NET ZERO 2045
Regional and Rural Network Roadmap

Powercor / AusNet VIC

Report Developed for PowerCor/Ausnet
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Innovative Assets Engineering

EXECUTIVE SUMMARY

SUPPORTING CUSTOMERS TO EQUITABLY TRANSITION TO AN ELECTRIFIED FUTURE

Powercor Australia and AusNet Services have jointly commissioned a Roadmap that identifies a pathway to improve their regional and rural customer outcomes as they transition towards a net-zero future. Their customers have identified that access to greater network capacity, reliability and power quality are crucial, and that they should be able to share in the benefits of the energy transition.

Powercor and AusNet Services' regional and rural customers receive poorer service levels than urban customers. Regional and rural customers experience 3 to 4 times more minutes off supply, are more severely impacted by long duration outages and are less able to secure adequate electrical capacity.

The gap in service levels between urban and regional and rural customers is challenging today, but the impacts are likely to be exacerbated in the future as the electrification of homes and transport grows. In turn, this risks our collective ability to meet Australia's long-term emissions reduction plans, and Victoria's interim targets.

The following are some examples of poor customer outcomes if the gap in service levels is not addressed:

- households limited to trickle EV charging due to lack of network capacity;
- customers persevering with fossil fuel-based appliances and business facilities due to lack of confidence in the availability of adequate electricity supply;
- customers exposed to higher bushfire risk from Single Wire Earth Return (SWER) assets due to lengthening fire seasons combined with increasing numbers of high fire danger days caused by a warming climate;
- business customers missing out on expansion opportunities due to high network upgrade charges; and
- customers with surplus renewable energy being unable to access the electricity market due to network export constraints.

Powercor and AusNet Services' capacity to address the current gap in service levels is constrained by existing economic regulatory frameworks that prioritise relatively more dense fast growing urban areas, while long-lived assets installed when the electricity system was centralised limit business as usual opportunities for improvements especially in low growth areas.

The scale of change required to make broad and meaningful improvements to the service levels of regional and rural customers is substantial. Dedicated investment over a long period of time will be required to empower regional and rural customers. The focus of this report, therefore, is on identifying a no-regrets roadmap and actions to take now.

CONTINUED

The Roadmap identifies three long-term strategies that will support and enable regional and rural customers to equitably benefit in an electrified future:

1. Powerline upgrades through a mix of targeted SWER system upgrades, extension of three phase high voltage lines, along with the conversion to standalone power systems for end of grid customers.
2. Integrate and adapt renewable energy technologies to support the network to provide reliable and resilient electricity to customers, and to provide enabling technologies to maximise the value of customers' investments in consumer energy resources.
3. Integrate joint distribution and transmission network planning and development in prescribed Renewal Energy Zones, enabling increased renewable generation connections.

This report also includes three recommendations to implement the initial stages of the Roadmap:

1. Begin their process of identifying remote customers suitable for a Stand Alone Power System (SAPS), and then refine the process of customer engagement and connection of the SAPS. In this way sections of aged SWER lines can begin to be removed from service.
2. Implement the technology developments that can provide some import and export capacity and power quality improvements to residential and small business customers in the short term, while the network is being reconfigured in the long term.
3. Begin the formalisation of incorporating distribution network planning into Renewable Energy Zone planning with the transmission planning bodies.

TABLE OF CONTENT

1

A ROADMAP TO SUPPORT REGIONAL AND RURAL CUSTOMERS

1 A ROADMAP TO SUPPORT REGIONAL AND RURAL CUSTOMERS

This report was jointly commissioned by Powercor Australia (Powercor hereinafter) and AusNet Services (AusNet hereinafter), the two largest electricity distribution businesses in Victoria. Both networks cover large regional and rural areas of Victoria, Powercor in the west, and AusNet in the east of Victoria.

This report outlines customer expectations of the rural and regional network both today and in a net-zero future. These expectations are informed by the extensive customer engagement undertaken by Powercor and AusNet (the Distributors hereinafter), with the genesis of this report being feedback received from stakeholders, including those at Powercor's regional and rural summit, that a long-term supply plan for regional and rural customers needs to be developed.

In 2022, Powercor hosted a Regional and Rural Summit in Creswick that sought to better understand the specific challenges facing these customers today and in the future. This was supplemented with further engagement sessions in regional areas, including in Bendigo, Ballarat, Geelong and Shepparton (and online).

AusNet have also undertaken similar engagement with their customers.

The overwhelming feedback from these customers was that prevailing lower levels of investment in regional and rural areas has created a divide in their customer experience relative to their urban counterparts. While this is a concern today, it is alarming looking forward to an electrified future with a greater need for improving reliability, network capacity and power quality. In the absence of these improvements, customers feared for their communities' ability to participate in the energy transition and their future ability to grow both physically and economically..

While today there are some gaps in meeting customer expectations, the report looks at the gap in achieving future net-zero expectations in a status quo scenario where the Distributors and Regulators continue their current approaches. This scenario is called the ‘do nothing different’ scenario.

The Report highlights the emerging limitations of the regional and rural networks (herein rural networks) considering their historical design and development and outlines the ideal characteristics of the 2045 rural networks if customers’ net-zero expectations are to be realistically met.

The report is neither a detailed economic nor technical analysis, but rather proposes a long-term vision of the network characteristics required to deliver customer’s expectations and the 2045 Victorian Government net-zero targets. A high-level overview of network development strategy and supporting technologies to meet these required network characteristics is proposed in this report. The intention is to ensure regional and rural customers can best participate in and benefit from the energy transition.

The roadmap is not constrained by the current regulatory framework, as it is acknowledged the current regulatory framework is undergoing its own transition. Appendix B of the Report contains key background network information informing the recommendations.

The regional areas are experiencing population growth as well as a changing energy mix landscape:

ELECTRIC VEHICLES

Adopting electric vehicles and ensuring regional and rural participation in the energy transformation

RENEWABLE GENERATION

Growing penetrations of renewable generation, particularly large-scale renewable generation

ELECTRIFICATION

Electrification of gas load

BUSHFIRE RISK

Ongoing management of rising bushfire risk

ASSET REPLACEMENT

Technical obsolescence and asset replacement lifecycles

2 REGIONAL AND RURAL CUSTOMERS RECEIVE LOWER SERVICE LEVELS TODAY

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The Distributors are responsible for providing electricity to 99%* of the area of Victoria through their distribution networks.

The majority of their networks supply electricity to customers in rural and regional areas of Victoria, as well as some outer urban areas of Melbourne, including almost 1.7 million customers of which approximately 1 million, or 60%, are classified as 'Rural'.

[* Aust Govt website ga.gov.au states Vic is 227,444 sq kms.].

AUSNET

80,000 KM[1]
ELECTRICITY
DISTRIBUTION

818,000 CUSTOMERS
479,000 Rural Customers
339,000 Urban Customers

POWERCOR

145,651 KM[2]
ELECTRICITY
DISTRIBUTION

900,000 CUSTOMERS
540,000 Rural Customers
360,000 Urban Customers

Customers of the Distributors are concerned that the changing energy mix landscape means they risk being left behind under a net zero future. These challenges, based on customer experience and existing networks, are outlined in the following sections.

2.1 CUSTOMER EXPERIENCE

Rural customers have experienced poorer reliability and quality of supply when compared to their urban counterparts. This is because power lines in rural areas are predominantly overhead and traverse long distances with limited remote control capability. As such, rural distribution networks are more exposed to weather events, including bushfires, and can also have longer repair times. As the severity and frequency of weather events increases due to climate change, supply quality and reliability is likely to deteriorate from current levels, unless additional measures are implemented.

The most recent annual report of reliability experienced by customers is shown in Table 1 below. The Customer Groupings align with AER reporting, where 'short' and 'long' rural describe whether the customer is supplied by distribution feeder lines shorter or longer than 200km.

Customer Grouping	Performance per year	AusNet	Powercor
Urban	Minutes without power	84	71
Short Rural	Minutes without power	244	124
Long Rural	Minutes without power	413	303

Table 1 - Reliability Performance of AusNet and Powercor [1][2]

2.2 LIMITED NET ZERO PARTICIPATION

Regional and rural Victoria is home to an increasing number of large-scale wind and solar generation sources, which mostly connect into the extra high voltage transmission grid. In contrast, regional and rural customers are facing unique challenges in being able to participate in the net zero future in several ways, including:

- Rapidly declining ability to export power to the grid from their own zero or low carbon energy resources such as roof-top solar and battery, due to diminishing local network export hosting capacity.
- Difficulty in converting household appliances and business operations from fossil fuels to electric power, due to the relatively high upfront cost to upgrade the local network capacity.
- Limited access to EV charging stations, due to distance to charging points.
- No direct connections from their communities to any local large-scale renewable electricity generation

Rural customers want to participate in the net zero future, shown by their applications to install rooftop solar units at a greater rate than Urban customers. An example of the declining ability for rural customers to realise the benefits of these decisions is outlined below.

