evoenergy

Annual Planning Report 2023

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Acknowledgement of Country

Evoenergy acknowledges the Traditional Custodians of the Canberra region, the Ngunnawal and Ngambri peoples and pays respect to Elders past and present. We recognise and celebrate all First peoples' continuing connections and contributions to the region in which our footprint extends.

Disclaimer

This document is the responsibility of the Strategy & Operations Group within the ActewAGL Distribution partnership (ABN 76 670 568 688) (trading as Evoenergy).

This report is prepared by Evoenergy in its capacity as the Distribution Network Service Provider in the Australian Capital Territory (ACT).

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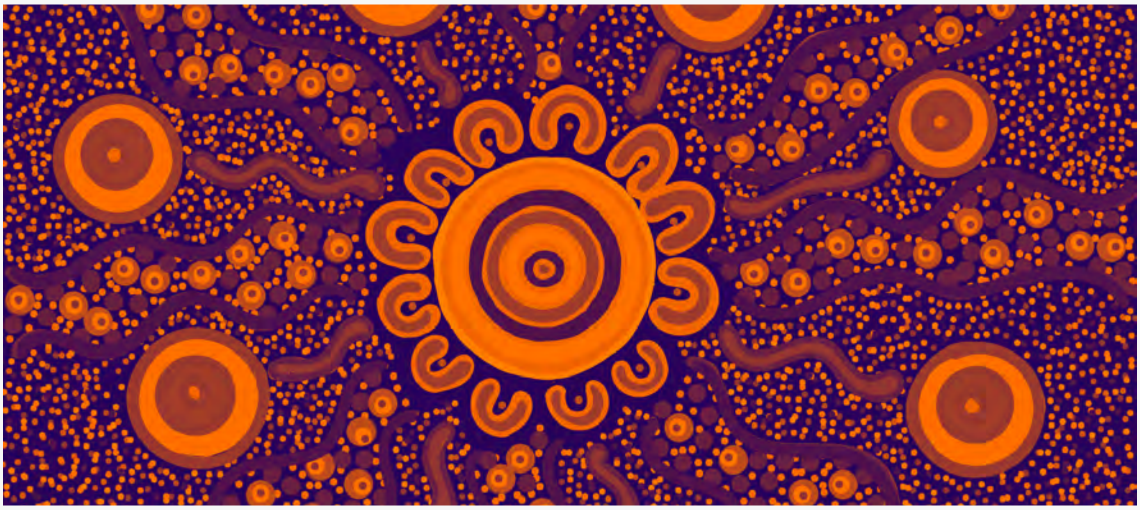
Review date

It is intended that in compliance with the regulatory requirements this report will be updated annually, and the next report will be published by 31 December 2024. However, if Evoenergy identifies that material changes are required, Evoenergy may amend this document at any time. Amendments will be indicated in the version control table.



Featured artwork

"The Energy of Connection"
By Shaenice Allan

Shaenice Allan is a Ngunnawal, Bundjalung and Kamilaroi artist. She has been painting for more than 15 years, telling the stories that are told to her. Shaenice's paintings represent and connect to the Land of her peoples. The stories are an important part of Shaenice's art. They describe the many stories, the many pathways and the many lines that connect her to Mother Earth.

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Foreword

This year has marked a pivotal time in shaping the future of our electricity network. In November, we submitted our revised regulatory proposal and tariff structure statement for the 2024-29 Electricity Network.

While the final decision from the regulator is expected in April 2024, our efforts in community engagement have been crucial in understanding what our community want for the future of their electricity grid.

Through our latest phase of community engagement, we've heard Canberrans support balanced growth and investment in our network. This aligns with our net zero targets and includes a transition to electrification and the integration of two-way energy flow. We are also mindful of the cost pressures on consumers as we have strived to maintain affordable network charges while advancing towards this transition.

The most significant focus of our proposal has been ensuring there is suitable infrastructure to support the growing registrations of electric vehicles (EVs). The number of registrations has exceeded optimistic forecasts for the territory, with a 122% increase in light vehicle EV registrations from October 2022 to October 2023[1]. This trend is expected to continue to increase and our electricity network plan accounts for revised forecast peak demands based on the amount of charging we anticipate from more EV charging.

Planning for the electricity network has also taken into account new ACT Government legislation prohibiting new gas connections in the ACT. Understanding the likely impact on both the electricity network and the gas network will continue to ensure we transform our networks in a way that achieves net zero targets and delivers ongoing safe and reliable energy to our customers.

Evoenergy's 2023 annual planning report focuses on the end of the current regulatory period as we prepare for the next five-year investment cycle. Our report demonstrates our commitment to providing safe and reliable electricity as the ACT community and its energy needs shift towards electrification.

Peter Billing
Evoenergy General Manager

1 Total vehicles registered in the ACT, Open data portal, https://www.data.act.gov.au/Transport/Total-vehicles-registered-in-the-ACT/x4hp-vihn

Introducing Evoenergy

Evoenergy owns and operates electricity and gas networks and is licensed by the Independent Competition and Regulatory Commission (ICRC) to provide distribution, and connection services in the ACT. Evoenergy is a Distribution Network Service Provider registered with the Australian Energy Market Operator (AEMO). We are a regulated service provider subject to commonwealth and jurisdictional laws and statutory instruments including National Electricity Law (NEL), National Electricity Rules (NER), Utilities Act 2000, Utilities Technical Regulations Act, industry codes, technical codes, and regulations. The NER require Evoenergy to undertake annual planning review and prepare the Annual Planning Report. Our "poles and wires" network is supplied predominantly by power imported from interstate, however there is an increasing amount of power generation and storage embedded within Evoenergy's network. Evoenergy's primary focus is on the provision of a safe, reliable, and quality electricity supply in a cautious and efficient manner. We are asset management certified for compliance with ISO 50001 Asset Management Standard. Safety and risk management are key considerations of our business decisions. Whenever practicable, risk management is integrated with investment decisions and considers the life cycle of assets and least cost solutions.

Purpose Of This Report

The core purpose of the Annual Planning Report (APR) is to inform other network services providers, market participants, consumers and interested parties of near-term constraints impacting Evoenergy's network, and factors impacting long-term demand forecasts and network reliability.

The report also addresses network capacity limitations, asset renewal, power quality and reliability in relation to subtransmission lines, zone substations and distribution network. The identified limitations are opportunities for non-network solutions including embedded generation and demand-side management. The report addresses five-year planning requirements for the distribution and subtransmission networks.

This APR has been prepared to comply with the NER Clause 5.13.2 and Schedule 5.8 Distribution Annual Planning Report (DAPR).

"A sustainable business, energising our evolving community".

Executive Summary

Transforming Our Business For The Future

In recent years, the electricity industry has been changing at an unprecedented pace with increased uptake in Distributed Energy Resources (DER) driven by improvements in affordability, advances in technology and the rise of energy consumer desire for energy independence.

The ACT Government has a strong focus on their climate change strategy, with a legislated target for net zero emissions by 2045. Aligning with this, the federal government and the private sector have been accelerating and crystallising strategies around net zero emissions targets. These are key drivers for Evoenergy's network planning strategy. As we work towards these goals, we are using both innovative solutions and optimising network utilisation, within our regulatory and legislative requirements.

A key component of the Evoenergy strategy is the transition to a contemporary Distribution Systems Operator (DSO), enabling Evoenergy to effectively facilitate a two-way energy market for consumers that enables efficient utilisation of consumer and network assets, to both generate electricity and access new energy products.

Evoenergy is also working to diversify our energy system through integration of non-network solutions, minimise the carbon and environmental footprint of our network operations and build network resilience to the changing climate. It is also important to understand the implications of, and road map to, a zero emissions future for the electricity network, gas substitution with electrical energy and how this will impact energy consumers throughout the transition process.

Changing demand patterns

Over the last two years we have experienced record levels of winter peak demand on our electricity network and declining usage of our gas network over winter. Evoenergy is closely monitoring these trends, with analysis ongoing. Some early observations that may explain these patterns include:

- the introduction of policy initiatives, such as financial incentives to substitute gas heating with electric heating in 2021, and
- changing work patterns, with continuation of work-from-home activities adopted during early COVID-19 years.

Electric vehicles are likely to have a profound impact on electricity usage patterns as their adoption rates grow. Evoenergy has undertaken modelling to understand these impacts over time, and enable preparations to accommodate this growth over coming years.

Our 5-year plan for the 2024-2029 period

In January 2023 Evoenergy submitted its 2024-29 electricity network proposal to the Australian Energy Regulator. It sets out our plan to invest in and operate the electricity network over this period to ensure we take steps toward a net-zero future whilst also playing our role in maintaining energy affordability. The Australian Energy Regulator has provided its draft determination, with a final determination expected in April 2024. For more information on the contents of the plan, visit the Evoenergy website here.

Evoenergy Snapshot

220km
Subtransmission lines

33
Power Transformers

2,200km
Overhead distribution lines

16
Zone substations & switching stations

4,812
Distribution substations

221,466
Customers

48,726
Distribution poles

3,323km Underground distribution lines

Safety

Evoenergy recognises the importance of safety in the delivery of our services. Safety underpins everything we do and is our primary consideration when we plan, design, construct and operate our assets. Evoenergy has safety obligations under a number of legal instruments including acts, regulations, codes and guidelines. We do not compromise when it comes to safety as it relates to our workforce, the community and the environment.

POWERED BY **SAFETY**

System Level Demand

Continuation of La Niña through the summer of 2022/2023 again led to a relatively mild summer season. Peak summer electricity demand was below historical trend levels, although it increased from the previous year with a peak of 508MW (15% increase from the 2022 peak summer demand). A relatively mild winter overall retained some especially cold periods, leading to a sustainment and further increase of the 2022 jump in winter demand, peaking at 690 MW (1% increase on the 2022 peak winter demand and 10% increase on the 2021 peak winter demand).

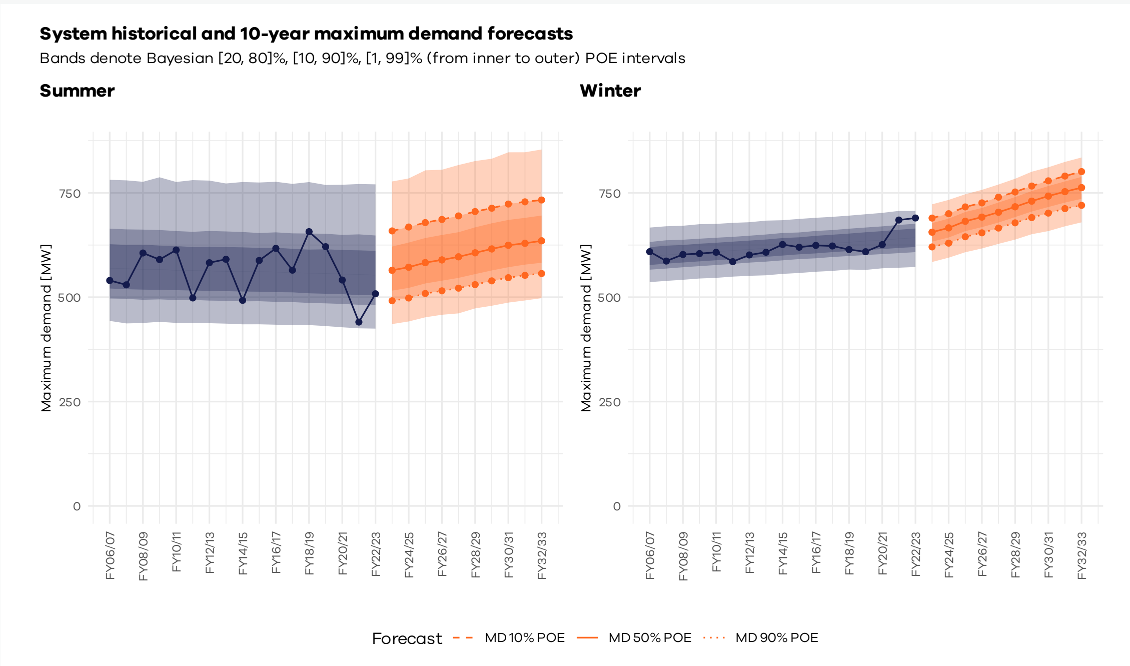
The 2023 forecast peak demand for network-delivered energy shows significant growth over the next decade in winter peak demand and a more modest increase in summer peak demand. Drivers of this trend include net-zero driven growth in electric vehicle charging, and electrification of the gas network, as well as population growth and large data centre connections in the region.

A key feature of peak demand has been the relative volatility of peak summer demand over the last ten years culminating in the highest recorded peak, of 657 MW recorded in 2019 and the lowest recorded peak of 440 MW recorded in 2022. This highlights the impact of changing weather conditions and the impact of cooling loads during the summer period. In contrast to the summer demand, the peak winter demand has historically been more stable but is forecast to increase, reflecting the impact of organic growth on heating loads during the winter period. Two consecutive years of winter peak demand well above expected levels suggest a possible step-change in demand patterns.

These trends are illustrated in **Figure 1** showing the historical and 10-year maximum demand forecast 2023.

Peak demand forecasts are used to inform unserved energy (and energy at risk) projections, which determine when network capacity should be augmented to underpin the security and reliability of supply. Chapter 5 and Appendix E provide more information on demand forecast methodology and outcomes for the system and distribution substations.

Figure 1. Summer and winter historical demand and forecast with probability of exceedance (PoE)



The Net Zero Transition And Shift In Energy Sources

The ACT is leading the way in Australia with a legislated goal to achieve net zero greenhouse gas (GHG) emissions by 2045. This means the way electricity is generated, stored, and used is changing too. Evoenergy is committed to working towards a sustainable, net zero emissions (NZE) future for the ACT. Our goal is a responsible transition to NZE by 2045, taking into consideration the long-term practicalities, costs, benefits, and impacts for the ACT community. Transitioning to NZE ensures the long-term sustainability of our energy system and meets community expectations around the need for action against climate change, factoring in the societal, environmental, and economic costs and benefits of a sustainable, net zero future.

Evoenergy has continued to refine its detailed modelling to understand the potential impacts of NZE by 2045 for the Evoenergy energy networks in the ACT. This dynamic, strategic tool will enable future planning to prudently prepare and incrementally progress a consumer-centric, net zero transition roadmap prioritising safety, sustainability, and security, balanced against reliability, and affordability. Evoenergy and the ACT Government are working together to better understand the implementation pathways as we work towards a net zero future.

Evoenergy anticipates further load growth will be driven by emissions reduction across transport and the natural gas network which together are the biggest emitters accounting for 64% and 22%, respectively. Recently the ACT government announced a Zero Emission Vehicle Strategy which included the phase out of light internal combustion engine vehicles by 2035 and several incentives to encourage electric vehicle uptake.

As Evoenergy sees an increase in the uptake of DER as well as other generation such as solar farms, bio-generation, and grid batteries we anticipate that a higher proportion of demand will be supplied within the ACT rather than imported via Transgrid. In the future, there is also the potential for the ACT to become a net exporter to Transgrid during times of minimum demand.

Localised Constraints

While Evoenergy's relatively flat demand profile means that it does not face system-wide security issues, it does face localised capacity constraints over the next 5-10 years. These constraints correspond mostly to areas which are experiencing or are forecast to experience high levels of residential and commercial growth. Consequently, Evoenergy has identified a number of limitations within the zone substations and distribution network.

These constraints are summarised in **Table 1**, however the following constraints are of particular note.

Molonglo Valley Demand Constraints

In 2020 Evoenergy completed a Regulatory Investment Test for Distribution (RIT-D) process for constraints in the Molonglo Valley due to significant growth as a result of new greenfield residential developments. As part of this process Evoenergy identified that a non-network solution, such as a network scale battery, could be used to defer the required construction of a zone substation. Evoenergy is currently working with a proponent to implement a battery energy storage system (BESS) at the site of the future Molonglo Zone Substation. This solution is planned to be operational by winter 2024.

Gold Creek Demand Constraints

The maximum demand in the Gungahlin District is forecast to continue to increase over the next ten years with continual growth in greenfield areas as well as high density residential and commercial developments. There is currently insufficient redundant capacity at Gold Creek Zone Substation for short but increasing periods of time and minimal coincident opportunity to transfer load to neighbouring zone substations. Evoenergy is currently undergoing a RIT-D for the Gold Creek constraint. Additional information can be found on the Evoenergy website here.

