT-154-114)
- United Energy Emergency Management Manual (UE-MA-0009)

19.2 Mutual Aid

Mutual Aid Agreements allow for sharing crews and resources to improve restoration times when major disasters strike.

These agreements detail the application and co-ordination of Mutual Aid between network operators during Network Electricity Supply Emergencies. It covers transfer of resources including, labour and specialist resources, materials and equipment. It details how requirements for resources will be established and met.

19.3 Customer Communication During and After Extreme Weather

Providing regular, consistent, and clear communication is vital during a major event to avoid confusion, enable customers to feel supported and make their own decisions.

We provide our customers with Estimated Times to Restore (ETR) supply, and these estimates are usually reliable during normal, business-as-usual outages. During extreme events, however, safe access limitations and the widespread and dynamic nature of the outages make providing accurate ETRs inherently more challenging. We also need to strike a balance between using finite resources to improve the robustness of ETRs and the workforce restoring supply.

Notwithstanding the above, our customers have told us the following:

- They want accurate estimates of the time when power will be restored so they can make informed decisions.
- ETRs should be updated for new or revised information and should be consistent across sources.

In response, we have developed improvements to our website and customer communication to improve our ETRs during widespread outages including introducing 'storm mode' capabilities, dedicating resources to manage provision of ETR information to customers and increasing our ability to send messages to individual customers on their specific outage.

19.4 Operational Response Preparations and Improvements

Historically, energy companies respond quickly to extreme weather disasters to restore power as soon as practicable. Emergency management teams follow emergency response plans to assess damage, provide resources to restoration locations, to repair damage, communicate with the community and execute recovery.

Aspects such as resource deployment and optimisation between depots, better resource planning during times of forecast severe weather and improved communication between field crews and NCC are frequently reviewed.

Material stocks are reviewed regularly and mobile plant such as generators are maintained.

Focus areas for improved resilience for operations preparation and response include:

- Visualisation tools to improve situational awareness during extreme events for impact to network assets and community impact. Tools will improve timeliness and efficacy of real time decision making for operations staff and provide clear communications to the community.
- Improved coordination with emergency authorities on operational response for extreme weather events.
- Improved coordination of resources and communication of information to support community relief centres and hubs.
- Engage with other critical infrastructure providers for improved coordination for extreme weather events, and extended outages including telecommunication and water utilities.
- Further invest in aerial inspection technologies, including helicopters and drones, to provide rapid damage assessment to expedite design, logistics and operational response activities.
- Extend the use of GPS on CPPAL company vehicles during natural disasters to ensure employees get home safely.
- Explore work practice changes under fire scenarios to ensure safety for field crews and effective response.
- Explore work practice changes under higher heat scenarios to ensure safety for field crews and effective response.

AEO is also well prepared to manage major events caused by severe storms, flooding and earthquakes. AEO shares emergency preparedness responses with its service provider due to the commonality of their asset locations, hence experiencing similar impacts and events.

20. Community Resilience

Network resilience is sometimes used interchangeably with community resilience. They are different but related concepts. A resilient electricity network can assist community resilience. But many different entities have a role in supporting communities to withstand and recover from the impacts of natural disasters. Government bodies, individuals themselves and other critical infrastructure operators have a role to support community resilience.

Community resilience has been defined in many ways. CPPAL and UE have adopted The Royal Commission definition:[17]

Community Resilience is the ability of communities to withstand and recover from the impacts of natural disasters.

A well-prepared community is better placed to handle outages while we work to restore the network with other emergency management stakeholders. This applies equally to other critical infrastructure operators, who should have robust plans to ensure continuity of their service during extended electricity outages. Response and recovery measures include availability of equipment and staff; customer communications during a disruptive event and how to provide for vulnerable customers.

The *Australian Disaster Resilience Index* assesses the capacity for disaster resilience in communities across Australia. It is made up of coping capacity and adaptive capacity, based on community characteristics that contribute to their resilience to natural hazards. The chart below was published in July 2020 and indicates the results for Victoria.

[17] Royal Commission into National Natural Disaster Arrangements, Final Report, 2020, p. 396.