Increasing levels of Customer Energy Resources (CER) specifically rooftop PV installations are resulting in significantly greater reverse power flows as customers seek to export the excess generation back into the network. Intrinsic hosting capacity (IHC) is a measure used of the capability of the network to support reverse power flows (e.g. solar export) without any modifications or upgrading of the network. Powercor's short rural customers have installed solar PV equivalent to 82% of total IHC, and long rural customers have installed solar PV equivalent to 92% of available IHC.

Further evidence of the declining hosting capacity is seen in the total number of solar customers being approved for the standard export capacity of 5kW. Since January 2022, Powercor has connected some 109,000 solar customers who have requested export capacity, and there is a clear trend that short rural customers are being approved for a standard 5kW export at a lower rate than urban customers. In addition, export approval rates decline further for customers on long rural lines and decline again for SWER connected customers. This highlights the need for options to increase hosting capacity to meet rural customer expectations as solar PV applications continue.

2.3 HISTORIC NETWORK DESIGN

The rural networks were significantly extended during the period of state-wide rural electrification, mostly finishing in the 1960s. The rural electrification program achieved its goal through innovative low-cost design for areas of low and very low customer density/customer demand. Specifically, the low-cost network designs adopted for low customer density areas were the Single Wire Earth Return (SWER) design which only needed one high voltage overhead wire, and the ‘2 phase’ design which utilised only two of the three-phases of the 22,000-volt network. Both these designs were of much lower capacity than equivalent length of three phase 22,000-volt overhead lines.

While areas of the rural networks have been upgraded over time as communities and businesses have grown, large areas of low customer density were not upgraded because capacity upgrades could not be justified under the current regulatory economic frameworks.

The age profiles of the SWER overhead conductors indicate they remain largely as initially installed with the statewide electrification program. The Powercor and AusNet SWER conductor age profiles are shown in Figure 1 below, noting that Powercor accounts for approximately 70% of all SWER conductors, and that AusNet's median age of SWER conductors is also 67 years.

Replacement needs will grow from now until 2045 as the reliability of the ageing conductors decreases.

Under a 'do nothing different' approach, however, these low customer density network assets, i.e. SWER network, would just be replaced as they reach the end of their service life in a like-for-like manner, and as a result, the capability of the rural network would not greatly change. Under this scenario, it is likely that many customers on SWER networks will not be able to participate fully in the net zero future because of network capability limitations.

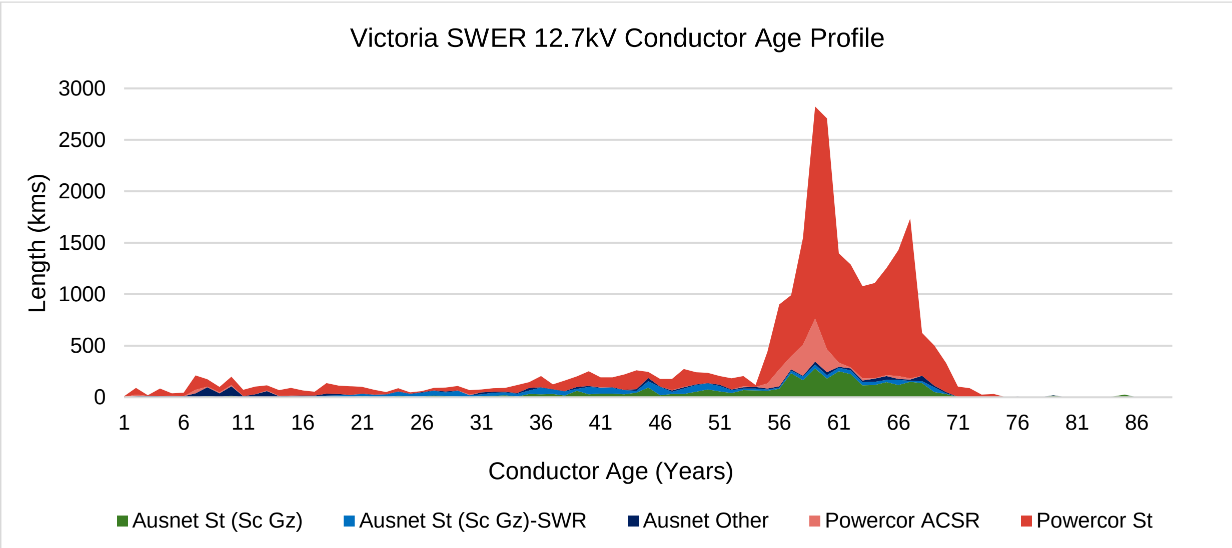

Figure 1 – Victoria SWER Network 12.7kV Conductor Age Profile [4][5]

2.4 SAFE RURAL NETWORKS

Rural networks are already more exposed to significant weather events than urban networks, due to the length of overhead poles and wires, along with the proximity of trees and vegetation. Of the 1 million 'Rural' classified customers across both networks, 38% reside within the CFA proclaimed Hazardous Bushfire Risk Areas (HBRA), which have a much higher risk of severe bushfires.

While Rapid Earth Fault Current Limiters (**REFCL**) have been installed to mitigate the risk of fire-starts from, for example, vegetation falling into powerlines, this technology is not effective in the SWER areas of both networks. Across both networks there are currently some 44,500 customers connected to the SWER network and they are not protected by a REFCL against powerline related fire-starts.

Climate change is forecast to bring more severe weather events, including the likelihood of more frequent high and extreme risk bushfire risk days, which SWER networks remain exposed to.

2.5 TIMELY KEY INVESTMENT DECISIONS

The range and scale of the challenges facing regional and rural customers and the relatively short amount of time to achieve net-zero requires Distributors to make timely asset management and network planning investment decisions now with a view to long-term outcomes. Accelerating and coordinating regional and rural network decision making will ensure the networks can continue to adequately provide the service that regional and rural customers require in a net zero future.

Prudent investment decisions are required to provide multiple benefits to customers and ensure maximum customer value.

This net zero strategy can be likened to the next phase of last century's statewide rural electrification program.

3

THE ROADMAP RECOMMENDS TARGETED UPGRADES, NEW TECHNOLOGIES AND INTEGRATION OF RENEWABLES TO DELIVER CUSTOMER OUTCOMES

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There are three major strategies of the Roadmap, to ensure these customer priorities can be met:

1. Distribution Powerline Upgrades
2. Integration of non-network and new technology solutions
3. Integration with Renewable Energy Zone (REZ) Planning

The implementation of the three strategies involves necessary co-ordination to ensure cost synergies in achieving the customer outcomes, and the strategies are outlined below.

The implementation will also require Governments, Regulators and Distributors to take a long-term view to system planning, and possibly require regulatory change to facilitate timely and efficient investment in regional and rural Victoria to support and enable customers in a net-zero emission future.

3.1 DISTRIBUTION POWERLINES STRATEGY

This strategy relates to the long radial 22kv 'feeder' powerlines that are supplied from the zone substations and extend across the landscape, including the rural SWER system powerlines connected to these feeders

3.1.1 EXTENDING THE 3 PHASE 22KV NETWORK TO ALL ESTABLISHED TOWNSHIPS

Some established townships are supplied with 2-phase 22kV power, which means 3-phase low voltage power is not available to customers. Extending 3-phase 22kV lines will then ensure greater capacity is available to business and residential customers that require a supply upgrade to meet their electrification needs.

3.1.2 SWER NETWORK OPTIONS

In consideration of the age and condition of overhead powerline conductors and their capacity, review each SWER line to determine the optimal combination of:

- Offering a Distributor owned Stand Alone Power System (SAPS) to the customer, to replace under-capacity customer connections around the grid-edge SWER. This will lead to better reliability, greater access to capacity and more ability for customers to adopt CER and net-zero technologies.

- Replacing SWER line sections with multi-phase 22kV lines depending on anticipated remaining customer demand.

- Increasing the maximum standard size of SWER distribution transformers to 30 kVA, or greater if increased demand can be met without significant line upgrades.

It is noted that any conversion of SWER lines in a REFCL area to multiphase 22kV lines has the added benefits that customers on these lines will have their powerline bushfire risk mitigated.

3.1.3 REZ OPPORTUNITIES

Reconfigure and shorten some 22kV powerlines if new distribution connection points become available from nearby utility scale generation connections (refer to REZ planning strategy). This will require Distributors working with AEMO and VicGrid to extend the integrated system plan for REZ planning to include consideration of distribution system planning opportunities.