Overview Of Constraints

Table 1. Existing and emerging limitations of the subtransmission network and distribution network

Location	Network Element	Limitation	RIT-D	MVA Required	Consult	Decision	Required	Estimated Cost***	Project Reference
Molonglo Valley	Zone Substation & Feeders	Capacity	Yes	22.6	Complete	Complete	(Apr-25)	$30.5m	See Section 7.6.1
Denman Prospect	Feeder	Capacity	No	8.9	Complete	Complete	(Apr-24)	$1.8m	See Section 7.6.2
Dickson - Dooring St	Feeder	Capacity	No	4.1	Complete	Complete	(Jun-24)	$3.8m	See Section 7.6.3
Gold Creek Zone	Zone Substation	Capacity / Reliability	Yes	-	Nov-23	Feb-24	(Jul-25)	$8.6m	See Section 7.6.4
Fyshwick	Feeder	Capacity	No	40	Complete	Complete	(Jun-24)	$5.5m	See Section 7.6.5
Pialligo	Feeder	Capacity	No	8	Complete	Complete	(Jul-24)	$4.8m	See Section 7.6.6
CBD West (S63)	Feeder	Capacity	No	5.6	Complete	Complete	(Apr-25)	$5.1m	See Section 7.6.7
Gilmore	Zone Substation	Capacity / Reliability	No	-	Complete	Complete	(Jun-24)	$2.5m	See Section 7.6.8
Braddon - Donaldson	Feeder	Capacity	No	1.3	Complete	Complete	(Apr-25)	$4.3m	See Section 7.6.9
Strathnairn	Feeder	Capacity	No	1.2	Complete	Complete	Apr-24	$2.5m	See Section 7.8.1
Kingston^^	Feeder	Capacity	No	0.9	Dec-24	Jun-25	Apr-27	$1.1m	See Section 7.8.2
Fyshwick Dairy Road	Feeder	Capacity	No	2.1	Complete	Complete	Apr-25	$0.7m	See Section 7.8.3
Lyneham	Feeder	Capacity	No	0.8	Dec-24	Jun-25	Apr-27	$4.1m	See Section 7.8.4
Curtin (diplomatic)^^	Feeder	Capacity	No	1.3	Dec-25	Jun-26	Apr-28	$5.1m	See Section 7.8.5
Woden/ Phillip^^	Feeder	Capacity	No	-	Dec-26	Jun-27	Apr-29	$4.1m	See Section 7.8.6
Fairbairn South^^	Feeder	Capacity	No	2.6	Complete	Complete	Apr-25	$1.8m	See Section 7.8.7
Hume West	Feeder	Capacity	No	1.2	Dec-24	Jun-25	Apr-27	$2.3m	See Section 7.8.8
Greenway^^	Feeder	Capacity	No	0.3	Dec-25	Jun-26	Apr-28	$2.7m	See Section 7.8.9
CBD South (Parkes)^^	Feeder	Capacity	No	1.1	Dec-23	Jun-24	Apr-26	$5.1m	See Section 7.8.10
Gungahlin Town Centre	Feeder	Capacity	No	1.1	Complete	Complete	Apr-25	$5.1m	See Section 7.8.11
Barton	Feeder	Capacity	No	1.1	Complete	Complete	Apr-25	$3.0m	See Section 7.8.12
CBD	Feeder	Capacity	No	0.6	Dec-23	Jun-24	Apr-26	$3.2m	See Section 7.8.14

Location	Network Element	Limitation	RIT-D	MVA Required	Consult	Decision	Required	Estimated Cost***	Project Reference
Franklin	Feeder	Capacity	No	1.2	Complete	Complete	Apr-25	$5.2m	See Section 7.8.15
Braddon^^	Feeder	Capacity	No	1.7	Dec-25	Jun-26	Apr-28	$3.8m	See Section 7.8.16
Watson^^	Feeder	Capacity	No	-	Dec-26	Jun-27	Apr-29	$5.4m	See Section 7.8.17
Ainslie^^	Feeder	Capacity	No	-	Dec-26	Jun-27	Apr-29	$5.4m	See Section 7.8.18
Campbell^^	Feeder	Capacity	No	-	Dec-26	Jun-27	Apr-29	$1.2m	See Section 7.8.19
Ginninderry (Strathnairn)	Zone Substation & Feeders	Capacity	Yes	1.6	Dec-24	Jun-25	Apr-28	$42.0m	See Section 7.8.20
Molonglo Valley^^	Zone Substation	Capacity / Reliability	Yes	-	Jun-26	Feb-27	Apr-29	$9.1m	See Section 7.8.21
North Canberra	Subtransmission	Voltage	No	2029-2034 period					See Section 7.9.1
Belconnen Zone	Zone Substation	Capacity / Reliability	Yes	2029-2034 period					See Section 7.9.2
Mitchell	Zone Substation & Feeders	Capacity	Yes	2029-2034 period					See Section 7.9.3
Curtin	Zone Substation & Feeders	Capacity	Yes	2029-2034 period					See Section 7.9.4
East Lake Zone	Zone Substation	Capacity / Reliability	Yes	2029-2034 period					See Section 7.8.5
Gold Creek Zone	Zone Substation	Voltage	No	2029-2034 period					See Section 7.9.6

* Network is operated beyond firm rating prior to the construction of new feeder.

** Cumulative MVA required represents a shortage of capacity required to supply forecasted load for a zone substation or group of distribution feeders. Based on the load forecast.

*** Direct capital cost of credible solution identified by preliminary NPV analysis, FY23 dollars

^ Where options analysis has determined that there is no viable non-network option, no public consultation was initiated for projects below the RIT threshold

^^Constraint forecast beyond 2028 planning horizon

Note 1: RIT - The National Electricity Rules require Regulatory Investment Test for projects above $6 million

Note 2: The cost in this table for the option as determined in preliminary analysis or Project Justification Report. Projects may be subject to further options analysis and detailed cost estimation.

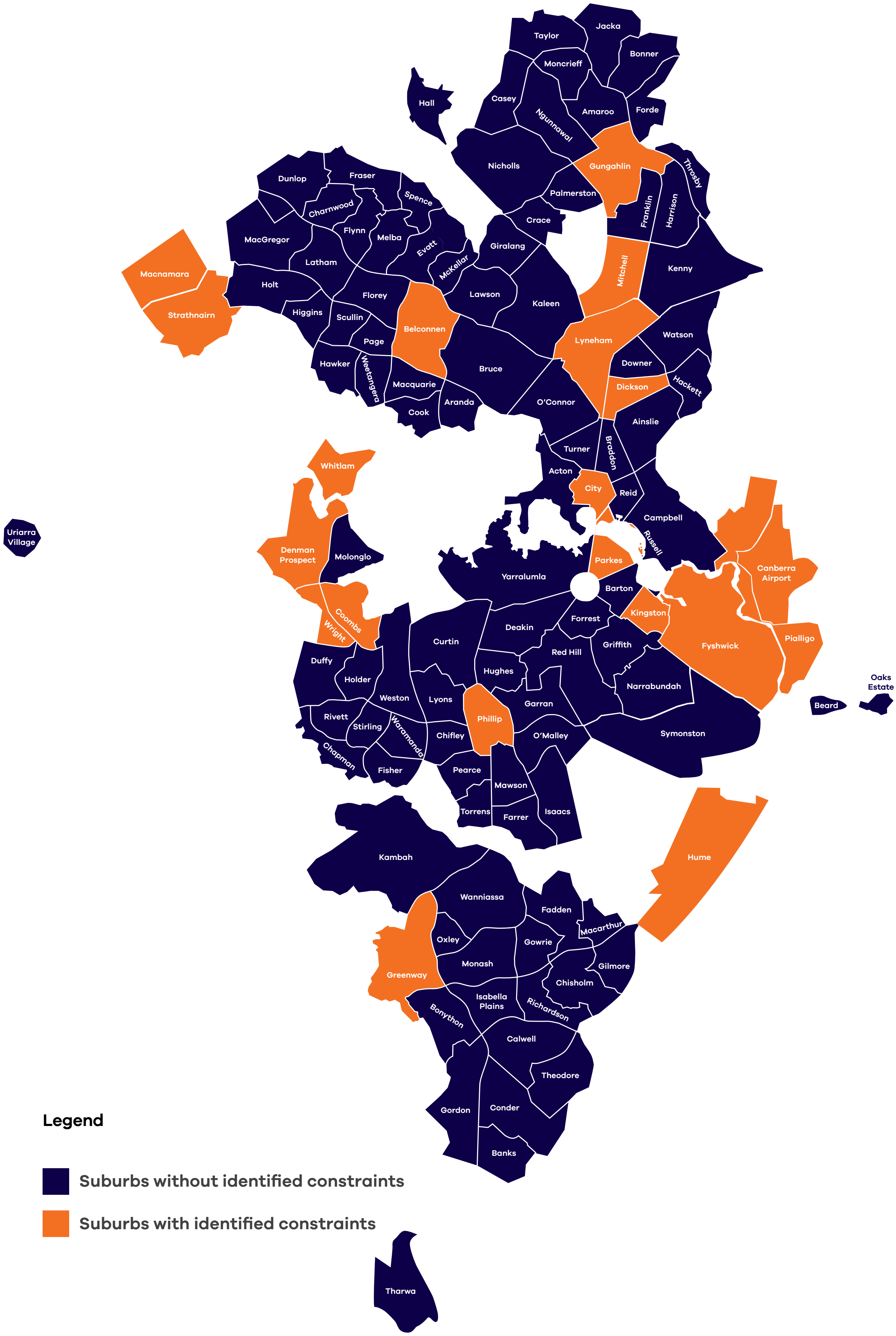
In addition to these localised capacity constraints, the make-up of electricity demand is changing in the ACT; specifically around consumers driving localised growth in electricity demand, where electricity is sourced, and the impact that is having on network utilisation and performance.

Load growth has been primarily driven by:

- Urban infill development – The ACT Government 2018 Planning Strategy states that it aims for 70% of new housing to be within the existing urban footprint. This is also supported by the ACT Government land release program and development policies.
- Commercial/industrial growth is currently centred around Hume and Fyshwick industrial parks – with a significant proportion focused on large relatively stable loads as required, for example, data centres.
- Greenfield residential developments primarily in Gungahlin, Molonglo Valley and Ginninderry - with an increasing proportion of medium density developments.

Figure 2 provides an overview of the geographic locations where network limitations exist or are forecast to emerge due to urban in-fill, greenfield residential and commercial developments. Suburbs with constraints are shown in orange.

Figure 2. Overview – Network Limitations Heat Map



Network Performance

Evoenergy continues to focus on the management of existing assets taking into account asset performance and risks relating to asset condition, age and criticality. Our annual planning review process identified a need for several major asset retirements over the next five years. **Chapter 6** summarises the major asset retirements identified during the regulatory review including timing and costs. In addition to these major asset retirements, Evoenergy runs a number of grouped programs for smaller assets including distribution poles, substations or switchgear. These programs are further discussed in **Chapter 6**.

Table 2. Identified Retirements Of Major Assets

Area	Network element	Primary driver	RIT-D	Estimated cost ($ million)	Consult	Decision	Date required
Fyshwick Zone Substation	66 kV Assets	Asset condition & performance	No	$2.1m	Jun 2021 complete	Dec 2021 complete	Jun 2024
Latham Zone Substation	Substation Switchboard	Asset condition & performance	No	$3.1m	Dec 2022	Jun 2023	Jun 2025
Wanniassa Zone Substation	Substation Switchboard	Asset condition & performance	No	$3.1m	Dec 2022	Jun 2023	Jun 2026

Maintaining Reliability

Evoenergy's reliability performance continues to be one of the best amongst its peers in Australia. We are subject to the Australian Energy Regulator's (AER) reliability performance targets for unplanned outages and local jurisdictional ACT reliability targets for planned and unplanned outages. Our current strategic intent is to maintain reliability performance within the existing regulatory targets and ensure we comply with our license conditions. Our plan to address key reliability challenges is to develop a more responsive network through investment in people, process and technology, embed risk-based asset management and incorporate best practice vegetation management.

Power Quality - Voltage Regulation

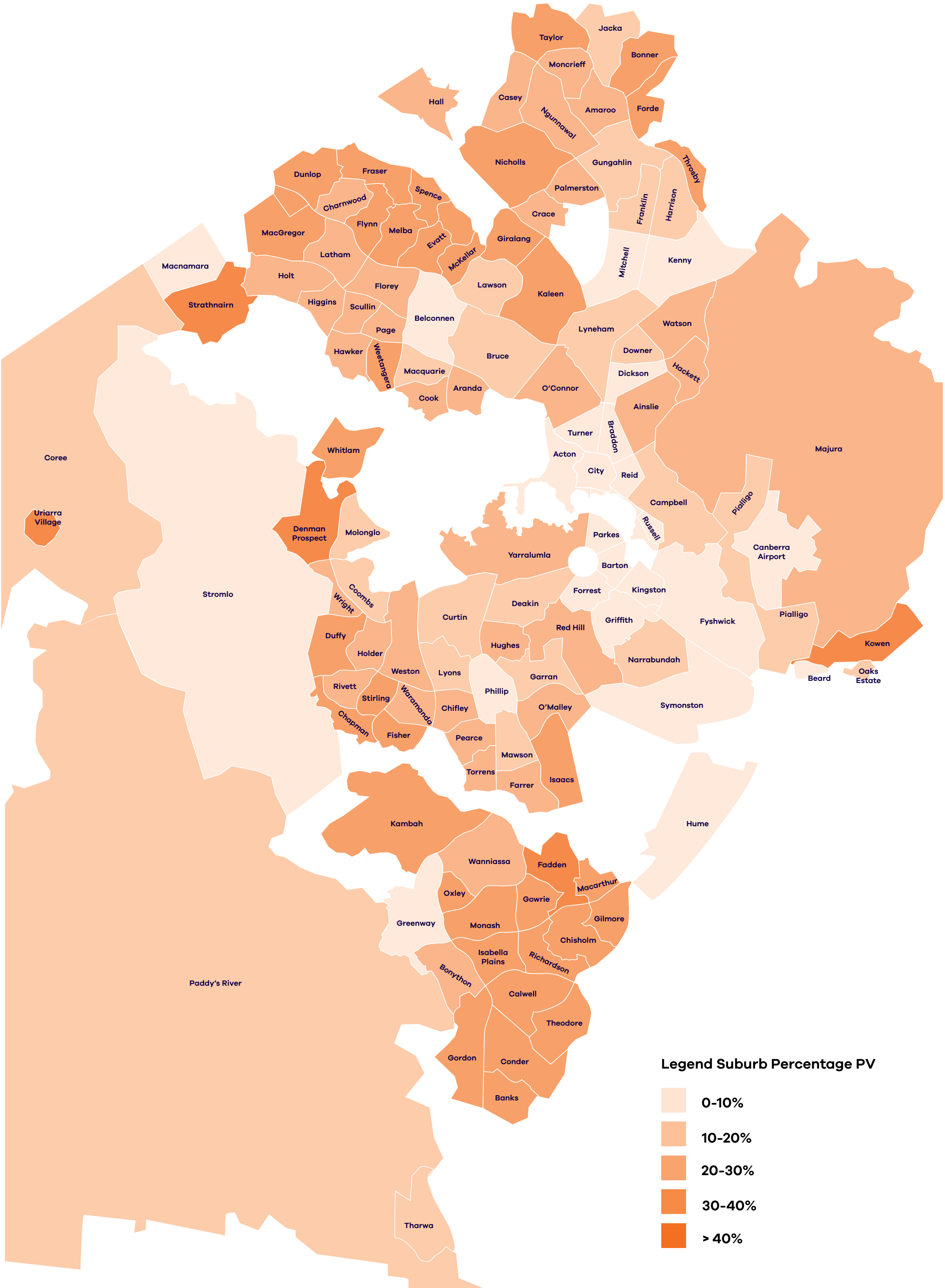
One of the most important planning considerations affecting forecast demand is the gradual shift from electricity generated and transmitted outside the ACT to embedded generation within the ACT, and unprecedented growth in "in front of the meter" and "behind the meter" generation. Forty-three (43) MW of large-scale solar generation is currently embedded in the ACT network. There is continued strong growth in rooftop photovoltaic generation with around 35% of all detached or semi-detached residential dwellings in the ACT now with photovoltaic installations. Over the 2022/23 financial year rooftop photovoltaic generation increased by 90 MW, which was the highest annual increase on record, with total embedded generation capacity now approximately 371 MW[2]. See **Appendix B** for further detail on embedded generation connected to the Evoenergy network.

This presents a key challenge for Evoenergy as this increase in embedded generation creates two-way energy flows and potential over-voltages in some locations. The voltage regulation limitations usually occur in the locations where the penetration of photovoltaics is high, which may lead to power quality issues.

Figure 3 provides a heat map of the solar photovoltaic penetration per suburb as a percentage of total customers (by NMI).

2 Based on recorded total inverter size

Figure 3. Overview - Rooftop Photovoltaic Generation Heat Map[3]



3 ACT suburbs only

In addition to the demand constraint, an emerging need has been identified at zone substations in relation to voltage regulation systems. Evoenergy is continuing the investigate these constraints and explore options to manage power quality performance.

Working with stakeholders on solutions

Solutions to constraints will fall into one of two categories – solutions over $6 million which are required to go through the regulatory investment test for distribution (RIT-D) process and solutions under $6 million which are not required to go through the RIT-D process.

Solutions which are required to go through the RIT-D process will have analysis performed to determine if there may be a preferred non-network solution to the constraint. The findings of this analysis are published in a non-network options report which is publicly available on the Evoenergy website and communicated to our Demand Management Register[4] participants.

For solutions not required to go through the RIT-D process, Evoenergy will go through a non-network screening process. If it is determined that a non-network solution may be viable, Evoenergy will engage proponents through the Demand Management Register.

Customers may also approach Evoenergy with proposals, for example, if a customer would like to install a battery but would like to know where it would benefit the network and help to address current or future constraints, they can utilise the constraints summary in this report (see **Table 1**) or contact Evoenergy through demandmanagement@evoenergy.com.au.

Evoenergy is also working closely with government and other related stakeholders on initiatives such as the renewable energy auctions including grid level batteries, electric buses, and utility master planning.

Grid Connected Battery Systems in the ACT

During 2022, the first customer-initiated grid connected battery energy storage system (BESS) in the ACT was operational and provided wholesale market services in the National Electricity Market (NEM) through an aggregator. This was the privately owned system installed in the suburb of Holt, owned by the Elvin Group. No further additional BESS units were connected in 2022 in Evoenergy's network.

Evoenergy also understands the ACT Governments' commitment towards investing in $100 million towards large battery units has been awarded to a third-party provider to connect a 250MW/500MWh BESS unit in the Southern part of ACT near Williamsdale[5].

In addition, Evoenergy is progressing its interest in the Federal Government supported grant funding process for Community Batteries in the ACT through the Business Grants Hub. The grant process for these funding programs have begun in 2022 and are still awaiting final decisions from the respective bodies and Evoenergy expects that there will be multiple grid connected Community Batteries within the ACT in the next 18-24 months.

Grid connected batteries within the distribution network could have substantial impact for the electricity operations in the ACT and Evoenergy is keen to understand how to leverage these systems to provide additional value to the energy consumers in the ACT.

4 To sign up to the Demand Management Register please fill in the form at the bottom of this page: https://www.evoenergy.com.au/emerging-technology/demand-management

5 https://www.act.gov.au/our-canberra/latest-news/2023/april/contract-signed-to-help-deliver-big-battery

Chapter Overview

Chapter 1:

Explains how interested parties can engage with Evoenergy. It discusses the four available paths for engagement with Evoenergy in relation to the non-network, demand management and network options.

Chapter 2:

Provides information on Evoenergy's physical network environment, regulatory environment and an overview of current factors and challenges impacting our network.

Chapter 3:

Provides Evoenergy's philosophy and approach to network planning and asset management.

Chapter 4:

Describes Evoenergy's current reliability and power quality performance and planning outcomes.

Chapter 5:

Describes the electricity demand forecast for the system and zone substations.

Chapter 6:

Discusses management of the existing assets. Describes Evoenergy's asset retirement and renewals program planning outcomes for individual major assets and grouped assets.