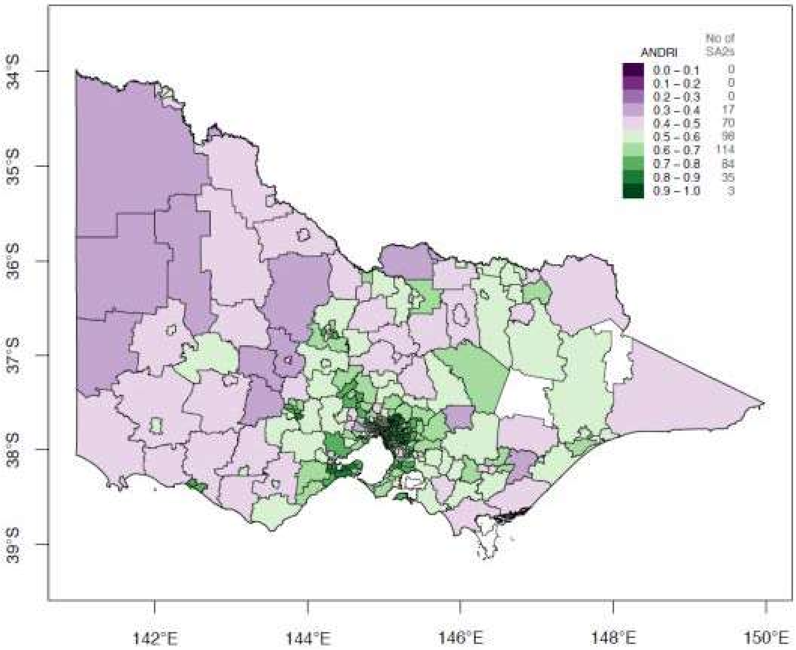

Figure 14: Australian Disaster Resilience Index in Victoria.[18]

We play a vital role in supporting and servicing our customers. In resilience terms this often means to provide information and consult locally. Our approach encompasses the following communication aspects.

20.1 Support our Customers Prior to Extreme Weather

Our ongoing efforts to better support our customers in the lead-up to and during extreme weather includes:

- An integrated communication campaign including advertising, traditional media, social media, and annual direct notifications to all customers in the lead up to summer providing information on how to prepare for outages.
- Information on preparedness for local councils and members of parliament to share with their constituents, and more recently information targeted to new regional residents used to living in the cities and suburbs.
- A communication campaign to promote preparedness messaging with multicultural communities.
- Ahead of a weather event, using our channels to promote preparedness messaging, and in some cases using SMS to encourage life support customers to be ready to enact their contingency plans.

The following additional actions would improve our capacity to plan and support our communities even further:

- Provision by a Government department of critical infrastructure locations to inform improved planning practices AND community refuge centres for all local councils to support a review of potential supply improvements.
- Overlay network maps with customer vulnerability maps to assist prioritisation of any investments.
- We actively support ENA engagement with CSIRO on the development of community vulnerability mapping focused on certain climate variables to understand approaches to supporting community resilience plans.

20.2 Support our Customers During Extreme Weather

As noted in Section 19.3, providing regular, consistent and clear communication is vital during a major event to avoid confusion, enable customers to feel supported and make their own decisions. We provide our customers with ETRs. During extreme events, safe access limitations and the widespread and dynamic nature of the outages make providing accurate ETRs inherently more challenging.

[18] The Australian Natural Disaster Resilience Index – final report Bushfire & Natural Hazards CRC (source: bnhcrc.com.au)

We have improved our website and customer communication management to improve our ETRs during widespread outages including introducing 'storm mode' during widespread outages, dedicating resources to manage provision of ETR information to customers and increasing our ability to send messages to individual customers on their specific outage.

The *Energy Legislation Amendment (Electricity Outage Emergency Response and Other Matters) Bill 2023* provides the Department of Energy, Environment and Climate Action (DEECA) Secretary powers to direct DNSPs to support those impacted by an electricity outage emergency. UK's Government's report into the impacts of storms Christmas 2013 on electricity networks also recommends improvements in the sector, many relating to communicating with customers.