3.2 INTEGRATION OF NON-NETWORK AND NEW TECHNOLOGY SOLUTIONS

A range of new technologies are available, or becoming available, that can be implemented and coordinated with the above strategies to aid customer's ability to participate in the net zero future. The key new network technologies to be implemented are set out below.

3.2.1 DYNAMIC VOLTAGE MANAGEMENT AND VOLT-VAR CONTROL SYSTEMS

While a form of these systems exists in the Distributors network management capabilities, they can be enhanced with essential grid hardware such as Statcoms[1], which can play a larger role in enabling distributed energy and grid capacity. These systems are designed to enhance the grid's ability to automatically adjust and maintain optimal voltage levels and reactive power (Var) balance, providing critical real-time responses to meeting customer's expectations of power quality in an environment of increasing customer energy resources.

3.2.2 FLEXIBLE EXPORT OPERATING LIMITS TO PROVIDE OPTIMAL CONSUMER ENERGY RESOURCES (CER) EXPORT

Adopt the use of dynamic operating limits for consumer energy resources exporting excess energy back into the grid, to maximise the level of export per customer and increase efficient use of the network.

Flexible import operating limits to provide optimal transport mode charging.

Adopt the use of dynamic operating limits for optimal grid supply of transport mode charging per customer and increase efficient use of the network. This is likely to involve working with Retailers and customers on additional metering technology for transport mode charging.

3.2.3 STAND ALONE POWER SYSTEMS (SAPS)

Stand Alone Power Systems are usually designed to serve a small number of customers (1-5) and have no physical connection to the rest of the distribution network. The implementation of SAPS facilitates the decommissioning of end-of-life or capacity constrained powerlines such as Single Wire Earth Return (SWER) systems. In typical operational scenarios, SAPS ensures the provision of electricity derived entirely from renewable sources to the consumer. To augment the reliability of the solar and battery ensemble, SAPS are often equipped with an auxiliary generation unit for backup purposes.

[1] Statcoms, or Static Var Compensators, are high voltage equipment installed on the network to dynamically adjust the line voltage.

3.3 INTEGRATION WITH RENEWABLE ENERGY ZONE (REZ) PLANNING

In Victoria REZ planning is coordinated by VicGrid and is focused on renewable energy connections into the high voltage transmission system. There are a number of benefits to regional and rural customers if REZ planning is extended to include Distribution network planning, with the following recommendations:

1. Victorian Government to allow Distributors to develop plans to invest in upfront works to remove constraints and support the connection of renewable energy generators to the Distribution networks within the prescribed Renewable Energy Zones. Connecting generators to a distributor's 66kV network can provide quicker connection times and earlier benefits if transmission REZ upgrades are delayed.

2. Joint planning of Renewable Energy Zone (REZ) projects to facilitate the scope for Distribution networks to be connected into the transmission system at new transmission connection stations. This could be beneficial where there is potential to reconfigure part of the local distribution network to:
    a. Improve security of supply for customers currently supplied by long radially fed zone substations,
    b. Shorten ageing sub-transmission and high voltage lines to improve reliability and power quality, and
    c. Incorporate new local mini Distribution zone substations (REFCL enabled if in prescribed high bushfire risk areas).

3.4 RECOMMENDED NEXT STEPS

From the Roadmap strategies, identify and prioritise investments that contribute higher economic value to rural, regional, and State economies and customers, which in-turn enables higher demand for electricity. Economic value can be derived from reliability valuation frameworks and should also consider employment levels and agricultural production value, as well as tourism value to the regions. The additional revenue from higher electricity consumption will also offset part of the cost of upgrades. Investments in areas of the network that supply businesses which provide essential supporting services in areas of high economic value should also be considered. The regional and rural investments that should be prioritised are likely to include:

PRIORITY A

Non-residential customers where stable supply and power quality are crucial to efficient operations, including essential infrastructure providers.

PRIORITY B

Non-residential customers who economically contribute to regional communities and can benefit from electrifying their production.

PRIORITY C

High growth regional areas where demand for capacity will grow as customers electrify.

PRIORITY D

Regional tourist areas with likely high EV traffic.

PRIORITY E

Commercial customers in small towns.

We recommend these investments are delivered in line with the network reconfiguration actions, outlined in section 3 of the Roadmap.

Further initial 'no-regrets' steps are:

1. Begin their process of identifying remote customers suitable for a SAPS, and then refine the process of customer engagement and connection of the SAPS. In this way sections of aged SWER lines can begin to be removed from service.

2. Implement the technology developments that can provide some import and export capacity and power quality improvements to residential and small business customers in the short term, while the network is being reconfigured in the long term.

3. Begin the process of formalising with the Victorian Government and transmission planning entities, the incorporation of Distribution network planning into Renewal Energy Zone planning.

4 CUSTOMER PRIORITIES AND EXPERIENCE IN THE NET ZERO FUTURE

4 CUSTOMER PRIORITIES AND EXPERIENCE IN THE NET ZERO FUTURE

Powercor and AusNet have provided a summary of their relevant customer and stakeholder engagement activities over recent years, and these are reproduced below.

4.1 POWERCOR CUSTOMERS VALUE THE OPPORTUNITY TO PARTICIPATE IN THE ENERGY TRANSITION

Powercor undertook its most extensive stakeholder engagement program ever to support its investment plans over 2026-31. The program included engagement sessions at Bendigo, Ballarat, Geelong, Creswick and Shepparton, with feedback reflecting that current lower levels of investment in regional and rural areas will exacerbate the differences in network performance experienced by those in regional /rural areas and those in urban areas, increasing 'energy poverty'.

From the beginning of broad and wide engagement in 2022, customers have considered the network a shared resource and expressed a willingness to invest in resilient infrastructure solutions to improve reliability, especially in underserved and extreme weather prone regions. This message was emphasised in Powercor's Regional and Rural Summit, where delegates prioritised improving reliability, network capacity and power quality. In the absence of these improvements, customers feared for their communities' ability to participate in the energy transition and their future ability to grow both physically and economically.

Rural and regional customers have also expressed frustration at their inability to access and benefit from the renewable resources within their communities. Customers noted their view that the renewable energy produced in their communities is transmitted to urban areas, which materially impacted their ability to reduce carbon emissions, and in some cases, compromises access to export markets which often rely on demonstrable 'green' credits.

For communities with access to reticulated and bottled gas, customers questioned whether the electricity networks that served regional and rural communities would be sufficient to meet their future electricity supply expectations. The need to electrify many core health and comfort aspects of customers' lives such as heat and hot water, and the growing expectation of electrified transport led many customers to question the capacity of the regional network to support electrification. For many customers, the participation of regional and rural communities in an electrified future was nothing more than a 'pipe dream'.

4.2 AUSNET CUSTOMERS SEEKING A MORE RESILIENT SUPPLY TO SUPPORT ELECTRIFICATION ASPIRATIONS

AusNet began engaging on its plans for 2026-31 in early 2023. Building on the deep engagement undertaken as part of the NewReg trial in 2018-19 (supported by the AER, Energy Consumers Australia and Energy Networks Australia), AusNet established a series of customer panels with approximately 50:50 representation of regionally and urban based customers, to ensure the voice of regional customers was integrated in all engagement sessions.

Regionally based customers have strongly emphasized the need for a reliable energy supply in regional areas, particularly to support electrification that is needed to drive the energy transition. They have also emphasized the shortfalls of the current regulatory framework – being heavily dependent on the use of averages (including when estimating the Value of Customer Reliability and also the Service Target Performance Incentive Scheme) to govern reliability improvements. There is also a perception that urban customers are often prioritized over regional customers due to this use of averages and the relative cost of upgrades in the urban and regional parts of the network.

The three extreme storms AusNet's customers and network have experienced in June and October 2021 and February 2024 have put network (and community) resilience in sharp focus. Rural and regional customers dependent on electricity as a single fuel source (i.e. no gas) incurred lower average costs during prolonged power outages resulting from the storms, indicating that the resilience of the electricity system will need to increase as households electrify gas. In addition, more than 7 in 10 of AusNet's customers think reliability is becoming more, not less, important, due in part to a perceived push (by government) towards electrification.

Rural and regional customers have also communicated the unique energy aspirations of different communities (which may include installing a community battery, a microgrid, or Standalone Power Systems) to reach their own net zero aspirations, and the role of the network to provide agency for communities to each realise these.