Chapter 7:

Discusses network planning, including existing and emerging network limitations relating to the network capacity.

Chapter 8:

Discusses strategies regarding demand-side management and why these are important to Evoenergy from a planning and investment perspective.

Chapter 9:

Discusses emerging technologies and why these are important to the operation in the changing business environment.

Appendices:

Provide additional and supporting data. The appendices are referenced in the individual chapters.

Chapter 1: Opportunities For Interested Parties

Evoenergy serves everyone who lives, works in, or visits the ACT and that's why we need to understand consumers' needs and preferences.

As an electricity distributor, we experience changes in technology, consumption patterns, customer preferences, energy policies and regulatory settings. This transformation presents both opportunities and challenges for us, our customers, and other stakeholders.

Engagement with our stakeholders is an integral part of our approach to being an innovative, flexible, and adaptable business. Some of these engagement activities include forums such as our newly established Energy Reference Advisory Panel (ERAP); a panel of experts focused on regulatory topics and matters, our Energy Consumer Reference Council (ECRC) which represents ACT consumers, as well as our Energy Matters forums which represents are major customers. We consult with stakeholders in relation to a range of business matters including regulatory submissions, policies and projects.

We believe in regular, structured, and two-way communication with stakeholders which is reflected in our Stakeholder Engagement Strategy[6]. This strategy guides our activities to enhance relationships with consumers and the interest groups that represent them. In here you will also find the principles which underpin our engagement which states our commitment to be adaptive, curious, courageous, transparent, and committed in all stakeholder interactions.

When it comes to projects and opportunities reflected throughout our annual planning report – the Stakeholder Engagement Strategy and Demand Side Engagement Strategy[7] are integral in involving our stakeholders.

This chapter focuses on the engagement with consumers and interested parties when Evoenergy investigates network limitations and optimum solutions including non-network options.

6 Available on the Evoenergy website: www.evoenergy.com.au/consumer-engagement
7 Available on the Evoenergy website: https://www.evoenergy.com.au/-/media/evoenergy/documents/demand-management/demand-side-engagement-strategy.pdf

Figure 4. Four Paths Of Engagement

Four ways Evoenergy works to engage with stakeholders on demand management or non-network options:

Path 1:

Broad-based program

Participate in a broad-based program as a consumer solution provider. These programs incentivise consumers to reduce electricity demand.

Review the existing and planned broad based programs in the annual planning report.

Path 2:

Targeted program

Participate in a targeted program. These programs aim to address network limitations in a specific area in the network, such as a suburb.

Review the network limitations in the annual planning report.

Path 3:

Regulatory Investment Test

Participate in a Regulatory Investment Test (RIT). RITs apply to projects above $6 million and are usually aimed at larger market participants.

Review Evoenergy projects subject to RIT in the annual planning report.

Path 4:

Provide a suggestion

Reach out to us to provide a suggestion or comment to us, or to receive correspondence on specific matters relating to network development.

You can get started by completing our enquiry form.

1.1 Engagement in broad-based demand management programs

Our demand management programs include meaningful stakeholder engagement. Our ongoing network initiatives are available on our website. These initiatives will progress over the short to medium term with various levels of trials being undertaken. The programs are summarised in **Chapter 8** (Demand Management) of this report.

Broad based demand management programs

Broad based demand management programs are designed to address large groups of customers and other stakeholders who can assist in peak demand reduction. For example, interrupting appliance load for short periods of time, or using cost reflective or innovative tariffs to incentivise consumers to modify their demand patterns. The programs may include proof of concept pilots and trials before the programs can be implemented at scale.

Consumer benefits

While there can be a number of benefits to demand management programs, the specific benefits depend on the design of the particular program. For example, customers have the opportunity to benefit from a reduction in their electricity network bill through "time of use" or "demand" tariffs. This benefit is realised through changes in usage patterns as customers respond to the price signals contained in those cost reflective tariffs by shifting usage outside of peak periods. There are various types of monetary incentives which can be considered and tested including cash buy-backs, one off incentives, availability payments or event-based payments.

How to participate

If you would like to participate in a broad-based program, including a pilot or a trial, register as either an energy consumer (end-user) or a business operating in the demand management space. You can also make suggestions relating to demand management or register to receive information on any of the future projects or programs.

Your contribution is valuable however, there is no obligation to participate if you register. We may ask if you are interested in participating in future programs or pilots or invite you to respond to a Request for Proposal (RFP) for proposed solutions.

Our engagement will always include details about the network constraint, possible solutions and incentives which could be available to you. If you are a business operating in the demand management space, we may also invite you to discuss your demand side management proposal or provide additional information.

1.2 Engagement In A Targeted Initiative

As part of the network planning process, Evoenergy identifies existing and emerging electricity network limitations. **Table 12** in **Section 7.5** identifies limitations in relation to the distribution and subtransmission networks. The table identifies the type of constraint, location of constraint, level of constraint and its timing. As part of the network development process Evoenergy must resolve identified limitations either though network or non-network solution. The information is updated as new data becomes available.

Targeted solutions to constraints

Targeted programs focus on a reduction of demand in specific areas or pockets of the network where limitations are identified or the provision of other services such as voltage regulation, "solar soak" services or provision of contingency. The majority of limitations identified by Evoenergy in the 2023 planning review relate to the distribution line (feeder) capacity constraints, however there are also voltage and contingency constraints emerging.

Evoenergy endeavours to identify limitations as early as possible to allow sufficient time for consideration of a full range of solutions. If the limitation emerges late in the process (e.g. as the result of a late connection application from a large customer) the time available for consideration of all options may be limited. Consideration of non-network and demand management solutions is a mandatory part of Evoenergy's network planning process.

Consumer benefits

There are a number of possible non-network solutions ranging from demand reduction to contracted embedded generation. The incentives can range from reductions in electricity bills to substantial contributions towards capital costs of solutions.

If a consumer proposes a viable alternative which defers or eliminates a need for network investment, Evoenergy is likely to be interested in sharing the cost of investment. Under the National Electricity Rules Evoenergy has an obligation to implement least cost options.

How to participate

Interested parties can register for targeted programs on the Evoenergy website. There are no obligations on your part if you register[8]. You can also provide a suggestion or request information or updates on any program.

Evoenergy investigates identified network limitations and periodically updates data (e.g. load information) relating to the limitations. As part of the investigations, depending on the screening assessment of options, Evoenergy may issue an RFP to submit non-network solutions.

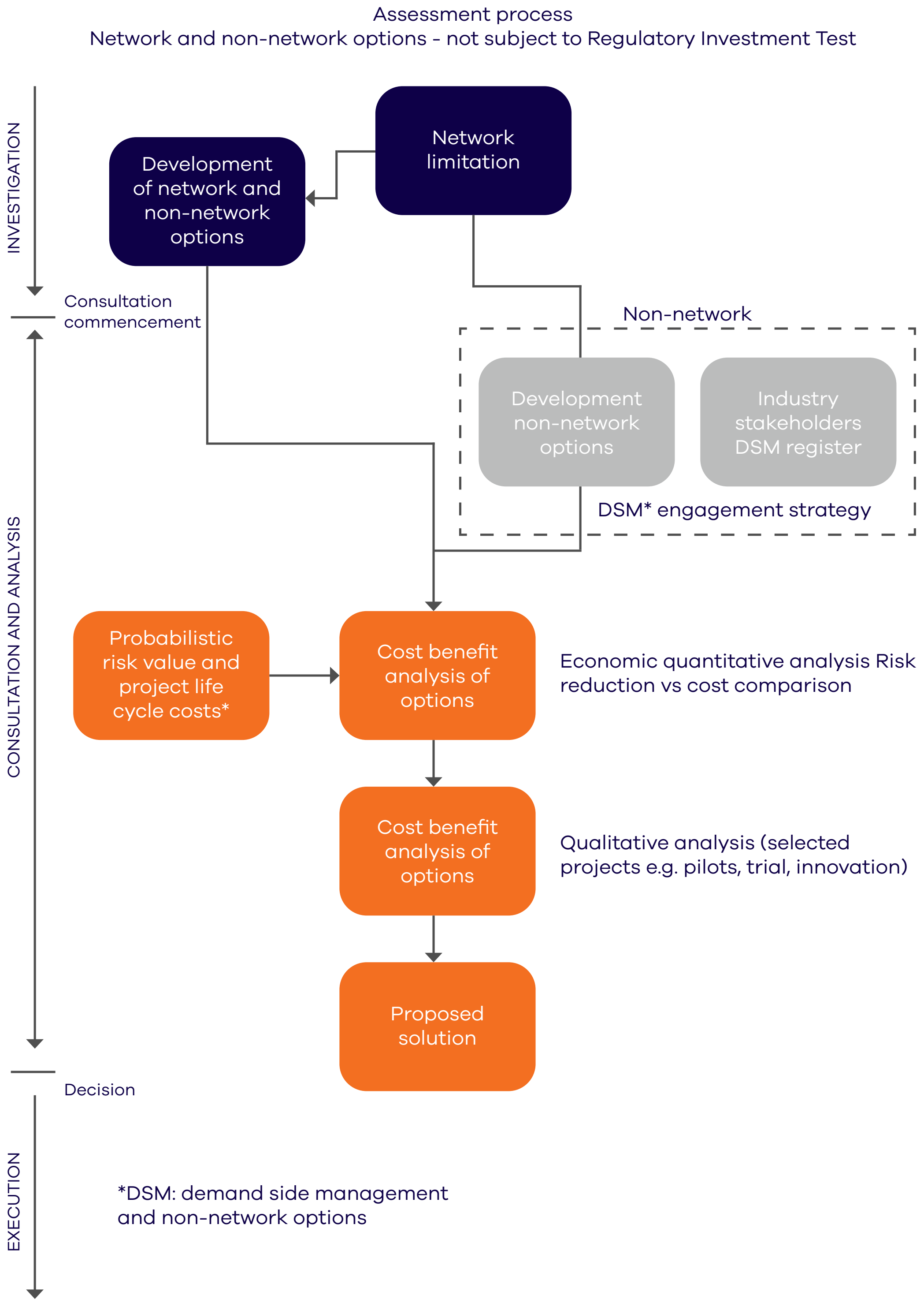
If you register for one or more targeted programs with Evoenergy, we will inform you of the relevant RFP, however you are not under any obligation to respond. The exact timing for an RFP may depend on the specific project requirements and available information. As far as practicable, for the distribution network limitations, we will endeavour to issue an RFP no later than 21 months before the limitation must be addressed and allow 3 to 6 months for selection of preferred solutions. For subtransmission system limitations we will generally endeavour to publish an RFP no later than 36 months before the network limitation must be addressed. **Figure 5** provides a process overview including Evoenergy stakeholder engagement through the demand side engagement strategy.

Our RFP will explain the network limitation, the timeline for resolution and possible solutions. The RFP will indicate what investment, capital contribution or incentive we are prepared to provide to external parties to resolve the issue.

Distribution projects above $6 million are subject to mandatory Regulatory Investments Test (RIT) process. As described in **Section 1.3** we follow the AER's guidelines for regulatory investment tests for distribution.

8 Strict privacy provisions apply: no marketing, no spam email, no sharing of information with third parties. Privacy policy available on the Evoenergy website, https://www.evoenergy.com.au/legal/privacy-policy

Figure 5. Process Overview – Projects Not Subject To Regulatory Investment Test



1.3 Engagement In A Regulatory Investment Test

The National Electricity Rules require Evoenergy to conduct a Regulatory Investment Test (RIT) on all investments above $6 million. The aim of the test is to consider the full suite of alternative solutions including network, non-network, and demand side management options. RIT requires consultation and review of the proposal with external stakeholders, particularly National Electricity Market participants who may submit an alternative proposal. If an optimised solution includes a mix of non-network and network elements, RIT rules oblige Evoenergy to implement such a solution.

RIT for distribution (RIT-D) projects are conducted according to the process set out in the AER's Application Guidelines for RIT-D.

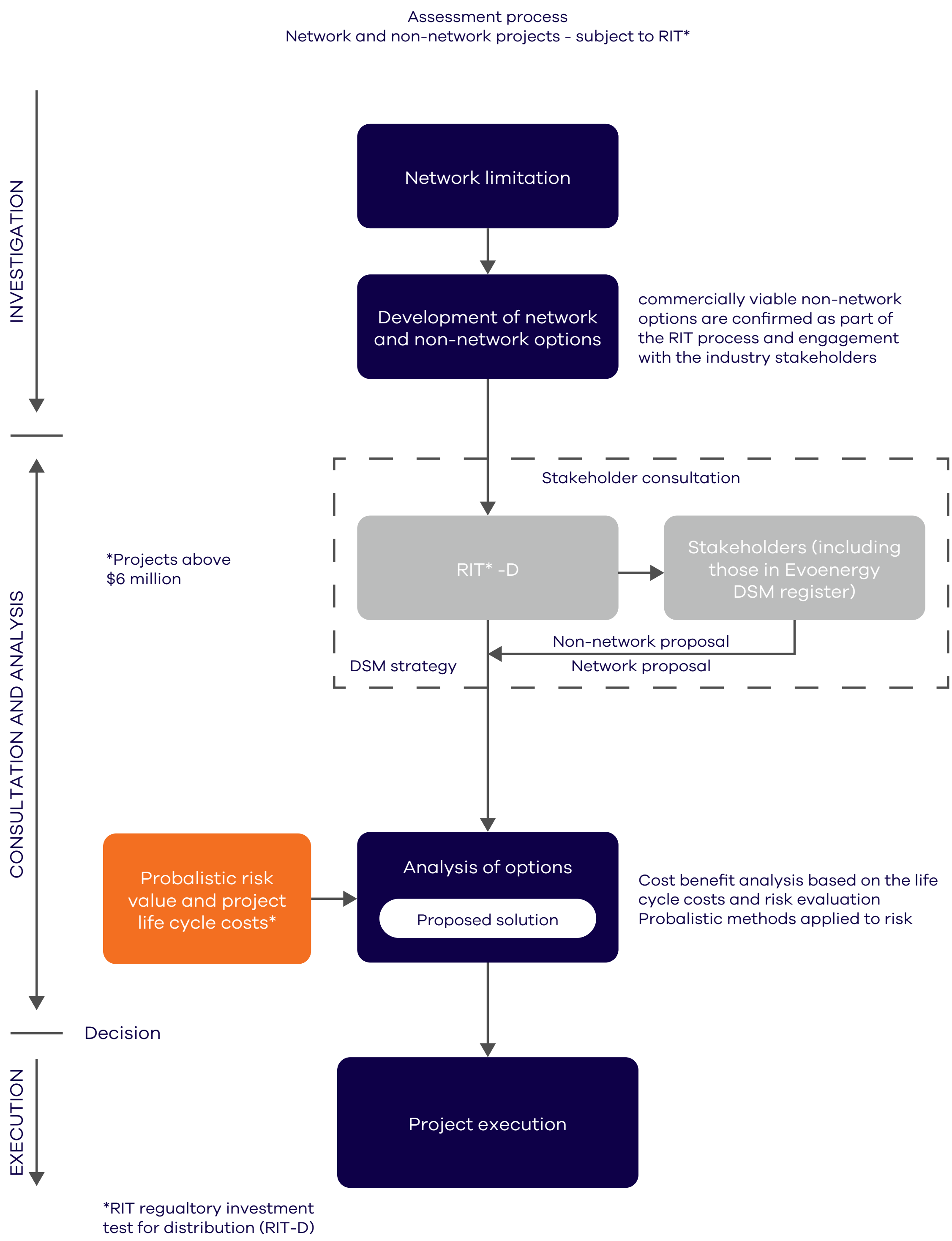
For eligible projects, Evoenergy initiates RIT-D consultations after preliminary investigation of viable options and selection of proposed solution. The exact timing is governed by the requirements and complexity of the project. For distribution projects, Evoenergy aims to commence the RIT-D process at least 21 months before the network limitation must be resolved.

As part of the RIT process Evoenergy is required to publish a non-network options report (NNOR) detailing the analysis of the viability of non-network options when compared with the proposed network option(s). If it is determined that a non-network solution is potentially viable, Evoenergy can use the NNOR to call for submissions from non-network proponents.

Stakeholders who would like to participate in the process or be notified of future regulatory investment tests can register their interest on the Evoenergy website[9].

9 To sign up to the Demand Management Register please provide your details here: https://www.evoenergy.com.au/emerging-technology/demand-management

Figure 6. Process Overview – Projects Subject To Regulatory Investment Test



1.4 General Feedback And Suggestions

Evoenergy invites feedback and suggestions from all interested parties in relation to the contents of this report and other matters relating to network planning and development. This report and information from ECRC meetings are published on the Evoenergy website. ECRC is a forum of Evoenergy's stakeholders. It is representative of consumers, businesses, and broader ACT community.

From time to time, Evoenergy conducts workshops, information sessions or sends out information on specific topics relating to the network development. You can register your interest to receive correspondence and notifications of future sessions using the form at the bottom of the Demand Management page on the Evoenergy website or by emailing demandmanagement@evoenergy.com.au.

Chapter 2: About Evoenergy

This chapter:

- Introduces Evoenergy as a licensed distribution network provider.
- Provides an overview of the electricity network and the physical environment.
- Provides an overview of the regulatory environment.
- Discusses the main factors and trends which are currently impacting Evoenergy's planning approach and outcomes.