20.3 Support our Customers After Extreme Weather

Connected micro-grids can make local supplies more resilient. A "Community Resilience Hub" where customers can relocate to gain access to telecommunications, power, emergency information and air-conditioning during an emergency supports community resilience, but given the random nature of weather, it is difficult to identify permanent locations which might be regularly used. Therefore, a more mobile approach is considered more prudent where we can deploy support to locations hardest hit at any time. These include:

- Deployable generators to provide supply to suitable community locations as required.
- Despatching more community liaison officers to support people impacted by an electricity outage emergency.
- More 'muster' trucks to be mobilised in the event of long outages. It includes power supply points, mobile charging lockers, broadcast speakers, a 5m light mast, refrigeration, and screens to display maps and safety messages.

Figure 15: Mobile Engagement Response Vehicle

20.4 Customer Resilience Priority Centres

In 2022, Powercor and United Energy conducted a feasibility study into Resilience Solutions, supported by a $650k grant from DEECA. The study investigated 'Tier 1' sites, with back up energy supplies for key individual customer sites, and 'Tier 2' solutions to keep part of the town centre energised during major events to operate as emergency centres.

Following the study, DEECA committed $7.5 million to fund 24 'Tier 1' customer sites across Victoria (10 in Powercor and 3 in United Energy networks).

This work initiated in our regulated businesses resulted in the below outcomes:

- DEECA awarded $4M to implement the 13 sites in Powercor and United Energy, with all scheduled to be completed by the end of 2024.
- Implementation of ~180kw/346kWh of battery storage, 116kW solar and 178kW diesel generation across our networks, owned by each customer site.

Early learnings include stakeholder engagement and management to be one of the key challenges for these projects, with each location having a considerable number of stakeholders with unique requirements.

Figure 16: DELWP Customer Resilience Priority Centres

20.5 Life Support and Vulnerable Customers

We have many responsibilities to life support customers, including to maintain a register of those customers under the *Electricity Distribution Code of Practice*. During an escalation event, we supply these details to the Department of Health and Human Services (DHHS) who can provide individual support and welfare checks. In addition, we also:

- Notify life support customers (and their carers if registered) of the unplanned outage via SMS.
- Provide care packages in extended outages where appropriate.

The life support customer provisions in the regulations are intended to support the most vulnerable members of society with managing the loss of electricity to their medical equipment. Life support customers are defined in the regulations, involving certification from a registered medical practitioner. We have clear visibility of these customers, as the B2B process with retailers contains a Life Support Notification (LSN) transaction.

21. Definitions

Table 1: Terms and Definitions

Term	Definition
Adaptation	The process of adjustment to actual or expected climate and its effects, to moderate harm or exploit beneficial opportunities.
Climate Change	A change in climate that persists for an extended period, typically decades or longer.
Community Resilience	The ability of communities to withstand and recover from the impacts of natural disasters.
Major Event	A significant event which has the potential to impact the network sufficiently to result in a Major Event Day.
Network Resilience	The ability to withstand and recover from the effects of a natural hazard or disaster.
Representative Concentration Pathways (RCPs)	Scenarios that include time series of emissions and concentrations of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover.
Vulnerability	The degree to which a system is susceptible to, or unable to cope with, adverse effects of hazards, including climate change, variability and extremes.

22. Referenced Documents

Table 2: Referenced Documents - Internal

Title	Document No
AEO Electricity Safety Management Scheme	AEO-STR-0001
Business Continuity Plan	JEQA4UJ443MT-154-417
Business Resilience Framework	R-001
CPPAL Reliability Plan	CPPAL-PL-0002
Crisis Management Plan	JEQA4UJ443MT-154-386
Enterprise Risk Management Framework	13-10-CPPCUE0005
Event Command Organisation Manual – Electricity Network Emergency Management Plan - Section 3 – Part A	JEQA4UJ443MT-154-114
Integrated Network Management System	STR-1440
Network Reliability Strategy	STR-0002
UE Network Reliability Plan	UE-PL-5010
United Energy Emergency Management Manual	UE-MA-0009