5

APPENDIX A - ROADMAP PROJECT INFORMATION

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5.1 PROJECT TEAM AND STAKEHOLDERS

PROJECT DELIVERY TEAM		
AusNet	Milana Lendeczki	Lead Network Planning Engineer
	Charlotte Eddy	General Manager Regulation and Policy (Distribution)
	May Maung	Strategy Lead
Powercor	Chris Gilbert	Regulatory Manager
	Jeff Anderson	Head of Regulatory Strategy
	Craig Savage	Head of Strategic Projects
IAEngg	Andrew Bianchin	Director and Principal Consultant
	Bala Rajendran	Project Manager / Consultant
	Dr Fardin Mafaher	Senior Consultant
	Ervin Fekovic	Senior Technical & Emerging Technology Expert
	Gabriel Wan	Senior Consultant
	John Dyer	Senior Consultant
	Neil Watt	Senior Consultant
	Dr Peter Wong	Senior Consultant
	Robert Jost	Engineering Consultant

STAKEHOLDERS AND WORKSHOP PARTICIPATES		
AusNet	Milana Lendeczki	Lead Network Planning Engineer
	Ana Erceg	Future Networks Manager
	Charlotte Eddy	General Manager Regulation and Policy (Distribution)
	Chirag Desai	Manager Network Planning
	Kenneth Chew	Lead CER Integration Engineer
	May Maung	Strategy Lead
	Rod Jones	GM Network Strategy and Planning
Powercor	Andrew Dinning	Head of Network Planning
	Chris Gilbert	Regulatory Manager
	Craig Savage	Head of Strategic Projects
	Jeff Anderson	Head of Regulatory Strategy
	John Mifsud	Head of Network Risk and Performance
	Michael Meraklis	Head of Network Asset Management

5.2 WORKSHOPS

5.2.1 REGIONAL SUPPLY PLAN KICK OFF WORKSHOP

Initial meeting for development of the regional and rural supply plan. As a collaboration between AusNet, Powercor and IAEngg project alignment on project objectives was confirmed. IAEngg initial data and information requests were also discussed.

IAEngg

Andrew Bianchin

Gabriel Wan

Neil Watt

Dr Fardin Mahar

Robert Jost

AusNet

Chirag Desai

Charlotte Eddy

Milana Lendeczki

May Maung

Powercor

Andrew Dinning

Craig Savage

Genevieve Hart

John Mifsud

Michael Meraklis

5.2.2 PLANNING AND REGULATORY WORKSHOPS

Determination of project purpose and workshop network and system planning. Key drivers such as electrification, likely network impacts and evolving customer expectations were identified. Regulatory regime barriers faced by DNSPs in delivery of solutions that are fit for purpose, timely and efficient were scrutinised.

Regional customer concerns due to adverse effects of an inadequate power system were discussed, i.e. the so-called burning platform. A narrative was established to ensure government and regulator awareness of the deteriorating situation. Opportunities were identified for alignment in distribution system improvements alongside AEMO, Vicgrid and REZ transmission development plans.

IAEngg

Gabriel Wan

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Robert Jost

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Charlotte Eddy

Chirag Desai

May Maung

Milana Lendeczki

Powercor

Andrew Dinning

Richard Robson

Jeff Anderson

5.2.3 EMERGING TECHNOLOGIES WORKSHOPS

Discussion of technological solutions beyond traditional poles and wires utility infrastructure. Drivers for customer uptake of new technology were raised. Current technological trials and future solutions both in the near and long term were explored.

IAEngg

Peter Wong

Neil Watt

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AusNet

Kenneth Chew

Ana Erceg

Bill Fahey

Milana

Shuyi Li

May Maung

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Genevieve Hart

Jeff Anderson

Tom Langstaff

Craig Savage

6 APPENDIX B - BACKGROUND INFORMATION

6 APPENDIX B - BACKGROUND INFORMATION

6.1 OVERVIEW OF VICTORIA'S RURAL AND REGIONAL DISTRIBUTION NETWORKS

Under their electricity distribution Licences, Distributors are responsible for the network that supplies electricity to customers in rural and regional areas of Victoria. In total both networks cover 99% of the area of Victoria.

AUSNET

80,000 KM
ELECTRICITY
DISTRIBUTION

818,000 CUSTOMERS
479,000 Rural Customers
339,000 Urban Customers

The AusNet electricity distribution network covers approximately 80,000 square kilometres. The supply area spans from the outer eastern and north-eastern urban suburbs of Melbourne through north-eastern and eastern regional and rural areas of Victoria to the New South Wales border. The network feeds electricity to more than 795,000 customers in urban and rural areas. Almost **479,000 (59%)** of customers reside in rural areas of the network of which **236,000 (30%)** of them reside in High Bushfire Risk areas (HBRA).

POWERCOR

145,651 KM
ELECTRICITY
DISTRIBUTION

900,000 CUSTOMERS
540,000 Rural Customers
360,000 Urban Customers

Powercor electricity distribution network covers 145,651 square kilometres. The supply area spans from the western and north-western urban suburbs of Melbourne through western rural regions of Victoria to the South Australian and New South Wales borders. The network feeds electricity to approximately 900,000 customers in urban and rural areas. Almost **540,000 (60%)** of customers reside in rural areas of the network of which **147,000 (16%)** of them reside in High Bushfire Risk areas (HBRA).

Much of the rural regions of Distributors are defined as Hazardous Bushfire Risk Area (HBRA) under Section 80 of the Electricity Safety Act[2].

[2] Victoria Electricity Safety Act 1998 No. 25 of 1998 [6]

6.1.1 KEY STATISTICS

An overview of the network key statistics in rural and regional Victoria is given below;

Medium Voltage 22kV Distribution Network

Medium voltage 22kV distribution feeders generally have to go over long distances in rural and remote areas, and generally operate in a radial mode. Unlike urban feeders, which often have several interconnections to neighbouring feeders close-by which enable customers to be transferred between these tied feeders during planned and unplanned feeder outages, rural feeders generally have very few or no interconnections between them resulting in longer outage times.

Medium voltage distribution feeders are usually designed and constructed to have three power carrying conductors (referred to as 3-phase), but many spur lines in rural areas where historical levels of demand were low are constructed with two-phase to minimise initial upfront cost. The capacity of these 2-phase spur lines is lower than 3-phase lines and can generally be increased when needed by installing the third phase.

For reasons discussed above, rural feeders have higher upgrade costs than urban feeder – due to low load density (measured as MVA/km) and geographical distances.

Distribution substations are located throughout the medium voltage distribution network and provide transformation from the 22kV reticulation to low voltage 230/400V or 230/460V network (see below for SWER network). The majority of distribution substations in rural areas are pole mounted.

Single-Wire Earth Return (SWER) 12.7kV Network

In remote and sparsely settled rural areas there are substantial number of radial Single Wire Earth Return (SWER) overhead pole line networks operating at a nominal voltage of 12.7kV. The SWER networks have been a common technology in rural networks, and are a relatively low cost technology, and have suited areas of low historical demand. The SWER networks are supplied from two phases of the three-phase 22kV network via an isolating transformer, which provides the appropriate voltage transformation, regulation, and electrical isolation between the 22kV and 12.7kV networks. The earth acts as the return path conductor in SWER networks which means that the network is constructed with a single conductor supported by single insulators on poles. The cost of this form of construction is low compared to typical three-phase construction The total length of SWER pole lines in the state is 27,713km, of which 21,303km is in Powercor and 6,410km is in AusNet. The majority of SWER pole lines are constructed using 3/2.75 mm steel conductor.

6.1.2 ASSET AGE PROFILE AND HEALTH

Poles and bare overhead conductors attached to poles are the main components of the distribution network in rural regions of Victoria. Poles and conductors in rural areas are determined to be at end of life when asset deterioration leads to increased failure risk resulting in increased risk of bushfire starts, increased risk of public safety incidents (e.g., electrocution, electric shock, flashover and arcing), and increased risk of loss of supply.



The majority of SWER pole lines are constructed using steel conductor. Steel conductors have been the preferred type for rural feeders, including SWER circuits, as they have a higher mechanical strength (breaking capacity) and allow the pole lines to be constructed with longer spans, hence requiring less poles. Steel conductors were introduced in the rural areas in the 1950's and are the second oldest conductor type after copper. Unlike aluminium conductors, which are relatively new (introduced in mid-1970's) and are used mostly in urban areas, steel conductors are impacted by corrosivity of the environment. They also have a higher resistance and therefore lower capacity to supply customer loads and to accommodate reverse power flow from Consumer Energy Resources such as rooftop solar.

Figure 1 and **Error! Reference source not found.** in section 2.3 presents the age profile of 12.7kV SWER conductor types in Powercor and AusNet. Most of the conductor is over 50 years old, and replacement needs will increase in the future.

6.1.3 RELIABILITY PERFORMANCE OF DISTRIBUTION NETWORKS

Rural customers have experienced poorer reliability and quality of supply when compared to urban customers. This is because power lines in rural areas traverse long distances and are more exposed to weather events. As the severity and frequency of weather events increases due to climate change, supply quality and reliability is likely to deteriorate from current levels under the do-nothing-different scenario.