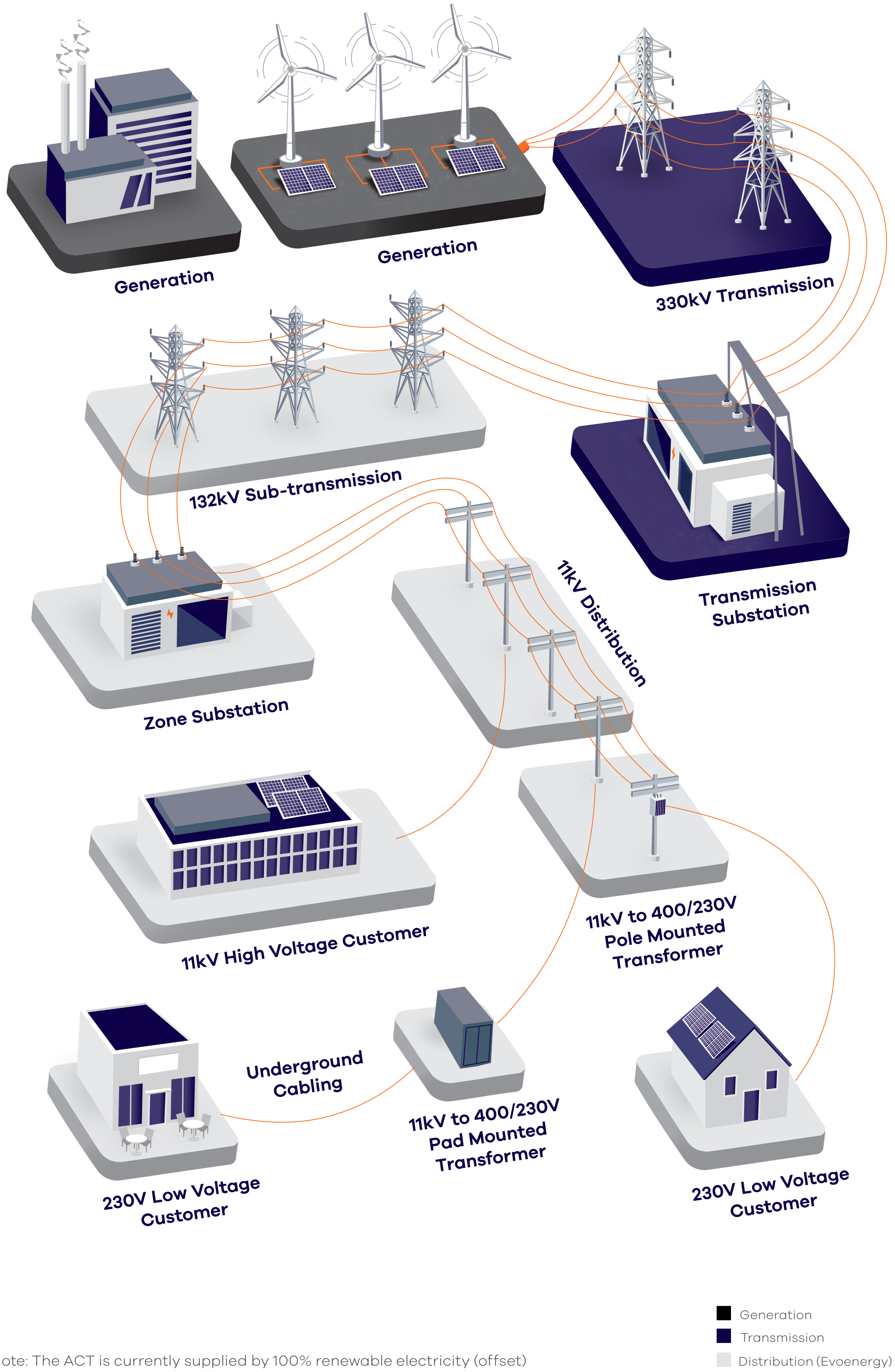
2.1 Introduction

Evoenergy is a utility licensed in the ACT to provide electricity subtransmission, distribution and connection services. Evoenergy also provides gas network services, which are outside the scope of this report. Evoenergy is a trading name of ActewAGL Distribution which is a partnership of Jemena Networks (ACT) Pty Ltd (wholly owned by Jemena Ltd) and Icon Distribution Investments (wholly owned by Icon Water Ltd). The licence was granted by the Independent Competition and Regulatory Commission (ICRC) in the ACT. The licence and the licence conditions are available on the commission's website. In addition to the jurisdictional licence, Evoenergy is registered with the Australian Energy Market Operator (AEMO) as a Distribution Network Services Provider (DNSP). Evoenergy also holds the gas distribution licence, but gas operations are outside the scope of this report. **Appendix C** provides further details in relation to Evoenergy's structure and licensing.

Evoenergy's obligations cover all aspects of operation of subtransmission and distribution networks including customer connections, network planning, design, construction and maintenance. The figure below shows Evoenergy's position in the energy delivery chain which is increasingly impacted by changes in technology, consumer preferences, distributed energy resources as the energy landscape shifts toward a net zero emissions future.

In practical terms this means that Evoenergy owns and operates the electricity and gas networks within the ACT. We are responsible for the power lines and other infrastructure used to distribute electricity through the network to your home or business. Evoenergy undertakes electricity network maintenance, connects new energy consumers, plans, and constructs new infrastructure and provides emergency responses.

Figure 7. Evoenergy Within The Energy Delivery Chain



Note: The ACT is currently supplied by 100% renewable electricity (offset)

2.2 Evoenergy's Physical Environment

Evoenergy provides electricity services over an area of 2,358 square kilometres to 221,429 electricity consumers as of 30 June 2023, within the ACT. It also supplies electricity to around 90 consumers in New South Wales.

Evoenergy owns and operates the electricity network which includes 220 km of subtransmission lines, sixteen 132 kV/11 kV and 132 kV/66 kV zone substations and switching stations, around 4,800 distribution substations and over 5,500 km of distribution lines. More detailed statistical information on the network asset numbers is provided in **Table 44**

Figure 8 and **Figure 9** below show an overview of the main components of the existing Evoenergy's subtransmission network including bulk supply points, zone substations and interconnecting lines.

Figure 8 is a geographic representation of subtransmission lines and zone substations within the ACT. Evoenergy's network includes subtransmission and distribution substations, lines and cables supplying to a range of areas including high density urban centres, lower density suburban areas and rural areas. The lines cross developed urban areas and bushlands. Significant sections of overhead subtransmission lines and overhead distribution lines are located in bushfire prone areas. The vast majority of low voltage distribution poles are located in residential backyards which is a unique feature of Evoenergy's network. Many sections of the network are heavily vegetated.

Appendix B provides additional details on the network's physical assets including the number of subtransmission and distribution assets, lengths of lines and cables, and the rating of the main subtransmission components and zone substations.

Figure 8. Evoenergy's subtransmission network Dec 2022 – geographic representation

Details current as at December 2022

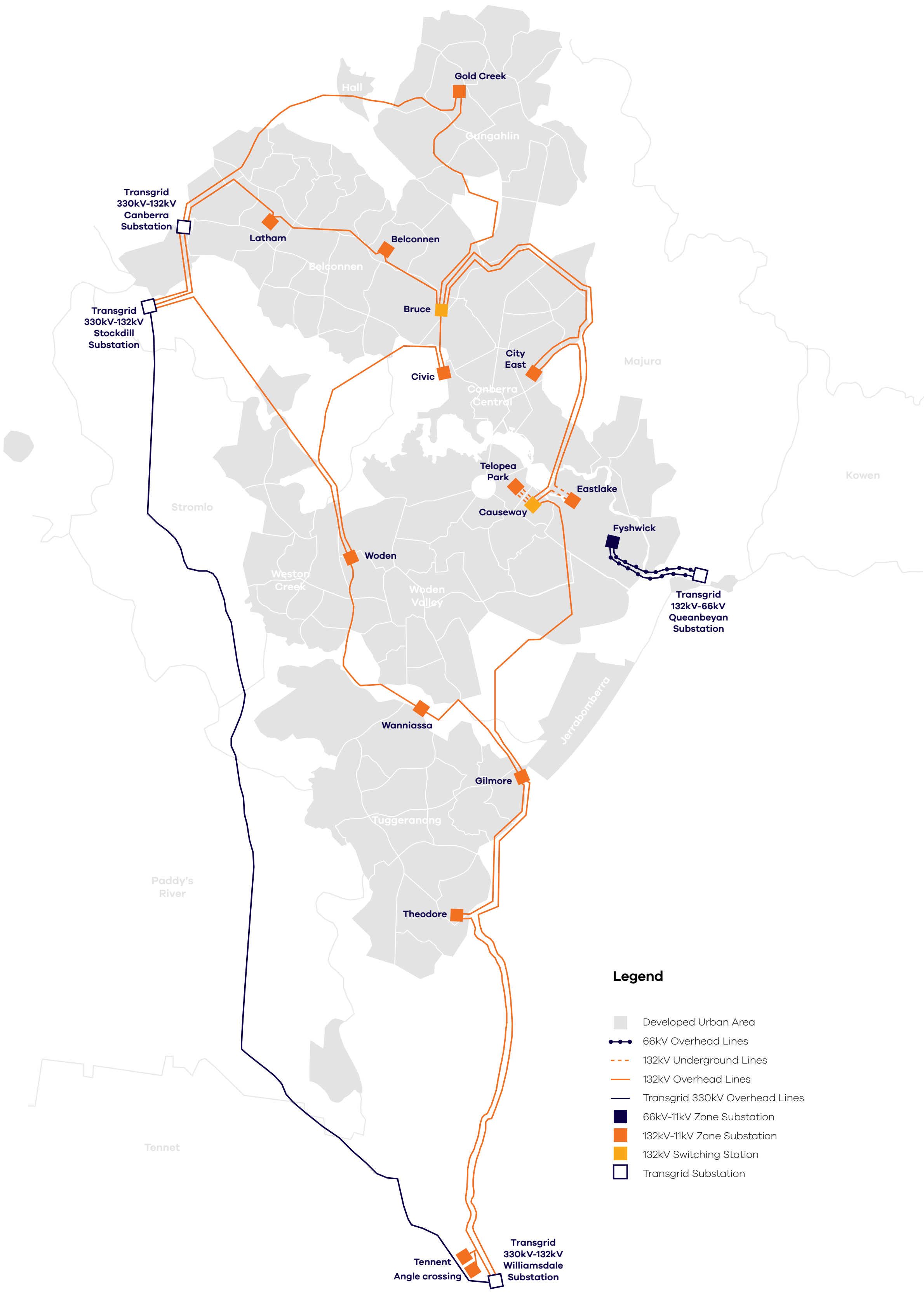
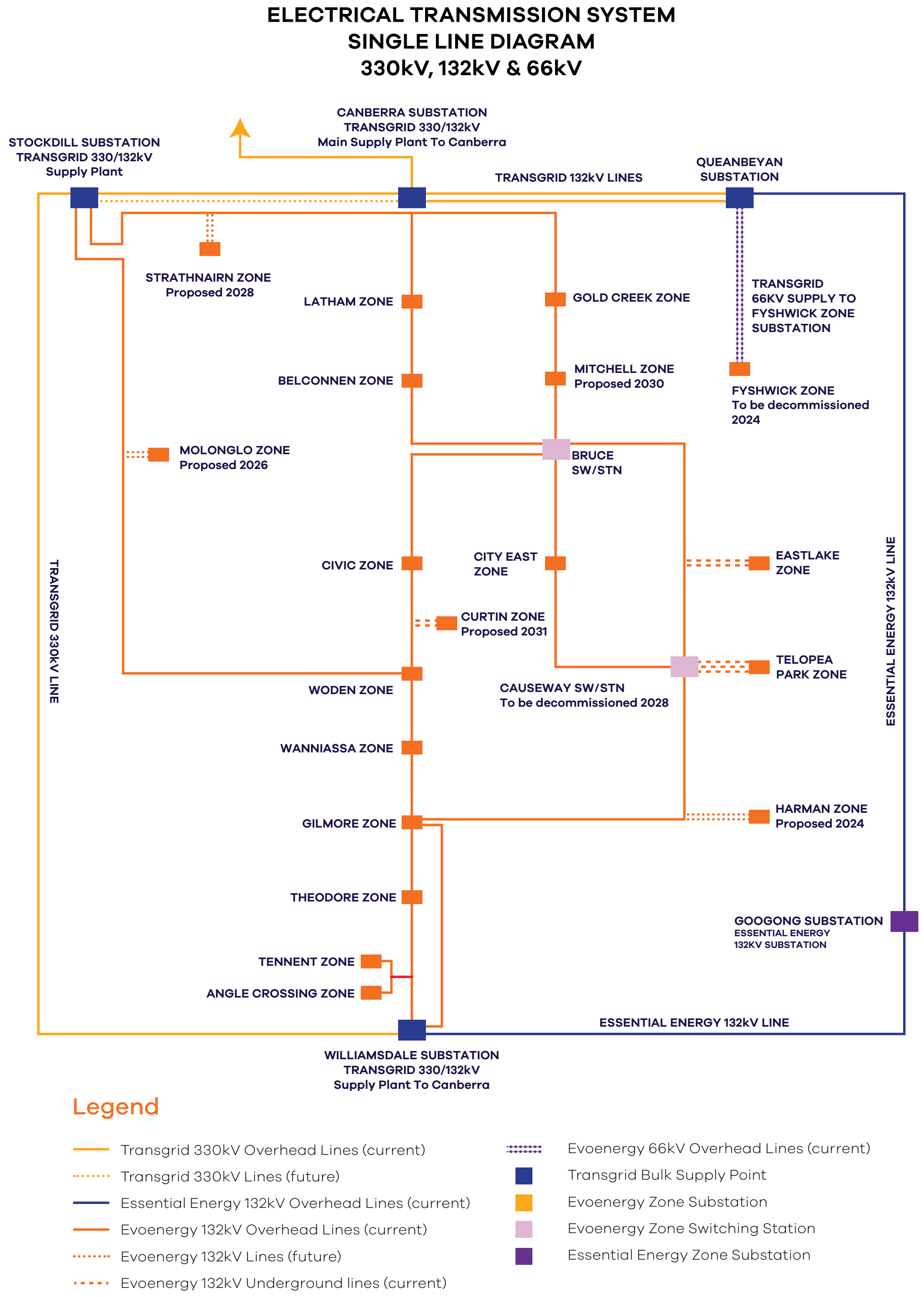


Figure 9 depicts Evoenergy's existing and future subtransmission network and Transgrid's 330 kV lines connecting Evoenergy's network through four bulk supply points (Canberra Substation, Stockdill Substation, Williamsdale Substation and Queanbeyan Substation) to the New South Wales transmission network. All the components marked for 132 kV, 66 kV and 11 kV voltage levels are operated by Evoenergy. The network consists of fourteen zone substations and two switching stations and the interconnecting subtransmission lines. The bulk supply substations and 330 kV lines are operated by Transgrid.

Figure 9. Evoenergy's existing and future subtransmission network - schematic representation



2.3 Regulatory Environment

Evoenergy is regulated by Commonwealth and jurisdictional legislative and regulatory instruments which cover economic and technical regulation.

The way we plan our network is consistent with a range of obligations and regulatory instruments which support the National Electricity Objective (NEO), as stated in the National Electricity Law *(NEL)* is:

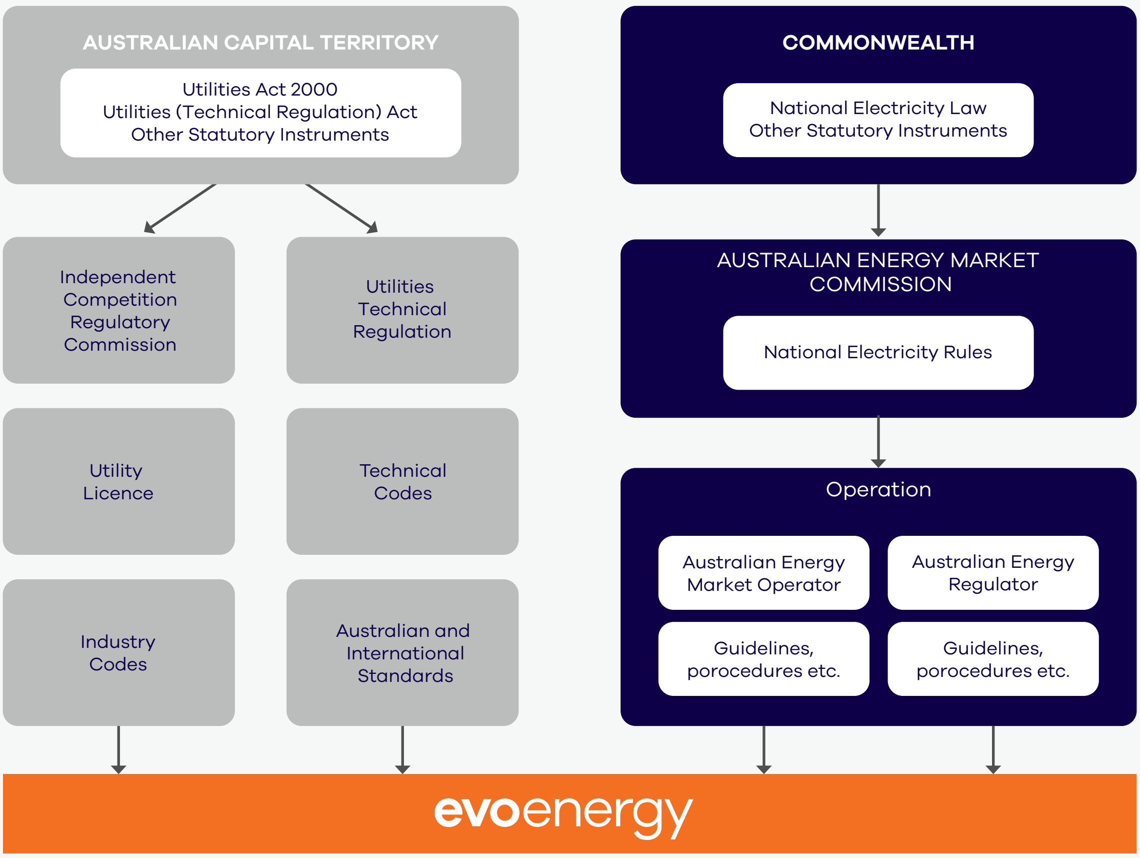
"to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:

a. price, quality, safety, reliability and security of supply of electricity; and
b. the reliability, safety and security of the national electricity system; and
c. the achievement of targets set by a participating jurisdiction –
   i. for reducing Australia's greenhouse gas emissions; or
   ii. that are likely to contribute to reducing Australia's greenhouse gas emissions."

Our network planning process aims to achieve operational outcomes in line with the NEO including supply security, reliability, quality, and safety. In addition, we plan and develop the network to fulfil obligations relating to price, emissions, investment efficiency and long-term interest of consumers. Thus, a consideration of technical and operational outcomes goes hand in hand with the economic and consumer interest when we make network investment decisions.