Table 3: Referenced Documents - External

Title	Document No
Adaptation to climate change – Guidelines on vulnerability, impacts and risk assessment	ISO14091
Asset Management – Management Systems	AS/ISO 55001
Australian Disaster Resilience Index	Bushfire & Natural Hazards CRC
Australian Government Department of Climate Change and Energy Efficiency	Climate change - DCCEEW
Climate Change in Australia technical report and interactive website	www.climatechangeinaustralia.gov.au
Climate Change Study for Victorian Electricity Distribution Businesses - Phase 1	AECOM
Climate Risk and Resilience - Industry Guidance Manual	ENA Doc 036
Contingency Planning & Resilience Analysis	IAM Subject Specific Guidance 32
Electricity Distribution Code of Practice	Victorian Essential Services Commission
Electricity Industry Act	Victorian Department Energy, Environment and Climate Action
Electricity Network Safety Management Systems	AS 5577
Electricity Sector Climate Information Project	Department of Industry, Science, Energy and Resources
Energy Legislation Amendment (Electricity Outage Emergency Response and Other Matters) Bill	Victorian Legislation
National Electricity Law	Australian Energy Market Operator
National Electricity Rules	Australian Energy Market Commission
Network resilience - A note on key issues	Australian Energy Regulator

Title	Document No
Overhead Line Design	AS7000
Security Legislation Amendment (Critical Infrastructure Protection) Act 2022	Federal Department of Home Affairs
Structural Design Actions - Earthquake actions in Australia	AS1170.4
The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report known as the “AR6” Intergovernmental Panel on Climate Change Data Distribution Centre	http://www.ipcc-data.org
Understanding of geomagnetic storm environment for high voltage power grids	CIGRE TB 780
Victoria’s Climate Change Strategy 2021	Victorian Department Energy, Environment and Climate Action
Victorian Climate Projections 2019	Victorian Department Energy, Environment and Climate Action
Victorian Government Climate Change website and publications	www.climatechange.vic.gov.au

Appendix A: Material Resilience Program Summary

Table 4: Material Initiatives

Initiative	Description
Community Resilience - Communication	Improved **prioritisation tool** to improve situational awareness and provide more relevant **customer information** during extreme events.
Community Resilience – individual customers	• Adopt **Stand-Alone Power Supplies (SAPS)** for individual customers most exposed to prolonged outages.
Community Resilience – Location specific	Assess network and community vulnerabilities: • Adopt **Microgrids** in communities most exposed to prolonged outages. • Alternate supply (**feeder tie lines**) to improve supply for worst-served customers. • New zone substation at **Shoreham** to improve customer supply options.
Community Resilience – Mobile	• Additional **deployable generators** to support affected communities **[to be completed 2025].** • Additional **Mobile Emergency Response Vehicles** to cater for multiple, concurrent outages. • **Community Liaison Officers**, who know and serve their communities
Fire - Adopt fire-resilient assets	Identify areas and assets most at risk of being in fire path and make assets more fire resilient in these areas: • Replace poles at end of life with **fire-resilient poles.** • **Explore fire retardant** use on other at-risk wooden poles.
Flood – Improve line clearances	Identify high voltage or subtransmission lines crossing flood ways **[completed 2024]:** • Remediate lines with **taller poles** to increase clearances above potential flood waters.
Flood – protect Zone substations	Identify zone substations and other key assets at risk of floods: • Protect at-risk zone substations with local flood protection **[completed 2023].**
Heat - Equipment standards	Revise equipment procurement standards for higher temperatures.
Heat – Ratings	Update ratings for thermally limited equipment.
Improve climate modelling	Enhance **climate modelling** to better forecast consequence and causality of extreme weather events.
Operational response	Support our **communications networks** to operate for 72 hours without power. Engage with emergency authorities and critical infrastructure providers for **improved coordination.** Explore aerial inspections to rapidly **assess damage** to expedite response activities.
Wind – Design standards	Improve design standard to cater for higher wind speeds.