Feeder	Performance Index	AusNet	Powercor
Urban	SAIDI	84.1 min	71.1 min
	SAIFI	0.67	0.92
Rural Short	SAIDI	244.4	123.6 min
	SAIFI	1.55	1.42
Rural Long	SAIDI	413.3	302.7 min
	SAIFI	2.63	3.23

Table 2 - AusNet and Powercor Reliability Statistics [1][2][3]

To put the reliability performance indices into perspective:

AusNet

Customers in rural AusNet communities experience up to 5 times as many 'minutes off supply' than urban customers per year.

Powercor

Customers in rural Powercor communities experience up to 4 times as many 'minutes off supply' than urban customers per year.

The lower reliability of supply being experienced by rural customers when compared with customers in urban area is due to rural feeders going over much longer distances, and theses have been costly to upgrade. Investment decision making necessitates a thorough consideration of customer reliability improvements. However, when assessing the value of customer reliability (VCR), particularly for rural communities, challenges arise due to the limited number of affected customers, and the relatively low energy consumption lost. As a result, the VCR analysis fails to economically justify investments in these smaller regions.

6.1.4 LIMITATIONS ON CUSTOMER SOLAR EXPORTS

Increasing levels of Customer Energy Resources (CER) specifically Rooftop PV installations are resulting in significantly greater reverse power flows as customers export the excess generation back into the network. Intrinsic hosting capacity (IHC) is a measure used of the capability of the network to support reverse power flows (e.g. solar export) without any modifications or upgrading of the network.

For example, Powercor, has analysed the IHC of its rural network based on current levels and locations of rooftop PV installations. This analysis shows significant variation across locations in the network to accommodate further export.

The analysis below in Figure 5 shows how much customers would be able to export if each customer were given an equal amount of hosting capacity and does not consider the 5kW export allowance currently placed on customers.

At a network level, Powercor's short rural customers have used 82% of available IHC, and long rural customers have used 92% of available IHC. Powercor report that solar applications from rural customers is more than double the rate of those from urban customers, yet the ability of rural customers to export excess solar is generally more constrained than urban areas.

Further evidence of the declining hosting capacity is seen in the total number of solar customers being approved for the standard export capacity of 5kW Since January 2022, Powercor has connected 109,000 solar customers who have requested export capacity. 95% of customers receive at least a 5kW static limit,

	Total Solar Applications	Approved for 5kW Limit	% Approved
Urban	36,605	35,437	96.80%
Short rural	43,748	41,880	95.70%
Long rural	29,106	26,688	91.70%
All	**109,459**	**104,005**	95.00%
SWER only	3,495	3,098	88.60%

Table 3 - Powercor Solar Intrinsic Hosting Capacity / Powercor June 2024 [7]

with a clear trend that short rural customers have less capacity to export than short rural customers, and long rural customers have much less capacity to export than urban customers.

3,500 of these customers are SWER customers. When looking at the 3,500 SWER customers that have requested solar export capacity, we find that less than 90% of customers receive at least a 5kW static limit.

There is also evidence showing that the available capacity for export on long rural SWER lines is reducing over time, from 90% approval for 5kW on average in 2022, down to 86% approval for 5kW on average in 2024 to April.

This highlights the need for continual analysis of options to increase hosting capacity to allow rural customers to participate in the energy transition.

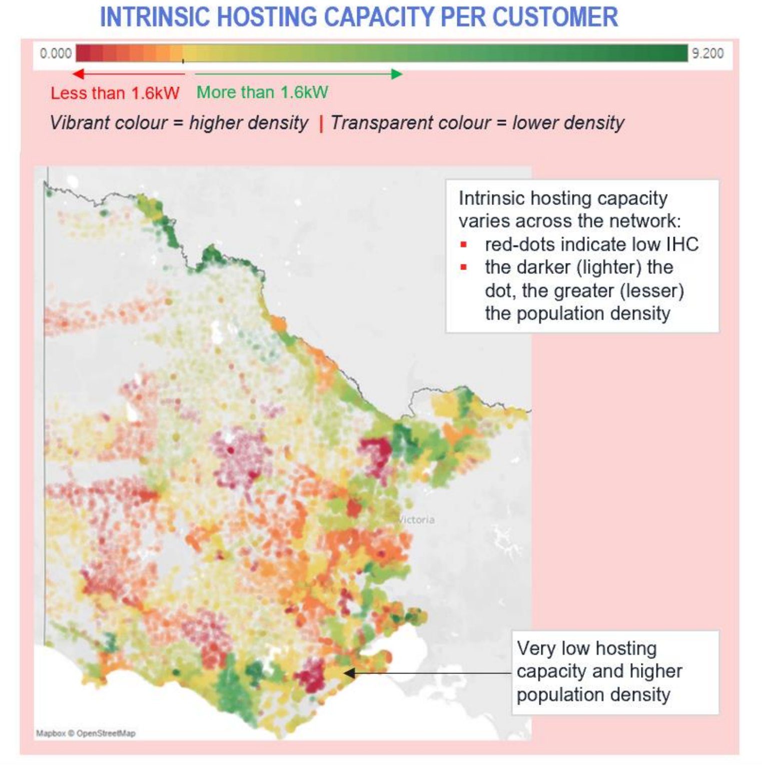


Figure 2 – Intrinsic Hosting Capacity Per Customer / Source: Intrinsic Hosting Capacity Per Customer, Powercor Customer Advisory Panel Pre-Read Pack Sept 2023 [8]

6.2 NETWORK CHANGE DRIVERS

6.2.1 VICTORIA 2035 EMISSION REDUCTION TARGETS AND NET-ZERO BY 2045

The Victorian Government has set an emissions reduction target of 75-80 per cent by 2035 and brought forward the net zero emissions target by five years to 2045[3]. Victoria's Climate Change Strategy sets out Victorian Government's climate action policies and programs. The Strategy establishes a target of 95 per cent renewable energy by 2035.

The proposed Roadmap has full alignment with the Victorian Government Climate Change Strategy, including, but not limited to, the accommodation of increasing electrification, enabling greater renewable generation and supporting transport electrification.

Key themes of Victoria's climate change strategy relating to energy include:

Work to establish six Renewable Energy Zones (REZ) in regional Victoria and strengthen & modernise Victoria's transmission grid to support renewable generation.

Support communities to switch to renewables such as microgrids, neighbourhood batteries and community-owned renewable energy projects.

Develop an Offshore Wind Strategy to take advantage of this so-far largely untapped energy resource in Australia.

Help businesses to reduce their energy use and deliver significant energy cost and emissions savings.

Help Victorian households and businesses to improve their energy efficiency.

Developed a Gas Substitution Roadmap to cut emissions from natural gas.

Drive uptake of zero emissions vehicles (ZEV).

Help farmers to reduce emissions and prepare for climate change impacts.

[3] Victorias's 2035 Emissions Reduction Target, DEECA, May 2023 [9]

6.2.2 BUSHFIRE MITIGATION

One of the significant recommendations from the 2009 Victorian Government Bushfire Royal Commission was Recommendation 27, related to powerline replacements. In response the Victorian Government established the Powerline Bushfire Safety Taskforce (the Taskforce) to consider how to implement Recommendation 27.

Following the Taskforce report[4] Energy Safe Victoria amended the Electricity Safety (Bushfire Mitigation) Regulations to require Distributors to carry out works summarised below in Hazardous Bushfire Risk Areas:

Install new technology Rapid Earth Fault Current Limiters (REFCL) at nominated zone substations to reduce the likelihood of fire starts from earth faults on multi-phase 22kV powerlines

Install new generation Automatic Circuit Reclosers on Single Wire Earth Return (SWER) powerlines to reduce the likelihood of fire starts on high-risk fire danger days

Targeted replacement of sections of bare overhead SWER powerlines with underground or insulated covered conductors

It is a widely held view that REFCL technology, as developed for the Victorian Distributors, is world leading technology available in responding to and mitigating fire starts on bare overhead medium voltage powerlines. The REFCL technology can only be applied to multiphase 22kV lines, so it cannot be used on SWER powerlines which are only single phase.

Projections suggest that Victoria will continue to become warmer and drier in the future and is likely to have a significantly lengthened fire season with the number of very high fire danger days likely to continue to increase. Rural and regional customers are disproportionately impacted by bushfires due to rural and regional areas having more vegetation. It is possible that the declared Hazardous Bushfire Risk Areas in Victoria could be expanded over time.