Figure 10 provides an overview of the main elements of Evoenergy's regulatory environment as a licenced and registered utility. The regulated Evoenergy's "poles and wires" business is ring-fenced from other entities and activities which operate in competitive markets. The National Electricity Rules (NER) and AER ring-fencing guidelines define the rules which apply to separation of a regulated business and non-regulated business activities.

Figure 10. Utility Regulation Framework – Main Elements



Apart from the main regulatory components presented in the above diagram, small parts of Evoenergy's network located outside the ACT are subject to New South Wales regulations with an oversight by the New South Wales Independent Pricing and Regulatory Tribunal. In addition to the utility obligations, Evoenergy is also subject to a range of other legislative obligations which apply to a broader business and corporate community.

Appendix C provides a more detailed description of key regulatory instruments relevant to utility regulation, in particular those relating to asset management and network planning. The description covers National Electricity Law (NEL) and NER, ACT's Distribution and Transmission Supply Codes and regulatory incentive schemes administrated by AER. These components are relevant to planning outcomes documented in this report.

2.4 Factors Impacting Future Network Development

The network planning process requires us to consider a range of internal and external factors impacting the electricity network. Internal factors include the introduction of new technology and increased levels of automation, cost considerations and technical standards. External factors are driven by consumer preferences, consumption trends, demand, development trends, technology, affordability and government policy, all of which have varying impacts on security of supply, reliability, power quality and safety.

The next ten years are going to be a critical time for our energy networks. Like other major infrastructure transitions that have been key to modernising our lives and contributing to the reduction of greenhouse gas emissions, energy networks need to evolve, and we are approaching a crucial stage in that journey.

The ACT is leading the way with a goal to achieve net zero emissions by 2045, with the ACT Government announcing a path to full electrification in the ACT to achieve it. This means the way energy is generated, stored, and used is changing. Technology such as batteries, electricity vehicles, and home energy management systems will be at the centre of driving a future that is cleaner and more sustainable, with energy that is efficient, flexible, and responsive.

There are over forty-five thousand solar installations in the ACT, over five thousand battery installations and the number of electric vehicles is on the rise demonstrating how forward thinking Canberrans are. The practical decisions Evoenergy makes in the short term to realise our energy vision are going to be essential to enable a smooth, affordable, and equitable net zero transition by 2045. We continue to look at every aspect of how we operate and maintain our energy networks as well as monitoring external factors so we can plan the required future network development while keeping the safety of our people and the community at the centre of everything we do.

Evoenergy is cognisant of the following current external factors impacting electricity network planning and asset management both in the short- and long-term future:

- Continuing high level of growth in distributed energy resources, in particular residential photovoltaic installations (rooftop solar) and medium size commercial installations which can create voltage regulation issues in some pockets within the network. For future network development this distributed generation must be carefully considered to ensure both power quality and capacity constraints are adequately managed.
- Small growth in summer and winter demand at the network level and higher demand growth pockets in several locations in the ACT.
- Urban intensification including increase in growth in medium and high-density residential development, higher rates of commercial developments and new greenfield developments leading to localised network capacity constraints.
- The existing trends and the long-term policy settings including ACT Government energy policies including the Powering Canberra electrification pathway, Zero Emissions Vehicles Strategy, perpetual 100% renewable energy target and 2045 zero emissions target reinforcing the need for changes to the way we operate the network.
- Impact of decarbonisation policies, gas substitution, and electric vehicle policies which form part of the ACT government Zero Emissions Framework.
- The full potential of technology including advanced metering or energy storage to support the network is yet to be fully realised.

The next section discusses the growth of distributed energy resources, ACT Government energy policies and provides a long-term context for the existing trends impacting Evoenergy's network.

Government policies and long-term context

Renewable energy generation in the ACT was initially encouraged by Commonwealth renewable energy certificates, ACT feed-in-tariffs, the 100% renewable energy target and reverse renewable energy auctions introduced by the ACT Government. In recent years, Evoenergy's network has experienced unprecedented growth in front of the meter and in behind the meter generation.

The growth in photovoltaic solar generation continued last year with 90MW of additional capacity installed, or an increase of just over 32%. Around one third of residential dwellings in the ACT have rooftop solar (PV) installations. This growth has had an increasing impact on the network, particularly in relation to voltage regulation in areas where the penetration of photovoltaic systems is high. **Figure 3** in the executive summary shows geographic areas of high PV penetration.

ACT energy policies point to the continuation of this trend. In 2022 the ACT Government announced full electrification as the pathway for the ACT to achieve net zero greenhouse gas emissions by 2045. Other Government policy includes the 100% renewable energy target, achieved in 2020 and which has been extended in perpetuity into the future. The 2019 government renewable auctions mandated provision of network batteries as part of the offer. The perpetual 100% renewable energy target means that future increases in energy consumption will have to be matched by additional renewable generation. The rapid uptake of distributed generation in the ACT is expected to continue. Consequently, Evoenergy predicts continued growth in both power quality challenges and electricity demand due to decarbonisation, gas substitution, and electric vehicles.

The ACT Government energy policy includes a Zero Emissions Framework with a long term zero emission target set for 2045. The discussion paper on ACT Sustainable Energy

Policy 2020-25 deliberates on a number of policy options. One of the key issues which the strategy sets out to address is a long-term transformation of the transport sector which now is the main contributor towards greenhouse gas emissions at around 64%. Most future transport scenarios, including whole electric, hydrogen and hybrid vehicles point to the likely increases in electrical energy requirements from the network. This report does not factor the impact of 2045 target which at the time of preparation of the report was subject to Government consultation.

Evoenergy recognises that ongoing close engagement with interested parties is essential to adapt and to address future challenges. Many of our stakeholders drive changes and propose solutions. We are committed to responding to future uncertainty through adaptability and innovation.

Planning for our future network

Evoenergy responds to the changing energy industry landscape. Energy consumers are embracing new technologies and increasingly taking control of their own energy generation, storage and usage. Power flows are becoming two-way, based on generation and demand patterns, and Evoenergy is evolving from a traditional DNSP to a Distributed System Operator (DSO). Evoenergy's strategic planning focus is to develop and operate the subtransmission and distribution networks effectively and efficiently catering for emerging technologies such as micro grids, embedded generation, smart networks, smart metering, electric vehicles, battery storage, and dynamic ratings for subtransmission lines and power transformers, all whilst identifying any opportunities for stakeholder input.

Figure 11 provides an overview of the changing business environment influenced by our key stakeholders.

The ACT Government 100% renewable energy target and the zero-emissions target set for 2045 are key drivers of transformation. Rooftop solar PV systems are being encouraged by developers of large residential estates, and it is likely that battery energy storage and home energy management systems will be further encouraged in the near future. Production of bio-gas from waste vegetation material is forecast to increase over the next few years. The extent that consumers generate and store energy both for their own use and export, will have a major impact on the topology and dynamic control of the distribution network.

The ACT has the highest rate of EV sales of any state, with EVs representing more than 21% of new vehicle sales in the year to June 2023[10]. Evoenergy is keen to create an electricity network that is fit for purpose for this new driver of energy demand stemming from the electrification of transport in the ACT including transition of public transport and commercial fleets to zero emission fleets. To this end, Evoenergy is keen to facilitate and innovate with local government, businesses, third parties and the general community on the various processes, requirements, and options for efficient transition regarding the electric vehicle uptake. Evoenergy is working collaboratively with all levels of the ACT Government on the various initiatives and strategies in the decarbonisation effort in this space and has already seen a significant uplift in enquiries and connection applications for private and public charging infrastructure.

The ACT Government has launched the Sustainable Household scheme[11] where Canberrans can apply for an interest free loan from $2,000 to $15,000 to buy energy-efficient products. These include:

- rooftop solar panels
- household battery storage systems
- electric heating and cooling systems
- hot water heat pumps (HWHP)
- electric stove tops
- electric vehicles
- electric vehicle charging infrastructure
- installation costs for these products.

These factors will influence future subtransmission and distribution infrastructure development and operation. Further information about Evoenergy's projects in the EV sector is detailed in **Chapter 9**.

10 https://electricvehiclecouncil.com.au/wp-content/uploads/2023/07/State-of-EVs_July-2023_.pdf
11 https://www.climatechoices.act.gov.au/policy-programs/sustainable-household-scheme

Accelerating the deployment of smart meters and unlocking their benefits

On 31 August 2023, the AEMC published recommendations on the review of the regulatory framework for metering services to target the universal uptake of smart meters through an accelerated deployment program. On 22 September 2022, a consortium of proponents put forward a rule change request for accelerating the deployment of smart meters and unlocking their benefits. The outcomes of the AEMC metering review and proposed rule change requires Evoenergy, as the network provider, to:

- develop and enable the implementation of a legacy meter replacement program (LMRP) for the accelerated deployment of smart meters across the ACT;
- expand system and process capabilities to capture, process, and store significantly higher volumes of smart meter data for billing purposes; and
- implement new system capabilities and processes to capture, process, and store basic power quality data.

Evoenergy's revised regulatory proposal includes a new step change for the costs of fulfilling responsibilities outlined in the AEMC's final report, which have been reflected in a proposed fast-tracked rule change. The AEMC expects that facilitating the accelerated roll-out of smart meters will include many market benefits, including network planning and customer safety.

The incremental costs to deliver on the AEMC's final report relate to IT capability to capture, store, and process smart metering data and additional labour resources to develop and manage the smart meter roll out program in the ACT. Under the final report, Evoenergy's legacy meter replacement plan would be due to the AER from late 2024 to early 2025, with the date yet to be confirmed.

Figure 11. Towards The Future Network

On-grid residential customers

Increased independence from the grid. Use of advance metering to optimise energy use, remotely controlled appliances, solar generation and use of battery storage. Increasing collaboration with distributors on demand management. Some consumers sell energy to retailers or peer to peer

Off-grid customers

Customers wholly independent from the network. Customers select micro-grid solutions

Developers

Increasing number of estates with compulsory renewable generation and battery storage. Estates requiring only limited support from the electricity network.

Government

Zero net emissions by 2045 target supports increasing penetration of distributed renewable energy resources and embedded generation.

Commercial Customers

Increased focus on energy efficient building management systems to minimise energy use. Installation of renewable generation to offset consumption and increased collaboration with distributors on demand management.

Zero emission vehicle owners

Vehicle owners require charging stations located through the network. Increasing energy consumption from electric, hydrogen vehicles or hybrid technologies.

Demand management sector

Growing number of operators collaborate with distributors in demand management and non-network solutions. Embedded generators, demand integrators and virtual plant operators provide network support and demand management solutions.

The ACT's climate provides for future extensive solar power generation, though it is not conducive to generation from other sources such as hydro and wind. The effectiveness of future battery energy storage systems coupled with solar PV generation and the use of natural gas as an energy source, will have a major impact on Evoenergy's future network operations.

Many of Evoenergy's distribution assets are approaching the end of their economic life and strategies will be developed regarding their retirement or replacement. Such assets include urban backyard overhead low voltage lines. With growing in-fill housing developments, these backyard lines are becoming increasingly difficult to access and maintain. Further information on the management of existing assets is available in **Chapter 6**.

The following sections discuss how specific observed trends impact security of supply, reliability, and quality. These factors were taken into account when developing network plans and this report.

Main Factors Impacting Security Of Supply And Demand

Security of supply relates to the available capacity to supply the existing and projected electricity demand. The available network capacity must be sufficient to cater for peak demand under normal conditions and credible contingency conditions (e.g. a failure or outage of a network component).

The capacity and demand on the main components of the network are considered during the planning process. The demand forecast is prepared for the whole of Evoenergy's system, zone substations and specific distribution system parts experiencing capacity constraints. Demand for electricity is driven by a number of factors including population growth, economic activity, energy efficiency, consumer consumption patterns, new commercial and residential developments and larger point loads. Distributed energy resources located behind the meter reduce the transportation of energy through the network by acting as localised generation and storage sources. Energy consumption and demand can be also influenced by electricity tariff levels and structures. Of equal importance to consumption patterns is the strong sensitivity of demand to weather conditions, particularly maximum and minimum temperatures.

Evoenergy Observations and Findings:

Projected demand at the system level is forecast to have a moderate increase (details available in **Chapter 5**). No new major security concerns have been identified at the system level to be addressed by Evoenergy. Evoenergy liaises with Transgrid to manage transmission voltage regulation constraints at zone substations at the time of low network load which coincide with high PV generation during the day or low consumption at night.

Identified network limitations (**Table 1**) relating to zone substation and distribution system capacity are localised to the areas experiencing higher growth. These limitations must be addressed either through network augmentation or demand side management solutions.

Factors Impacting Reliability

Reliability of supply is measured though the number and duration of electricity supply interruptions experienced by network consumers (details available in **Chapter 4**). Reliability of supply is impacted by the condition of network assets and factors outside Evoenergy control such as weather or accidental damage. Not all assets equally impact supply reliability, with the health of some network components being particularly critical to electricity supply. Each asset has a unique probability of failure and consequence of failure depending on its location and function in the network. Evoenergy optimises its maintenance activities according to the age, health, and criticality of its assets.

Reliability performance is measured against the target set by the *ACT Distribution Supply Standards Code* for all outages (planned and unplanned) and a target for unplanned outages set by the *Australian Energy Regulator as part of the Service Target Performance Incentive Scheme (STPIS).*

Evoenergy Observations and Findings:

Benchmark data on unplanned outages in Australian DNSPs reveals that Evoenergy holds one of the best records for network reliability amongst its peers in Australia[12].

12 AER 2022 Electricity network performance report 2022- https://www.aer.gov.au/publications/reports/performance/electricity-network-performance-report-2022

Evoenergy's current strategic intent is to maintain reliability performance within the existing regulatory targets and ensure we comply with our license conditions.

Opportunities to address key reliability challenges include investing in people and process, planning for a more responsive network, embedding risk-based asset management, incorporating best-practice vegetation management and creating a better outage experience for the customer. Refer to **Chapter 4** and **Appendix F** for key reliability challenges and planning outcomes.

Factors impacting power quality and other technical parameters

Power quality relates to the standard voltage and current experienced by consumers connected to the electricity network. Power quality can be measured and expressed through a range of parameters including voltage levels, voltage and current harmonics, voltage stability and power factor. Departures from the standard may have adverse impact on consumer equipment. Consumer equipment may also contribute to poor power quality and impact other consumers connected to the network. Departures from the standard can be transient, temporary or permanent which impacts power quality to various degrees. Poor power quality may adversely impact consumers for example through appliance overheating, disconnections or light flicker. In more severe cases power quality can cause appliance damage or shorten the life of appliances.

Distributed energy resources such as photovoltaics have a potential to impact power quality and reliability.

Evoenergy Observations and Findings:

Evoenergy's primary power quality initiatives focus on efficient management of impacts from increased solar photovoltaic (PV) distributed generation. As limited by voltage and thermal regulation constraints in some parts of the network, Evoenergy is assessing the hosting capacity of the network as the levels of PV increase.

As uptake of photovoltaic generation increases, Evoenergy's network will experience increased incidence of voltage regulation constraints during certain parts of the day.

During times of high energy production and low consumption, reverse power flow may increase voltage levels beyond the normal operating range. Inverters, programmed to current requirements of the relevant Australian Standard, will ramp down their output as voltage increases and may disconnect from the network at high voltages. The voltage regulation issues will require ongoing management are set to increase in line with the growing penetration of distributed generation.

Chapter 4 and **Appendix F** discuss network reliability performance and measures.

Chapter 3: Asset Life Cycle Management

This chapter provides an overview of Evoenergy's asset management and planning approach that underpins development of our work programs to meet the need for a safe, reliable, and high-quality electricity supply.

Optimising the value of investments is at the core of Evoenergy's network planning and asset management philosophy. Evoenergy's asset management decisions recognise that the electricity network and the role of network providers is undergoing substantial transformation to align with changes in consumer preferences and technologies. The approach is designed to support prudent and efficient investment and promote innovation.

The key characteristics of Evoenergy's asset management approach include:

- Planning and asset management processes aiming to maximise the benefits over the life cycle of assets.
- Employing and testing innovative solutions whenever cost effective and practicable.
- Integration of risk management and probabilistic planning into asset management investment decisions.
- Mandatory consideration of non-network and demand management solutions.
- Exploiting synergies between planning of the network needs and management of the existing assets.
- Philosophy of continuing improvement applied to asset management processes, components, and systems.
- Certification for compliance with *ISO 55001:2014: Asset Management.*

Certification of Asset Management System to ISO 55001

ISO 55001 specifies the requirements for the establishment, implementation, maintenance and improvement of a management system for asset management. Evoenergy has adopted ISO 55001 as the reference for measuring asset management continuous improvement and compliance. Evoenergy's Asset Management System is an integrated, effective management system for asset management which maximizes value derived from the use of assets.

Evoenergy holds a current certification under the ISO55001 standard, assessed through a Joint Accreditation System-Australia and New Zealand (JAS-ANZ) accredited auditor. This certification is valid until January 2027 and can be found in **Appendix D**. Evoenergy intends to maintain this certification and extend its validity as required over the forward planning period.