[4] Powerline Bushfire Safety Taskforce Final Report, Energy Safe Victoria and the Powerline Bushfire Safety Taskforce, Sept 2011 [10]

6.3 KEY NETWORK TECHNOLOGIES

In order to implement the recommended strategies, the Distributors will need to upgrade and develop their network technologies to keep pace with the expected exponential increase in adoption of customer technologies, as well as evolving technologies. While a detailed examination of these technologies and their maturity levels for each specific network goes beyond this report's scope, a summary of essential technologies envisioned to play a key role in this transformation is provided below. It's important to note that the Powercor and AusNet distribution networks, along with their underlying network technologies, differ somewhat. As a result, the priorities and selection criteria for these technologies require separate analysis.

6.3.1 GRID-CONNECTED MICROGRIDS

A Grid-Connected Microgrid represents an advanced, self-sustaining network architecture designed to manage real-time energy production and consumption within a specific geographical area through a mesh network of diverse energy nodes. An "energy node" within this context may comprise any entity capable of generating or consuming energy within the microgrid's perimeter, including but not limited to:

- Energy generation sources, such as residential buildings equipped with rooftop solar panels or small-scale solar farms
- Energy storage systems, including small or utility-scale batteries
- Various energy consumers, for example, street lighting infrastructure and electric vehicle (EV) charging stations

These nodes can be seamlessly orchestrated and integrated using the existing distribution network's infrastructure, including poles and wires. Grid-connected microgrids are normally designed to exhibit dual operational modes:

- Grid-Connected Mode - In this state, the microgrid remains connected to the broader distribution network, facilitating the exportation or trading of surplus energy generated within the microgrid to external communities.
- Islanded Mode - In islanded mode, the microgrid disconnects from the larger distribution network, functioning independently to bolster community resilience, especially during severe weather events, beyond the capabilities of traditional network systems.

Implementing grid-connected Microgrids can bring notable benefits to rural communities when contrasted with conventional power delivery methods. These systems bolster resilience and autonomy, ensuring a consistent power supply even during prolonged outages or severe weather events.

Microgrids can also enhance the reliability and stability of electricity supply, introduce heightened safety protocols to significantly lower the risk of bushfires, and cut down on carbon emissions by leveraging local renewable energy sources.

Additionally, the ability to export excess energy opens avenues for generating community revenue, making grid-connected microgrids a valuable asset for rural areas.

Both AusNet and Powercor have already explored the concept of regional Microgrids via small scale trial projects. These trials will enable the Distributor and Regulators to better understand Microgrid reliability, benefits, operation, ownership and the governing market rules.

As the Technology is becoming increasingly commercially feasible, it is envisaged that Microgrids will form a major role in achieving the Net Zero vision as well as improving rural network's reliability, safety and security parameters.

6.3.2 STAND-ALONE POWER SYSTEMS (SAPS)

Unlike the grid connected Microgrids, Stand Alone Power Systems are usually designed to serve a small number of customers (1-5) and have no physical connection to the rest of the distribution network. They therefore constitute an autonomous framework for electricity generation and distribution, installed downstream of a property's smart meter and recognised as conforming to utility-grade specifications. Due the stand-alone capability SAPS are especially advantageous for consumers situated in remote or rural locales. The implementation of SAPS facilitates the decommissioning of end-of-life or capacity constrained powerline infrastructures, such as Single Wire Earth Return (SWER) systems, with an added benefit of reducing bushfire start risks. In typical operational scenarios, SAPS ensures the provision of electricity derived entirely from renewable sources to the consumer. To augment the reliability of the solar and battery ensemble, SAPS are often equipped with an auxiliary generation unit for backup purposes.

AusNet has initiated a small-scale SAPS trial with some 17 SAPS units deployed in Phase 1 and another 23 units due to be deployed in Phase 2. The trials will enable AusNet as well as the Regulators and Market Participants to better understand wider implications of mass SAPS deployments, both from a technical and regulatory perspective. It should be noted that the regulatory and market aspects such as customer protection, choice of retailers, energy settlement are more complex issues to resolve than the technical aspects.

SAPSs transform how customers receive power and can offer significant benefits to remote rural customers including making the electricity supply more consistent and dependable. Additionally, these systems are inherently more resilient to adverse weather conditions and bushfires than traditional overhead power distribution systems, specially SWER infrastructure.

6.3.3 RENEWABLE ENERGY MANAGEMENT SYSTEMS AND INTEGRATION

The Distribution Network will require seamless integration of Customer Energy Resources (CERs) including solar photovoltaic (PV) systems, wind energy, and battery storage, enhancing grid flexibility and minimizing carbon emissions.

An example of such integration is the AusNet trial which incorporates the use of a cloud-based orchestration platform (DENOP) that integrates with customers' CER and can coordinate these resources and deliver improved network performance and customer experience. Note that the capacity of the physical network still sets out limits on the size of benefits from this integration.

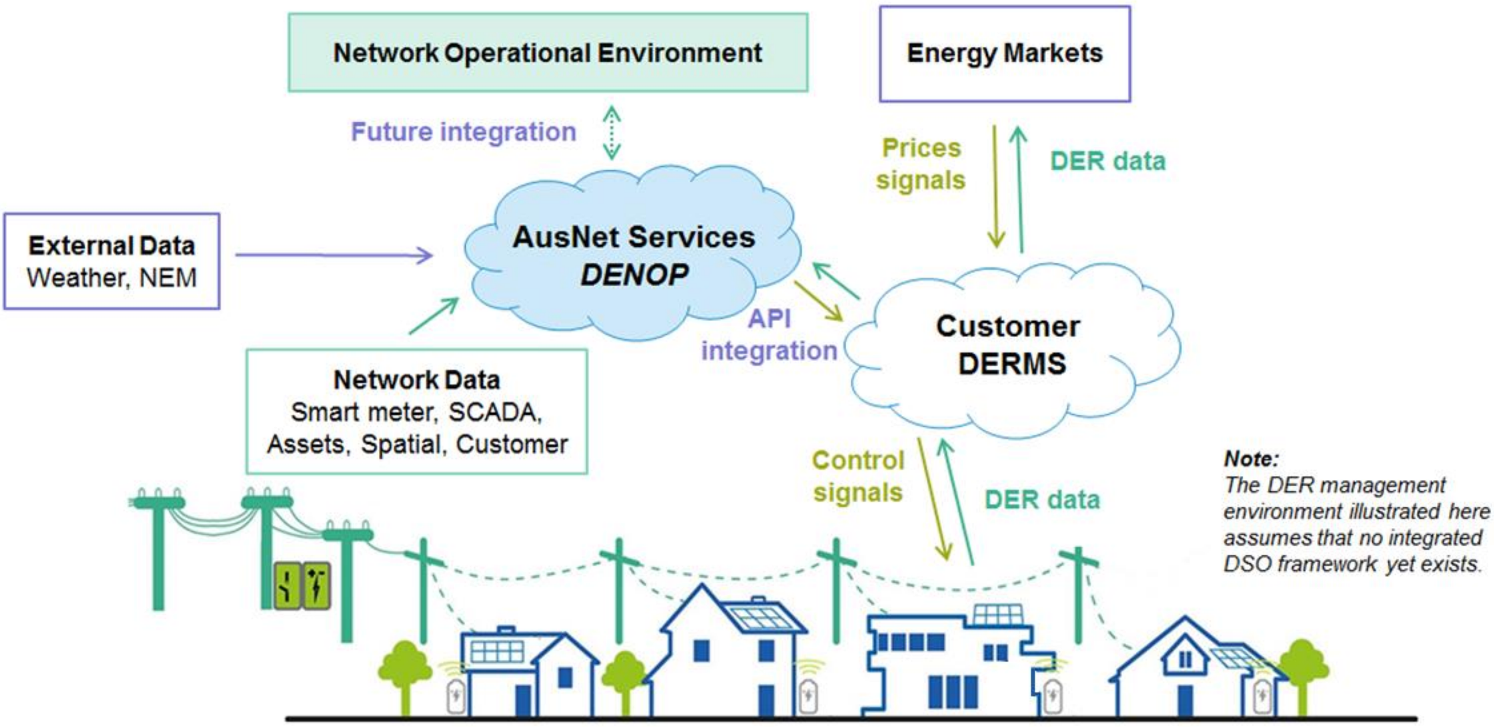


Figure 3 - Distributed Energy Network Optimisation Platform Architecture / Source: AusNet [11]

Customer CER Management Systems (DERMS) will rely on advanced IT/OT interfaces for the aggregation, dispatch, and optimisation of DERs.

Grid Operations will then be optimised to accommodate the intermittent nature of renewable energy sources, employing IT/OT systems for dynamic balancing and demand-side management.

Through the use of DENOP and orchestration of solar resources, more capacity can be made available for other customers to connect and allows them to increase their total solar generation. Active CER management can be harnessed to run the network more efficiently by:

- Using battery storage to balance power flows
- Managing solar to smooth network voltages
- Energy management to improve network utilisation
- Increasing the amount of solar that can be installed on the network
- Increasing the amount of solar generation that can be produced and exported per customer, using real time dynamic operating envelopes

6.3.4 DYNAMIC VOLTAGE MANAGEMENT AND VOLT-VAR CONTROL SYSTEMS

Dynamic voltage management and Volt-Var control systems will play a pivotal role in enabling distributed energy and smart grids of the future. These systems are designed to enhance the grid's ability to automatically adjust and maintain optimal voltage levels and reactive power (Var) balance, providing critical real-time responses to changes in energy demand and supply. Implementing these technologies will not only support the net-zero transition by optimizing energy use and reducing wastage but also bolster network and public safety, ensuring compliance with stringent regulatory standards.

Through advanced dynamic voltage management, AusNet and Powercor can even greater control over grid operations, enabling the anticipation and mitigation of potential network issues before they impact customers. Volt-Var control further refines this process by intelligently coordinating the reactive power in the system, improving the efficiency of electricity distribution and minimizing losses. Unlike current AMI systems that may delay data processing, dynamic voltage management and Volt-Var control provide instantaneous adjustments essential for addressing immediate grid challenges, safeguarding against potential risks to public safety and infrastructure integrity.

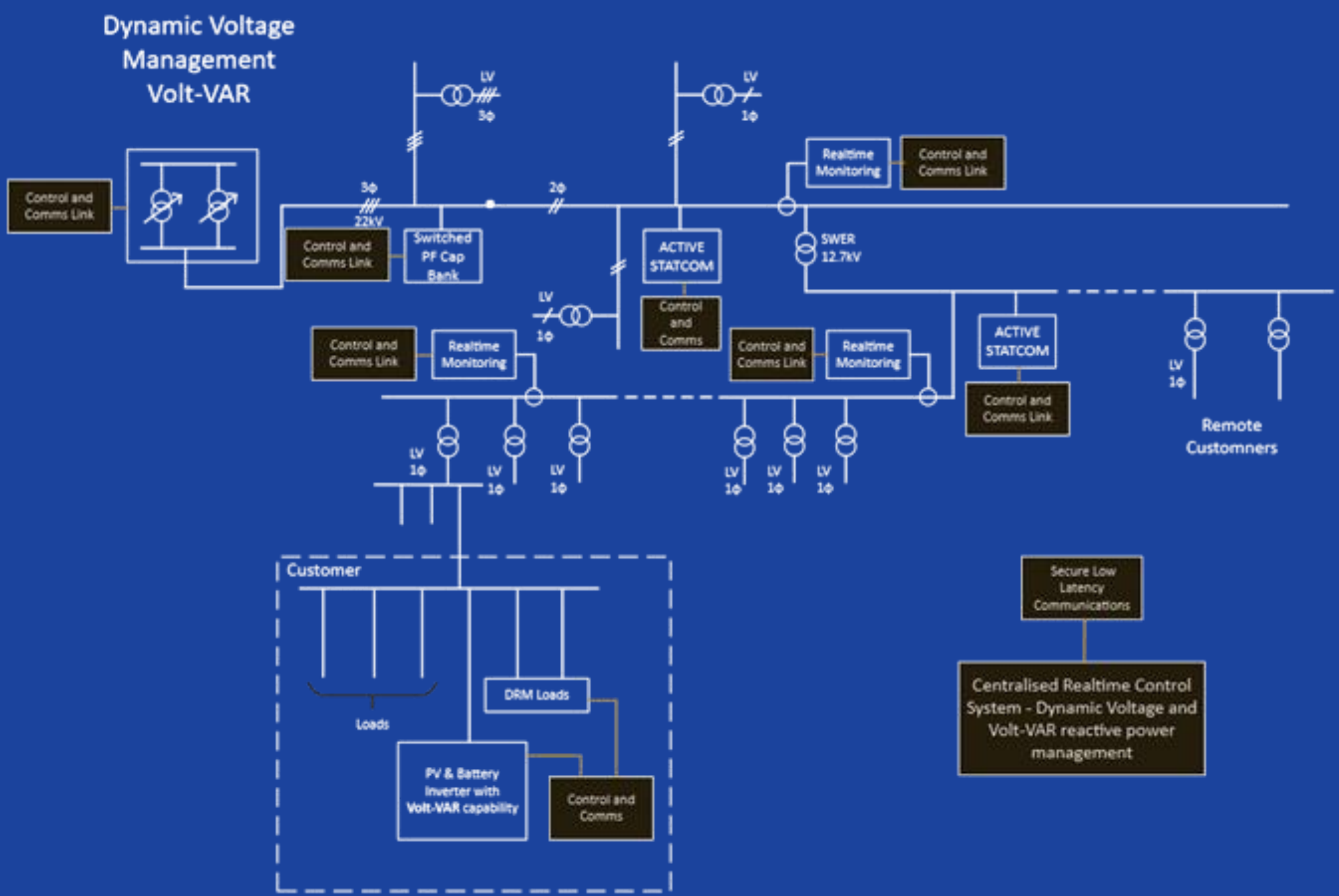


Figure 4 – Typical Dynamic Voltage Management Volt-VAR System Components / Source: IAENGG [12]

6.3.5 DEMAND RESPONSE AND ENERGY STORAGE MANAGEMENT

The networks will require enhancements to facilitate orchestration capabilities offered by new customer technologies, such as the integration of electric vehicles (EVs) and support for Vehicle-to-Grid (V2G) technologies, home energy management systems (HEMS), behind-the-meter battery energy storage systems, smart inverters and flexible loads. These mechanisms should be automated to modulate power consumption based on grid conditions, leveraging real-time data analytics. The systems will be capable of real-time management of Battery Energy Storage Systems (BESS), determining optimal charging and discharging schedules based on predictive analytics.

6.4 KEY STATISTICS RELATING TO CUSTOMER NUMBERS

6.4.1 AUSNET CUSTOMER AND NETWORK STATISTICS

Table 4 - Customers by Network Type / Source: AusNet, June 2024 [1]

	Residential	Commercial	Industrial	Agriculture	TOTAL
Urban	308,391	27,078	3,580	283	339,332
Short rural	302,364	19,566	2,320	14,887	339,137
Long rural	99,471	9,613	1,409	29,034	139,527
Total customer numbers	**710,226**	**56,257**	**7,309**	**44,204**	**817,996**

Table 5 - Customers by Network Type, BRA and REFCL[5] / Source: AusNet, June 2024 [1]

	LBRA	HBRA	Non-REFCL (SWER)	Non-REFCL (non-SWER)	REFCL area (SWER)	REFCL area (non-SWER)	TOTAL
Urban	289,143	50,189	No SWER	289,143	No SWER	50,189	339,332
Short rural	187,438	146,684	1768	187,438	3,247	146,684	339,137
Long rural	50,756	77,542	5,102	50,756	6,127	77,542	139,527
Total customer numbers	**527,337**	**274,415**	**6,870**	**527,337**	**9,374**	**274,415**	**817,996**

[5] REFCL stands for 'Rapid Earth Fault Current Limiter' – a device designed to detect an electrical fault occurring on one conductor of three phase lines and rapidly limit the energy released to drastically reduce the likelihood of fire starts.

Table 6 - Customers by Customer Type, BRA and Network REFCL / Source: AusNet, June 2024 [1]

	LBRA	HBRA	Non-REFCL (SWER)	Non-REFCL (non-SWER)	REFCL area (SWER)	REFCL area (non-SWER)	TOTAL
Residential	467,381	234,619	3,509	467,381	4,717	234,619	**710,226**
Commercial	36,284	19,367	247	36,284	359	19,367	**56,257**
Industrial	4,994	2,210	57	4,994	48	2,210	**7,309**
Agriculture	18,678	18,219	3,057	18,678	4,250	18,219	**44,204**
Total customer numbers	**527,337**	**274,415**	**6,870**	**527,337**	**9,374**	**274,415**	**817,996**

6.4.2 POWERCOR CUSTOMER AND NETWORK STATISTICS

Table 7 - *No of Customers by Network Type* / Source: Powercor, Feb 2024 [2]