3.1 Asset Management Approach and Components

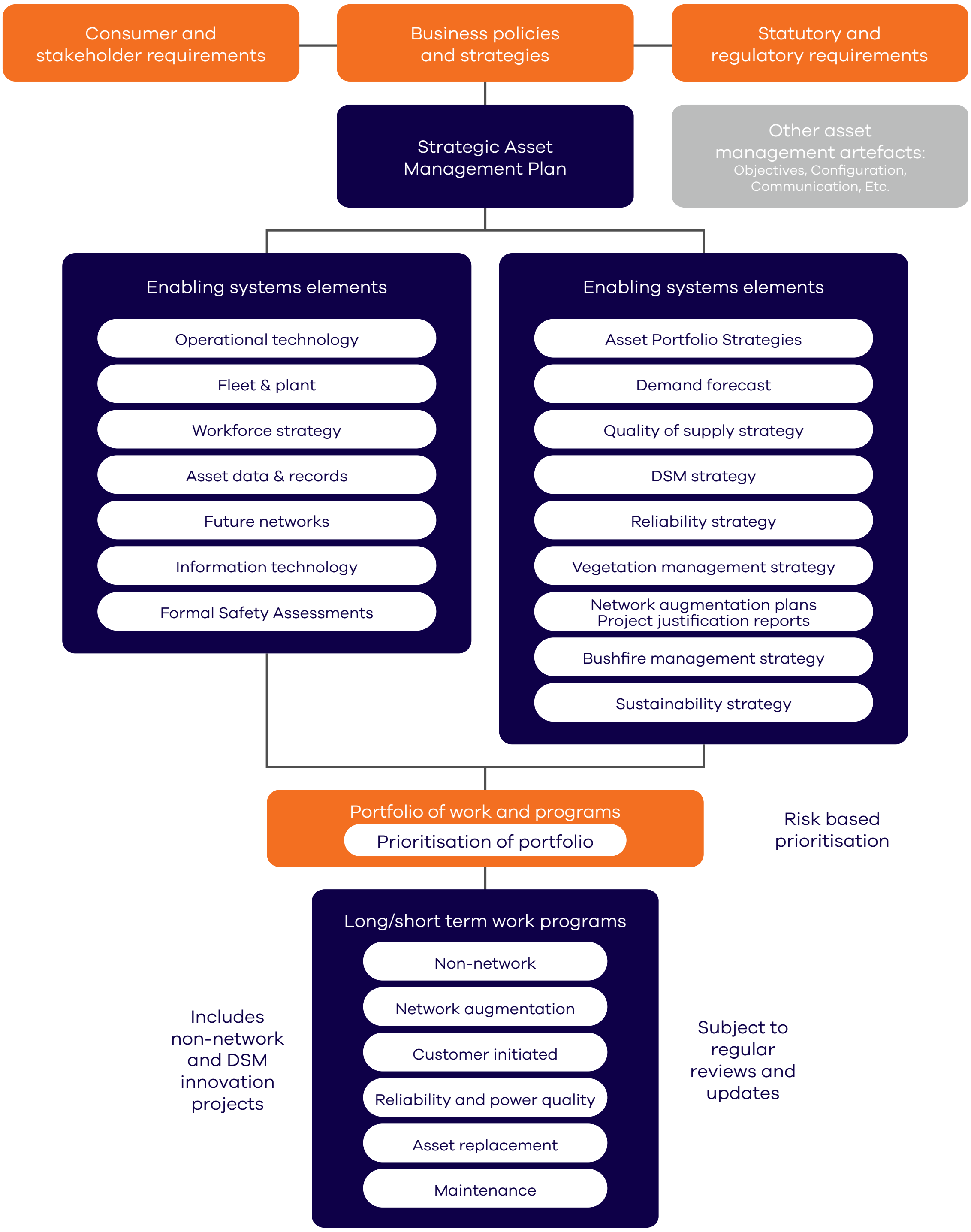
The asset management and network planning outcomes are achieved by applying methodologies which include:

- Development of network investment and maintenance programs through a bottom-up analysis of network and asset needs including safety, performance, load growth, security, asset health, and criticality.
- Exploration of demand management and non-network solutions through engagement with the consumers and industry stakeholders.
- Application of rigorous probabilistic risk assessment methods to operational risk analysis and network investments.
- Application of Reliability Centred Maintenance (RCM) methodology to the development of asset maintenance programs in accordance with asset performance, health, and criticality.

- Optimising programs across asset categories by using a risk-based top-down review to achieve the desired level of risk mitigation at least cost.

Figure 12 provides an overview of the main Asset Management and Network Planning artefacts relevant to the development of the network programs relating to asset augmentation, replacement and maintenance. The network planning outcomes are discussed in **Chapter 6** for the existing assets and in **Chapter 7** for planning of the network.

Figure 12. Asset Management and Network Planning – Overview of Key Artefacts



3.2 Network Planning Methodology

Evoenergy applies its network planning process to address existing and emerging network limitations and performance issues. The primary objective of network planning is to ensure sufficient security, quality, and reliability of supply at the lowest possible cost. Evoenergy's network planning processes consider network performance and capacity against future network needs based on the projected demand forecast for main network components such as subtransmission lines, zone substations and distribution lines.

Constraints are identified and assessed through a combination of deterministic and probabilistic methods. The network is designed with a limited redundant capacity margin in critical parts of the network to cater for credible contingency events, with this set of design requirements commonly referred to as the "N-1" criteria. Deterministic methods are used to identify a shortlist of network locations where demand may exceed either supply capacity, power quality, or N-1 limits where applicable. This is achieved by analysing demand forecasts with the Advanced Distribution Management System (ADMS) network analysis tools. Synergies with asset replacement and retirement programs are considered and captured at the same time. Probabilistic planning methods, detailed in **Section 3.3**, are applied to further assess shortlisted potential constraint locations.

3.3 Risk Based Probabilistic Planning

A decision to invest may be justified on the basis that it provides positive net market benefits and/or is required to enable Evoenergy to meet a compliance requirement. Risk management is at the heart of assessing market benefits, and hence is fundamental to Evoenergy's investment decisions including for the purposes of asset management (such as asset renewal) and network planning (such as capacity management). Typical risk assessment may include reliability, safety, environmental, and financial risks. The value of risk expressed in monetary terms allows for the comparison of the market benefits with the corresponding investment costs. Risk reduction in this comparison is considered as a benefit.

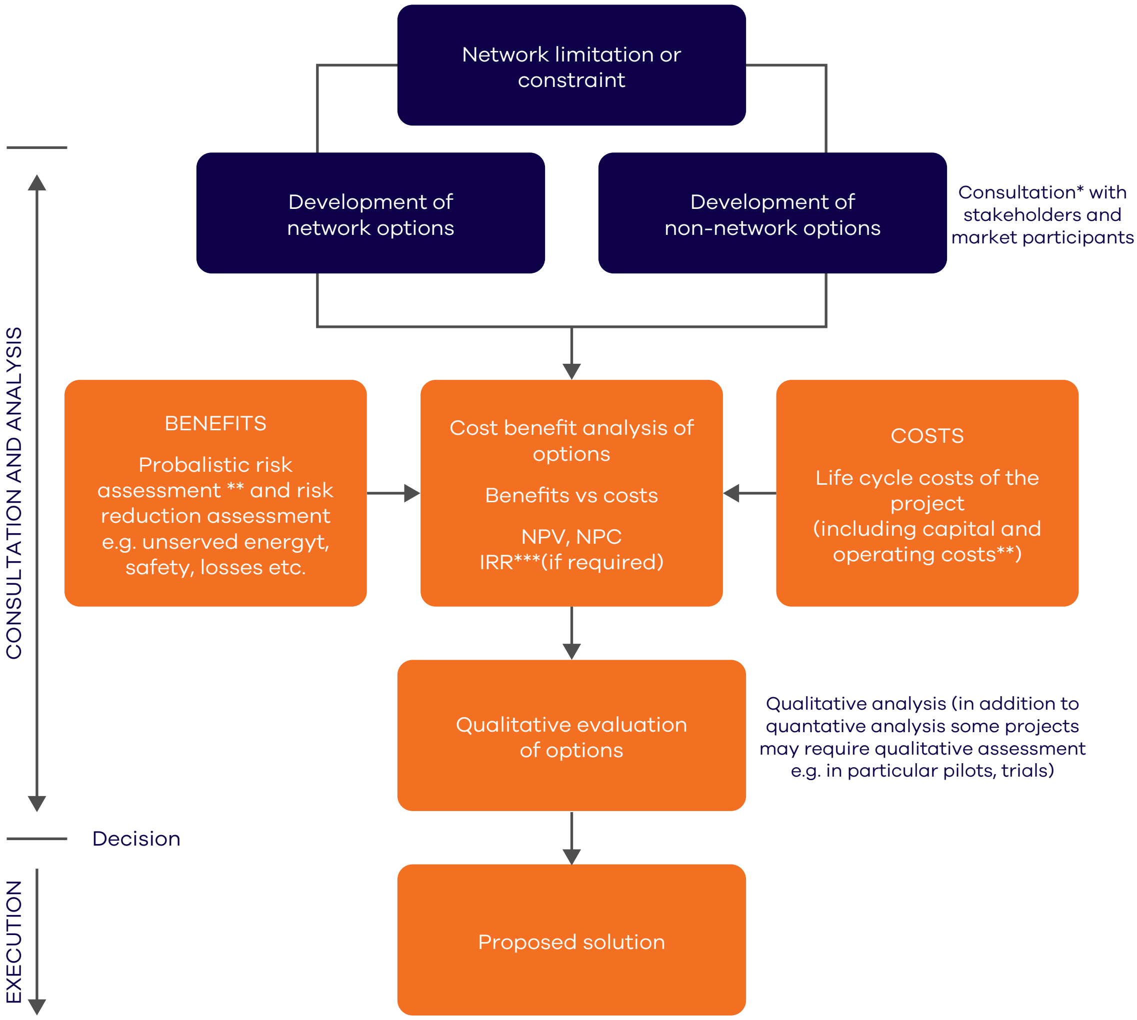
Evoenergy's asset management model applies a probabilistic risk methodology to asset renewal decisions. A software-based implementation of this model in the PowerPlan application, is utilised to prepare Asset Specific Plans which define renewal timings. The approach is consistent with the AER's applications notes on asset replacement planning[13]. Further detail on the management of existing assets is provided in **Chapter 6**.

Where a potential need to invest is identified, as far as practicable, the value of avoided risk from various solutions is assessed for each investment option alongside their implementation costs. This method forms the basis for a net present value (NPV) assessment or, often in the case of projects driven by compliance requirements, a net present cost (NPC) assessment, and an associated investment business case.

Figure 13 provides a high-level overview of the risk-based approach to investment decisions. It shows that risk assessment and valuation as far as practicable is a critical step in investment decisions. Unbiased consideration of non-network and network solutions is a mandatory step in the process.

13 AER January 2019. Industry practice application note. Asset replacement planning.

Figure 13. Overview – Probabilistic Risk-Based Investment Decisions



*As per Evoenergy demand management engagement strategy
** risk assessment and life cycle costs are applied as far as practicable, whenever appropriate market benefits are considered
*** IRR definition – internal rate of return

Where potential network constraints have been identified, probabilistic planning methods are used as far as practicable to quantify existing and emerging risks. The methodology accounts for the likelihood that a forecast load will materialise in a given planning period. The dominant risk is often related to supply interruptions (reliability). It is expressed as the value of "unserved energy" corresponding to probability of supply interruption and consequences of interruptions for credible network events.

These supply interruption consequences are assessed from an economic perspective. The valuation is based on the value of energy to the consumer. The unit value of reliability to consumers for each unit of energy ($ /kWh), known as the value of customer reliability (VCR), is published by the AER[14].

Typically, projects driven by compliance, projects for which the risk is not easily quantifiable, or innovative projects (including pilots and trials) would lend themselves to alternative assessment methods.

14 VCR values are sourced from: https://www.aer.gov.au/industry/registers/resources/reviews/values-customer-reliability-2019

3.4 Management Of Existing Assets

Evoenergy's approach to the management of the existing assets aims to optimise investment over the life cycle of the assets. Asset retirement and renewal are closely coordinated and integrated with the network augmentation plans to exploit synergies and capture savings. The foundation of the asset management approach is operational risk assessment based on the analysis of asset condition, performance, and criticality. Asset criticality takes into account the operational function of the asset and consequences of failure. The analysis includes a variety of data and information collected as part of network operations including asset monitoring, testing, and inspections. The performance and failure rates of specific assets or asset classes are factored into asset management whenever available.

Evoenergy's asset maintenance philosophy is based on Failure Modes Effects and Criticality Analysis (FMECA). Reliability centred maintenance is discussed in the next section.

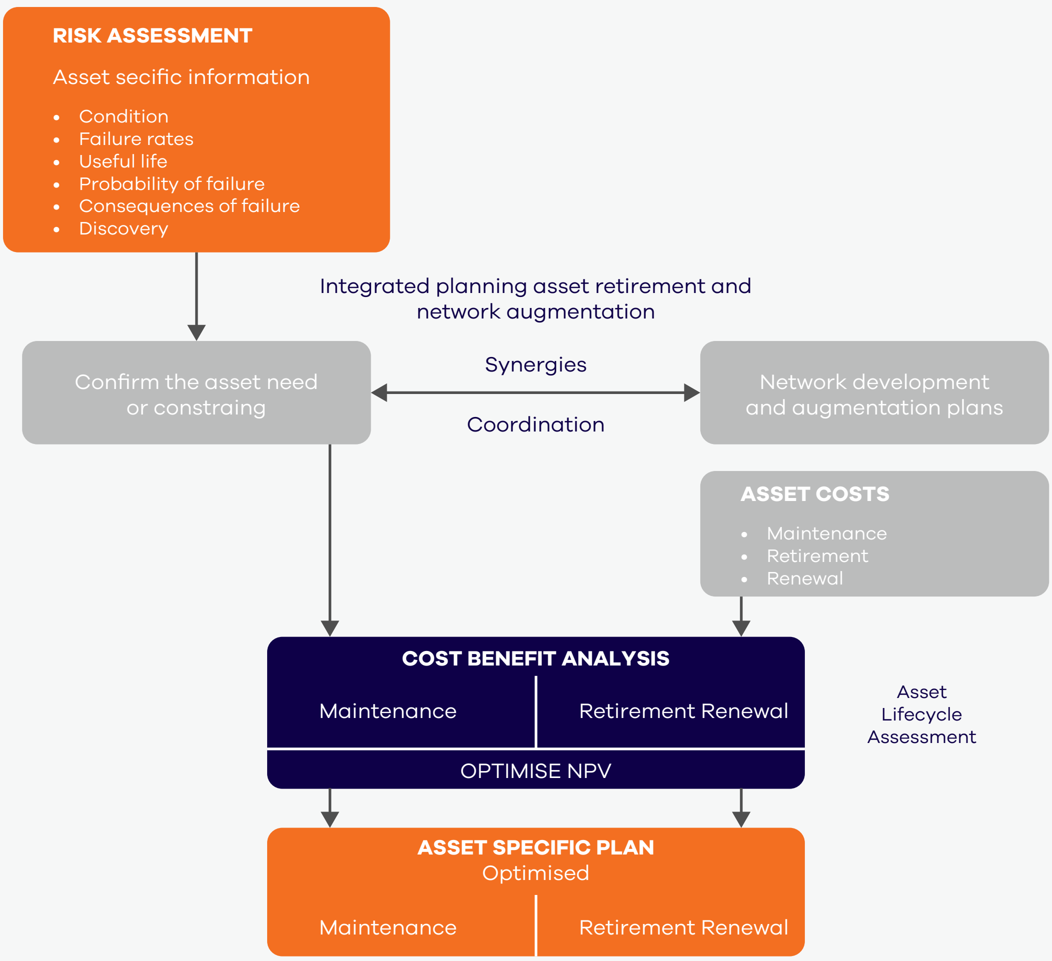
The main outputs from the process are Asset Class Plans (ACP) and Asset Portfolio Strategies for all network asset classes and types. These artefacts include planned asset retirement, renewal, and maintenance. Asset Portfolio Strategies are the results of the bottom-up analysis based on the available asset data.

An additional step is to optimise the investment across asset classes. The top-down analysis across Portfolio Strategies ensures that investment dollars are allocated to the assets where the overall benefits (e.g., risk reduction) are greatest.

Chapter 6 discusses outcomes of the planning review for asset retirement and renewal.

Figure 14 shows an overview of the life cycle optimisation process.

Figure 14. Optimising Asset Retirement And Renewal – An Overview



3.5 Asset Maintenance

Evoenergy maintains its assets according to the principles of reliability centred maintenance. The governing factor in reliability centred maintenance analysis is the impact of a functional failure at the equipment level dependent on the criticality of the asset.

The process of developing a reliability centred maintenance program depends on selecting scheduled tasks that are both applicable and effective for a given asset. Risk assessment is integrated into the process. For some asset classes, the reliability centred maintenance methodology is extended to FMECA which considers in more detail root causes and consequences of failures. The fact that failure consequences govern the decision process makes it possible to use a structured decision approach, both to establish maintenance requirements and to evaluate proposed tasks. As far as practicable the cost of maintenance and asset replacement are optimised over the life of the asset. Overall, the maintenance tasks tend to be weighted towards the assets where failure might have greater safety, environmental, reliability, or economic consequences.

The net result of the decision process is an optimised planned maintenance program that is based at reliability characteristics of the equipment in the operating context (function and criticality) in which it is used.

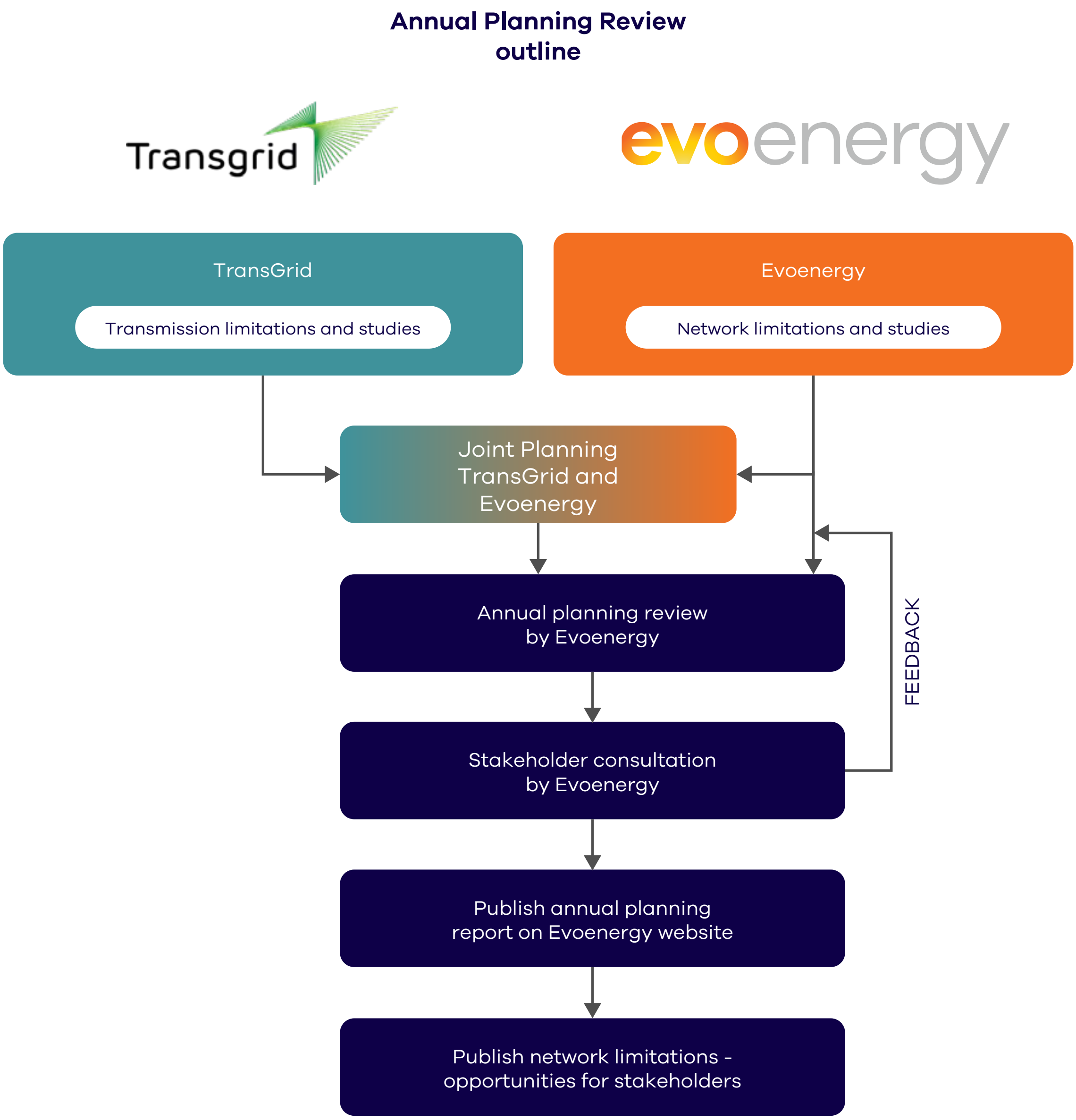
3.6 Annual Planning Report (This Document)

Evoenergy documents the approach and outcomes of network planning in its APR. The prioritised solutions are rolled into the network asset management and development programs and are periodically reviewed and updated. The report's planning horizon is five years for the distribution and subtransmission networks. The projects which are likely to be subject to regulatory investment test are included in this report.