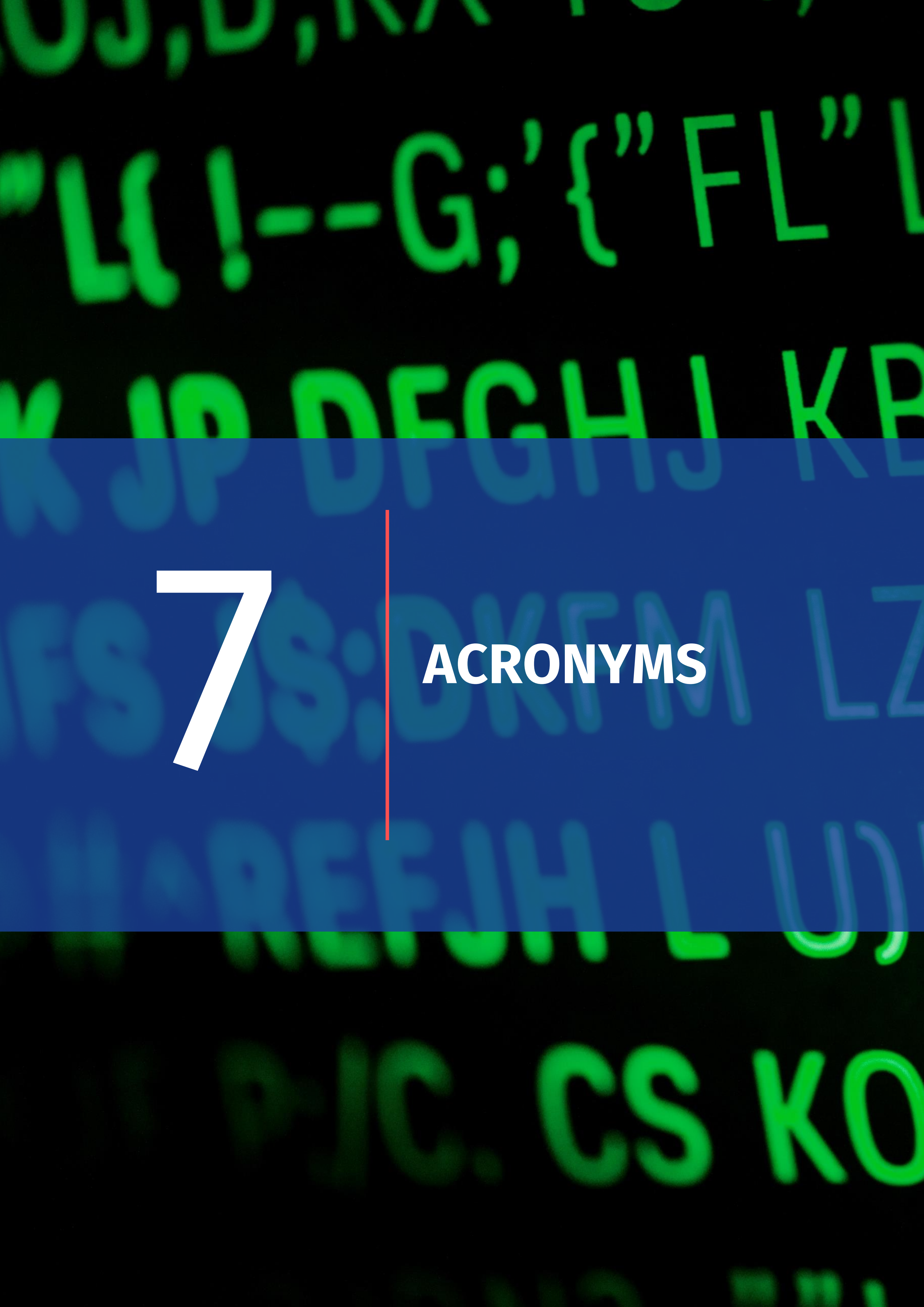
	Residential	Commercial	Industrial	Agriculture	TOTAL
Urban	333,858	26,974	9,865	834	371,531
Short rural	288,587	18,363	9,800	14,294	331,044
Long rural	145,479	17,378	10,067	45,993	218,917
Total customer numbers	**767,924**	**62,715**	**29,732**	**61,121**	**921,492**

Table 8 - *No of Customers by Network Type, BRA and REFCL* / Source: Powercor, Feb 2024 [2]

	LBRA	HBRA	Non-REFCL (SWER)	Non-REFCL (non-SWER)	REFCL area (SWER)	REFCL area (non-SWER)	TOTAL
Urban	365,644	5,609	3	302,042	0	56,025	358,070
Short rural	288,320	42,541	700	202,506	1,174	109,210	313,590
Long rural	114,222	104,623	8,885	55,077	17,523	117,684	199,169
Total customer numbers	**768,186**	**152,773**	**9,588**	**559,625**	**18,697**	**282,919**	**870,829**

Table 9 – *No of Customers by Customer Type, BRA and Network REFCL* / Source: Powercor, Feb 2024[2]

	LBRA	HBRA	Non-REFCL (SWER)	Non-REFCL (non-SWER)	REFCL area (SWER)	REFCL area (non-SWER)	TOTAL
Residential	677,734	89,823	1,762	486,340	6,514	234,174	728,790
Commercial	52,266	10,275	440	36,187	827	21,073	58,527
Industrial	21,752	7,905	529	16,764	943	8,806	27,042
Agriculture	16,342	44,767	6,857	20,281	10,413	18,833	56,384
Total customer numbers	**768,094**	**152,770**	**9,588**	**559,572**	**18,697**	**282,886**	**870,743**



7 ACRONYMS

7 ACRONYMS

ACRONYM	DESCRIPTION
AER	Australian Energy Regulator
AEMO	Australian Energy Market Operator
AMI	Advanced Metering Infrastructure
ARENA	Australia Renewable Energy Agency
BESS	Battery Energy Storage System
BEV	Battery Electric Vehicle
BTM	Behind The Meter
CER	Customer Energy Resources
DB	Distribution Business
DAPR	Distribution Annual Planning Report
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DENOP	Distributed Energy Network Optimisation Platform
DER	Distributed Energy Resources
DERMS	Distributed Energy Resource Management Systems
EV	Electric Vehicle
FOCS	Fibre Optic Current Sensors
HBRA	Hazardous Bushfire Risk Area
HEMS	Home Energy Management Systems
HV	High Voltage
IBR	Inverter Based Resource
IHC	Intrinsic Hosting Capacity
IIoT	Industrial Internet of Things
ISP	Integrated System Plan
IT	Information Technology
LBRA	Low Bushfire Risk Area
LiDAR	Light Detection and Ranging
LV	Low Voltage
MAIFI	Momentary Average Interruption Frequency Index
MV	Medium Voltage
NCIT	Non-Conventional Instrument Transformer
NEM	National Electricity Market
OT	Operational Technology
PAL	Powercor
PHEV	Plugin Hybrid Electric Vehicle
PV	Photovoltaic
REFCL	Rapid Earth Fault Current Limiter
REZ	Renewable Energy Zone
RWN	Rewiring the Nation
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAPS	Stand Alone Power System
SWER	Single Wire Earth Return
V2G	Vehicle to Grid
V2X	Vehicle to Everything
VCR	Value of Customer Reliability
ZEV	Zero Emissions Electric Vehicle
ZSS	Zone Substation

8 REFERENCES

8 REFERENCES

Reference	Source
[1] Customer and Network Statistics	**Ausnet communications, Feb 2024**
[2] Customer and Network Statistics	**Powercor communications, Feb 2024**
[3] AusNet Distribution Annual Planning Report 2024-2028	**AusNet, Dec 2023**
[4] Powercor Age Profile of 12.7kV SWER Conductors	**Powercor Customer Advisory Panel Pre-Read Pack, Sept 2023**
[5] Ausnet Age Profile of 12.7kV SWER Conductors	**AusNet June 2024**
[6] Victoria Electricity Safety Act	**Victoria Electricity Safety Act 1998 No. 25 of 1998**
[7] Powercor Solar Intrinsic Hosting Capacity	**Powercor, June 2024**
[8] Intrinsic Hosting Capacity Per Customer	**Powercor CAP Read Pack, Sept 2023**
[9] Victoria's 2035 Emissions Reduction Target	**DEECA, May 2023**
[10] Powerline Bushfire Safety Taskforce Final Report	**Energy Safe Victoria and Taskforce, Sept 2011**
[11] Distributed Energy Network Optimisation Platform Architecture	**AusNet**
[12] Typical Dynamic Voltage Management Volt-VAR System Components	**IAENGG**

Background Information	Source
Network Information	**AusNet / Powercor communications, Feb 2024**
Distribution Annual Planning Report 24-28 and RIN 22-23	**Powercor, Nov 2023**
Distribution Annual Planning Report 24-28 and RIN 22-23	**Powercor, Dec 2023**
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Rewiring the Nation website: https://www.dcceew.gov.au/energy/renewable/rewiring-the-nation	**DDCCEEW**
Technology Investment Roadmap	**DCCEEW, May 2020**
Integrated System Plan	**AEMO, Dec 2023**
Delivering Ag2030	**DAFF, April 2022**
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Hydrogen Insights Report	**Hydrogen Council, McKinsey & Company, May 2023**
Zone Substation Statistics	**Ausnet / Powercor communications, Feb 2024**

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