The APR also describes how we engage with our stakeholders to explore the full range of non-network and demand management solutions.

Figure 15 provides an overview of the planning review process including joint planning with Transgrid, the operator of the transmission network in NSW with which the ACT network connects.

Figure 15. Annual Planning Review – Outline Of The Process



Chapter 4: Network Performance

This chapter discusses network reliability and power quality performance. Network performance refers to the level of service Evoenergy provides to energy consumers in terms of availability and quality of supply.

This section identifies challenges and presents our plans to maintain network performance.

4.1 Network Reliability

Network reliability performance is measured by the frequency and duration of supply interruptions to energy consumers. Our strategy is to maintain the overall network reliability performance and implement set initiatives targeting specific improvements.

Network reliability performance in terms of duration (SAIDI) and frequency (SAIFI) of outages for the 2023 financial year improved compared to last financial year. In 2023, SAIDI and SAIFI performance was marginally above the AER's Service Target Performance Incentive Scheme (STPIS). Network SAIDI was higher than long term average performance and network SAIFI was in-line with long term performance. Asset failures had the greatest impact on network performance however the impact was less compared to previous years. The network continued to experience high levels of outages attributable to trees and vegetation compared to long term averages. Our network reliability performance and forecast performance is shown in **Figure 16** and **Figure 17**.

Figure 16. SAIDI - unplanned interruptions per consumer (minutes per consumer per year)

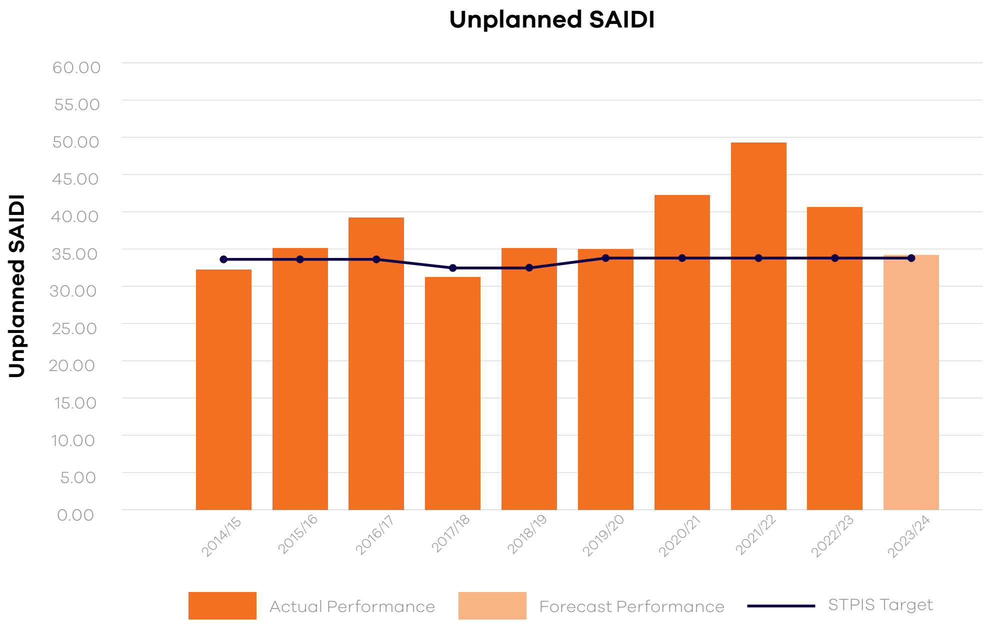
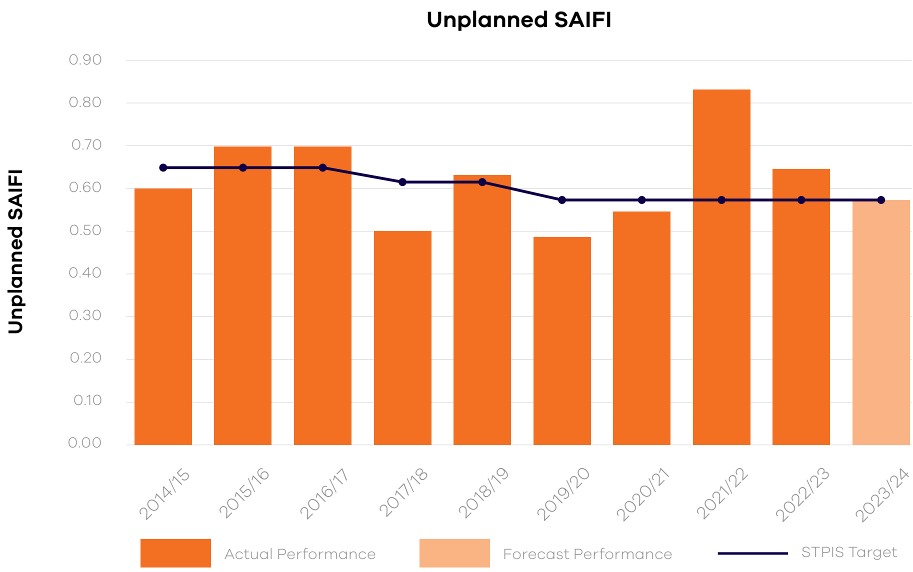


Figure 17. SAIFI- unplanned interruptions per consumer (number of interruptions per consumer per year)



Appendix F contains detailed network performance and a comparison to AER and local jurisdictional targets.

4.1.1 Reliability – What Are The Main Challenges

Benchmark data on unplanned outages in Australian DNSPs reveals that Evoenergy holds one of the best records for network reliability amongst its peers. In this context, we can view the following challenges as insights into known opportunities for continuous improvement of an already effective system.

Outage cause attribution

A mature reliability management system requires access to high fidelity, detailed data on the causes of incidents to inform targeted management regimes. Alignment of outage cause data could be improved to unlock some of these high maturity use cases that enable key risk management decisions.

Environmental variability

Vegetation and weather incidents can have a substantial and highly variable impact on reliability performance. Large sections of our network are located in bushlands, backyards and other heavily vegetated areas. Evoenergy sets stringent reliability targets based on detailed consultation with customers and regulators, and these targets leave little margin for uncertainty in network performance. The large performance variability attributable to our operating environment presents a dilemma in striking the right balance between performance, certainty, and cost when managing our network.

Project delivery

At present, reliability projects at Evoenergy have long lead times for delivery, carrying a high opportunity cost with respect to network performance. In the resource constrained environments that most businesses (including Evoenergy) operate within, projects compete on their merits for a limited pool of available resources in order to be delivered. A challenge for the business is to ensure that reliability projects are given sufficient opportunity to compete on an equal playing field amongst other worthy endeavours.

Defect management

Some defects remain on the network for extended time periods, reducing incident response flexibility. Not all defects cause immediate or ongoing loss of supply to customers directly. Faults can often be switched around, leaving the network in an 'abnormal supply' configuration. Similarly, assets may continue to perform their functions at an increased risk of failure where a defect has been initiated. A challenge for Evoenergy is that these defects can reduce reliability performance over time, despite having less obvious impacts than an active outage.

4.1.2 Reliability – What We Have Achieved In The Last Year

Evoenergy's network reliability improvement initiatives implement economically feasible options to maintain or improve network performance for consumers. Our reliability initiatives have focused on the fast and safe restoration of supply. In 2022/23 we installed remote controllable switchgear on two (2) overhead feeders to minimise consumers affected by faults and reduce supply restoration time to consumers on healthy sections.

4.1.3 Reliability – Planning Outcomes

Reliability strategy and tactics

Overall Evoenergy aims to maintain existing levels of reliability for consumers, ensure we comply with our license conditions, and elevate value delivered to consumers. To address the main challenges outlined in **Section 4.1.1**, Evoenergy will make improvements over the short, medium, and long term against the following guiding policies:

- **Invest** in people and process
- **Plan** for a more responsive network
- **Embed** risk-based asset management
- **Incorporate** best-practice vegetation management
- **Create** a better outage experience

Appendix F contains more detail on these policies.

Our reliability program of work continues to focus on the fast and safe restoration of supply. These initiatives include:

- Installing remote controlled automatic reclosers and load break switches on our overhead network to minimise consumers affected by faults and reduce the duration of outages for consumers on healthy sections. In 2023/24 this program is planned on four (4) overhead feeders.
- Utilise network augmentation opportunities to optimise network load and connected consumers to reduce the frequency and impact of faults when they occur.

For information on how Evoenergy is capturing emerging opportunities to use advanced technologies for reliability management, see **Chapter 9**.

4.2 Power Quality

Power quality refers to the network's ability to provide consumers with a stable sinusoidal waveform free of distortion, within voltage and frequency tolerances.

Power quality issues manifest themselves in voltage, current or frequency deviations, which result in premature failure, reduced service life or incorrect operation of consumer equipment or reduced service life of network assets.

The *NER Schedules 5.1a, 5.1 and 5.3* detail the applicable power quality design and operating criteria that must be met by Evoenergy. The Electricity Distribution Supply Standards Code stipulates power quality standards imposed on Evoenergy by ACT technical regulations. Evoenergy's Service and Installation Rules describe the applicable power quality design and operating criteria that must be met by our consumers. Optimisation of network power quality improves customer outcomes and enhances asset lifetimes due to reductions in operating stresses (e.g. lower transformer iron losses and resultant heating from harmonic voltage distortion) and can allow the full potential life of electrical appliances to be realised.

Evoenergy's objective is to maintain power quality at current performance levels to provide a safe and secure source of electricity to our consumers.

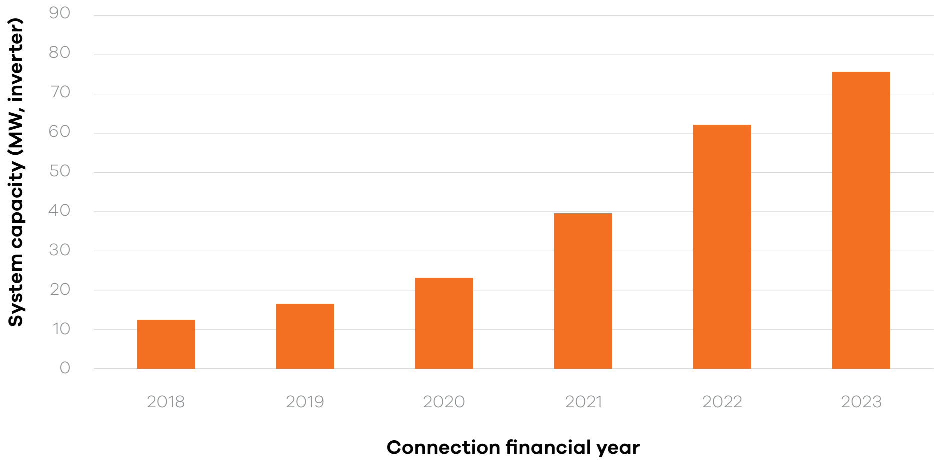
Appendix G provides more details on the power quality standards, obligations, and parameters.

4.2.1 Power Quality – What Are The Main Challenges?

This section discusses main challenges which Evoenergy is facing with respect to power quality.

Evoenergy is experiencing increasing voltage regulation challenges in the low voltage network as various distributed energy resources, such as roof top photovoltaics, residential battery energy storage systems and electric vehicle chargers, connect to the network. Most of these voltage regulation challenges currently relate to rooftop photovoltaics (see **Figure 18**), which are being installed on the Evoenergy network at an accelerating rate. These challenges can be exacerbated by the presence of other distributed energy resources (DER) such as residential battery energy storage systems and electric vehicle chargers.

Figure 18. Incremental installed photovoltaic system capacity (inverter size) by inverter connection FY



Where voltages are high because of concentrated penetration of DER, some parts of the low voltage network are increasingly subject to reversed power flows. Evoenergy is experiencing increasing numbers of voltage regulation enquiries particularly in locations where DER penetration is high, or generation clusters exists. Further information on customer enquiries is in **Section 4.2.2**.

Evoenergy has determined that hosting capacity limits for DER will be increasingly challenged in the future in various network locations. **Section 4.2.3** highlights Evoenergy current practices and new initiatives that are/ will be deployed to resolve voltage regulation issues.

Evoenergy also identified emerging constraints with voltage regulation systems at zone substations. Zone substation power transformer on load tap changers maintain voltage by regulating voltage automatically as a function of the subtransmission voltage and load and generation on the distribution network. Power transformer on load tap changers have an operating range and therefore their capability to raise or lower voltage is limited by this range. Some zone substation power transformers cannot regulate voltage within target levels because they are operating at the limits of their range. This affects the voltage regulation schemes ability to maintain power quality performance for customers. These constraints are being driven by increasing DER, changing customer load types and behaviour. Evoenergy is continuing to investigate zone substations experiencing voltage regulation constraints and options to manage power quality risks.

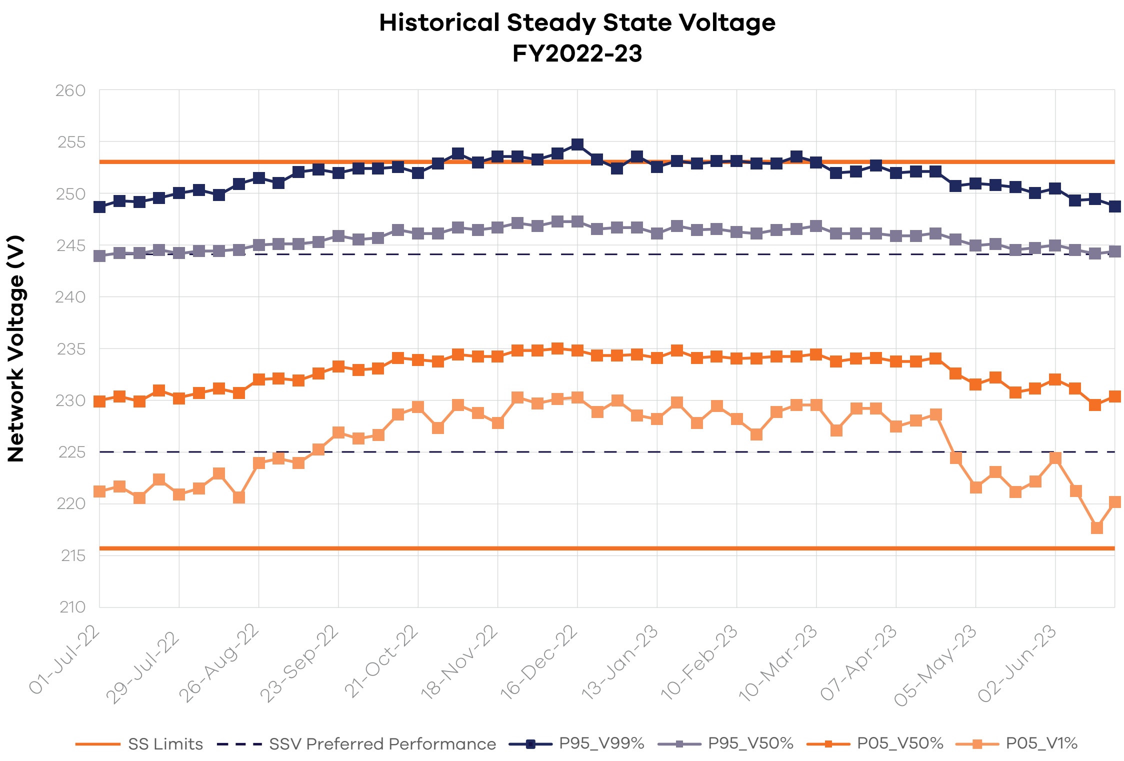
The integrity of neutral connections in the system may be impacted over time by aging assets, loose connections, and corrosion. Evoenergy undertakes immediate rectification works once these faults are known. Neutral to earth voltage is being monitored by Evoenergy at times when reactive and pro-active measurements are conducted in the system with the use of the portable monitoring and measurement devices.

4.2.2 Power Quality – What We Have Achieved During The Last Year?

Proactive Monitoring

Evoenergy's proactive program monitors the network steady state voltage (SSV) through analysis of power quality measurements sourced from behind the meter monitoring at DER customers. These customers are selected as indicators of how the network performs at high-risk sites, so that targeted proactive management can occur. SSV performance from the proactive monitoring is displayed in **Figure 19** for FY23. There is considerable seasonal voltage variation being driven by customer behaviour/demand and DER performance across seasons (a feature that does not extend to non-DER customers). High voltages were experienced by this subset of DER customers in spring, summer and autumn. Where the network exceeds limits, opportunities to improve the performance are investigated. Initiatives to improve performance are outlined in **Section 4.2.3** Power quality – planning outcomes.

Figure 19. Network steady state voltage performance by week

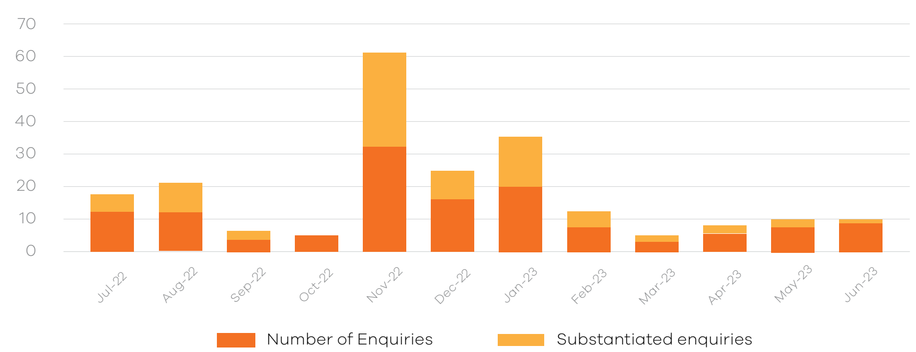


Customer enquiries

Evoenergy received 128 customer-initiated enquiries in relation to power quality during the financial year FY23.

Of the 128 enquiries received, 73 enquiries were substantiated to be an over voltage issue. Investigations showed that either concentrated penetration of distributed PV or uneven distribution of PVs across three phases of the LV circuit led to overvoltage at point of supply. Voltage issues are exacerbated during warmer months due to increased PV generation and low demand. Certain parts of the network required additional monitoring to account for seasonal variation of PV generation and its impact on the local voltage profile. Substantiated enquiries are addressed on a case-by-case basis and Evoenergy aims to resolve the identified issues through practices outlined in **Section 4.2.3** Power quality-planning outcomes.

Figure 20. Customer enquiries by month



Community Outreach

The Evoenergy website includes educational content on DER ownership, including the relationship between inverter settings and behaviour, and system performance. Additional information is available on opportunities to contact Evoenergy and enquire about power quality performance.

As a pre-requisite to commence a QoS investigation of an over voltage enquiry, Evoenergy now requires customers to provide details of their inverter configuration. This has helped in identification of non-compliant systems, where either:

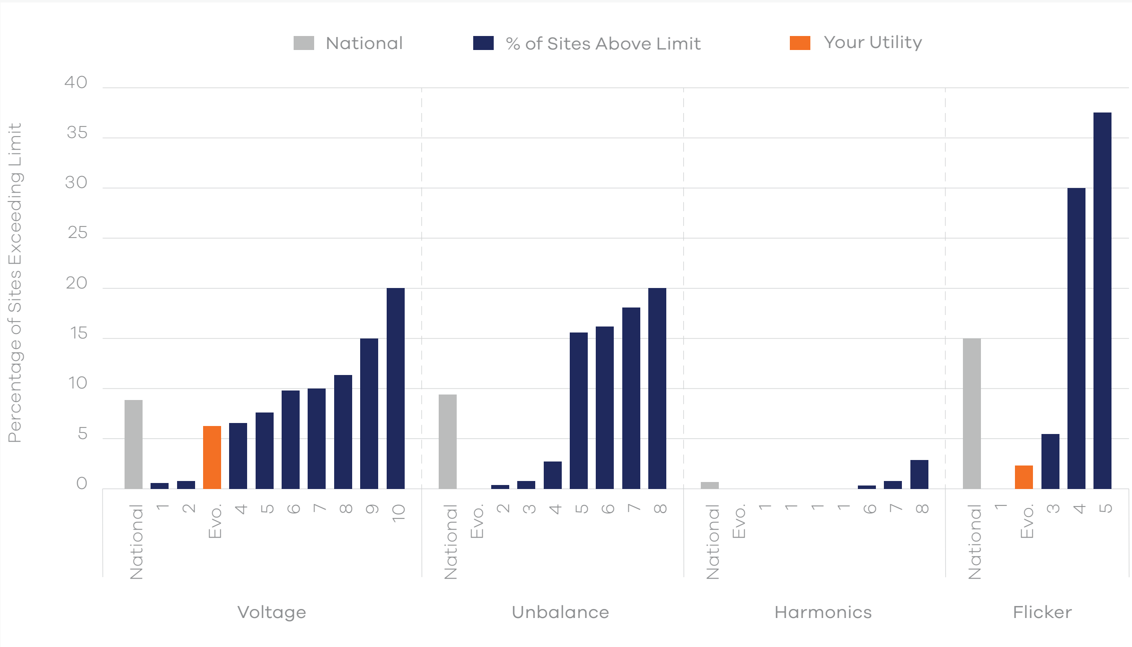
- the system has no approval from Evoenergy to connect to the network; or
- the system has been altered/ augmented and the new system was not approved by Evoenergy; or
- the system on site is different to details in Evoenergy records; or
- the system is not configured to Evoenergy's technical requirements.

These scenarios impact on Evoenergy's ability to effectively manage power quality for the benefit of all customers. To ensure that the system remains fair, customers/installers are encouraged to provide evidence that such noncompliance is rectified prior to Evoenergy proceeding with network power quality investigations.

Power Quality Compliance Audit Survey and Benchmarking

Evoenergy participated in a national benchmarking survey of power quality performance which is managed by the University of Wollongong. The survey revealed that Evoenergy's performance is significantly better than the national average. **Figure 21** illustrates Evoenergy's performance across various power quality disturbances.

Figure 21. Network Steady State Voltage Performance By Week



4.2.3 Power Quality – Planning Outcomes

In FY21/22, Evoenergy updated its Quality of Supply Strategy to address contemporary challenges for the network and created a Quality of Supply Operations Plan to support its operationalisation.

The Operations Plan highlights current practices to manage QoS parameters and details short-term new initiatives that address high level performance actions identified in the Strategy. The suite of measures includes uplift in investigation capabilities for customer enquiries, and development of in-house analytical and technical capabilities.

Initiatives that focus on management of voltage implications from high DER penetration are summarised below.

Automatic Voltage Regulation

Evoenergy's Automatic Voltage Regulation (AVR) schemes at zone substations regulate network voltage. These schemes were predominantly designed and installed before distribution networks had large penetration of DER and two-way power flow. AVR schemes at some zone substations are planned to be upgraded enhancing AVR capability to improve voltage regulation in networks with high DER penetration and two-way power flow. AVR upgrades at zone substations are planned where voltage performance is being impacted by DER and in conjunction with related secondary system equipment upgrades at zone substations.

Distribution Substation Monitoring

Evoenergy is installing distribution monitors within existing padmount distribution substations to provide better visibility of voltage profile in areas located towards the end of 11kV feeders. More information on this project is in **Section 6.2.5**.

Ginninderry Energy Pilot Project

Distribution system voltage levels have been observed to experience large fluctuations in areas of the network where there is a high penetration of rooftop PV generation.

The Ginninderry Energy Pilot Project aims to assess the real time implications/outcomes from an electricity-only neighbourhood with a very high penetration of solar PV systems and includes a trial of residential batteries. Evoenergy also installed distribution transformers fitted with an on-load tap changer (OLTC) voltage regulation capability in Stage 1 of Ginninderry. Full cost benefit assessment is applied for broader application of OLTC transformers in the Evoenergy network. More information on this project is in **Section 9.3**.

There are various innovative projects underway to investigate implications of high DER penetration and manage efficient orchestration of these resources with the electricity network. **Chapter 9** highlights such projects that will play a major role in voltage regulation in the future.

Power Quality Issues Management

Evoenergy investigates all instances of identified power quality issues and customer-initiated enquiries. At present, most issues result from the impact of the distributed energy resources on voltage regulation. Depending on the results of investigations, Evoenergy deploys one or more of the following solutions to resolve voltage regulation issues:

- Alteration of distribution transformer tap positions.
- Balancing of loads between phases.
- Conductor upgrades – either overhead lines or underground cables.
- Load shifting – either between low voltage circuits or between distribution transformers.
- Replacement of distribution transformers – typically upgrades.
- Replacement of fixed-tap transformers with transformers equipped with on-load tap changers.

PQCA National Survey and Benchmarking

As part of our proactive approach to power quality management, Evoenergy will continue to participate in the Power Quality national survey managed by the University of Wollongong. The survey allows Evoenergy to monitor power quality compliance within the network as well as relative performance against other Australian utilities.

Proactive monitoring

Evoenergy's proactive program monitors the network steady state voltage (SSV) through analysis of power quality measurements sourced from third-party fixed monitoring assets and existing network and internally derived data (from voltage monitors across the network, sites data logged for business needs etc.). This combination allows for better representation of the power quality throughout the network and enables proactive identification of areas with potential power quality concerns.

The QoS team continues to investigate performance drivers in monitored areas of the network and has noted a number of non-compliant embedded generators. In most cases they are exceeding their approved export limits which contributes to higher SSV during high production periods. As un-approved export to the grid can cause network reliability issues. The QoS team will continue to monitor the situation and where necessary will engage with customers to decrease their export limits.

Smart Metering Data

Integration of smart metering data into Evoenergy's "network visibility plan" and its use in network planning and performance monitoring is of strategic importance under the Distribution System Operator (DSO) strategy. During FY23/24, smart meter data will be used for trial of the network visibility and analytics project. This trial aims for 20% visibility of the low voltage network near or at Evoenergy's network boundary where customers connect to the network.

Standards

Evoenergy maintains standards governing the connection of rooftop generation. The purpose of these requirements is to mitigate the likelihood of network voltage or thermal constraints being compromised.

Appendix G provides a more detailed description Evoenergy's power quality obligations.

Chapter 5: System Load And Energy Demand, And The Supply-Demand Balance

5.1 Introduction

This chapter describes a ten-year forecast of maximum (and minimum) summer and winter electrical load demands for zone substations, bulk supply points and the whole of system. These forecasts are used by Evoenergy to identify constraints in the network. The forecast is a key input into the planning process described in **Chapter 7**.

Load demand forecasting is complex because of its dependence on a number of factors such as climatic conditions, population growth, uptake of embedded generation and emerging technologies, and economic factors such as electricity tariffs.

Load growth varies from year to year and is not uniform across the whole network. It is not unusual to find parts of the network that grow at three or four times the average network growth rate, while other parts of the network experience no growth at all.

ACT Government energy policies

The demand forecast is increasingly impacted by energy efficiency measures, behind the meter small scale and larger scale embedded generation, advances in technology, economic factors, and consumer preferences. In the long term, the demand in Evoenergy will be also increasingly driven by government energy policies such as ACT's zero emissions by 2045 target as well as incentives and mandates driving consumers to change from natural gas to electric appliances and preventing new connections to the natural gas network. These targets would require carbon dioxide emitting energy sources for transportation and gas to be transferred or substituted by alternative energy sources such as electricity or green gas. The overall impact on the network is expected to be significant but varied from location to location depending on the structure of the existing load, consumption trends and distributed energy resources.

Evoenergy has a strategic initiative for ongoing modelling of a zero emissions future. The initiative aims to work with the ACT Government to inform prudent planning for a comprehensive and practical zero emissions roadmap.

Appendix E contains more details on the demand forecasts and methodology.

5.2 System Demand

5.2.1 Historical Demand

Key features of the historical demand over the past 10 years are as follows:

- Summer maximum demand is weather dependent. For example, summer 2012, 2015 and 2022 maximum demands fell below 500 MW due to mild weather conditions with summer 2020 closely behind at 508 MW. The 2019 maximum demand rose above 650 MW due to persistent widespread heat, exceptional heatwaves, and below-average rainfall.
- The highest historical summer peak in real power was 657 MW (2018/19) and the highest winter demand was this past year of 690 MW (2023). This winter peak was a new whole of network maximum demand record.
- The historical winter maximum demand has generally been less variable than summer maximum demand. This is largely due to less variability in weather conditions.
- The hottest day of summer 2022-23 was recorded on Sunday 19th March 2023 where it reached 37.4°C. This did not coincide with the peak summer demand. The peak summer demand was **508 MW** and this occurred on Monday 20th of February 2022 at 6:00 pm (AEDST) after a few moderately hot days. It was a warmer and less wet summer compared to the previous year.
- The 2023 winter period was relatively mild with some especially cold periods. The coldest night was Tuesday 21st June 2023 where a low of –7.2°C was reached, coinciding with the peak winter demand day. The peak winter demand of **690 MW** occurred at 8:00am (AEST) on Tuesday 21st June 2023, which had a maximum temperature of 12.5°C after several days of cold weather and an overnight minimum temperature of -7.2°C.
- In 2023 peak winter demand occurred in the morning. This represents a deviation from 2022 and 2021, where peak winter demand occurred in the evening.
- In comparison to 2022, actual summer maximum demand showed a 15% increase and actual winter maximum demand a 1% increase. Winter maximum demand was over POE10 for the second consecutive year while summer maximum reverted towards POE80. This indicates that the 2022 maximum demand for winter was approximately a 1 in 10 year event.

Figure 22 and **Figure 23** show the daily demand curve for summer and winter days with distinctly different profiles for summer and winter.

Figure 22. 2023 Summer Maximum Demand Day Load Profiles

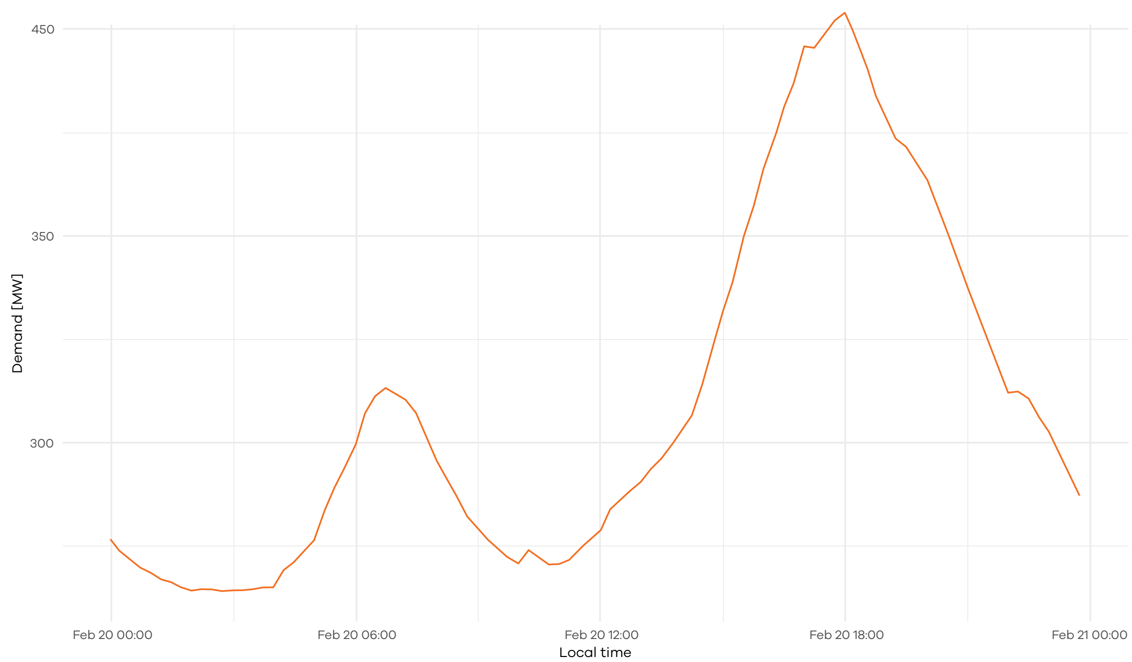
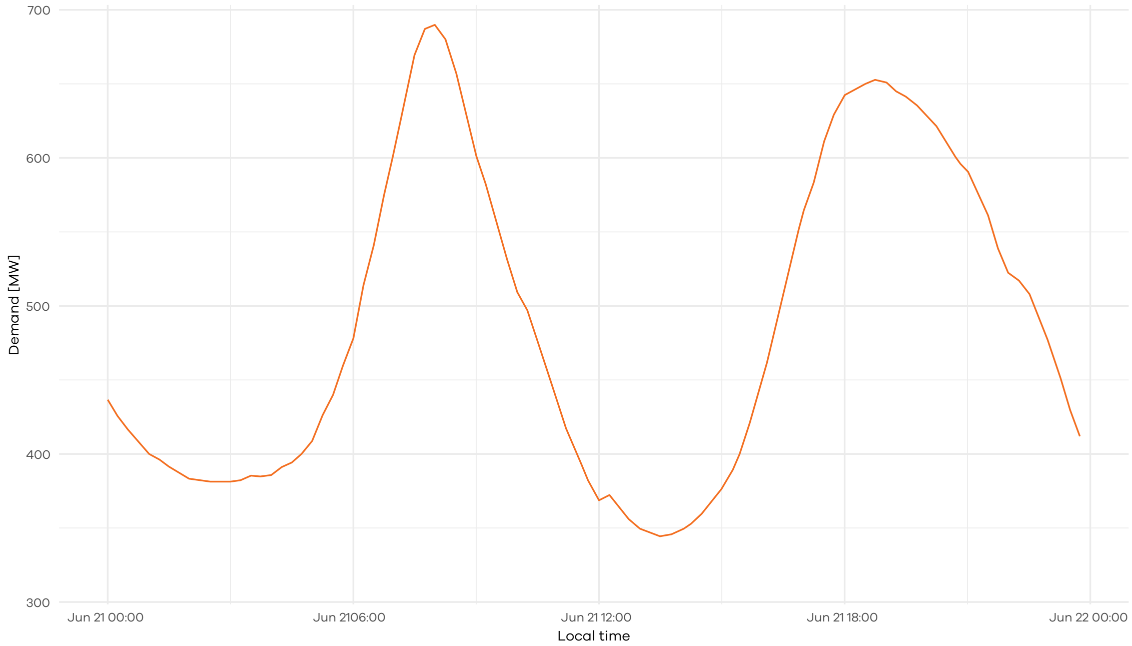


Figure 23. 2022 Winter Maximum Demand Day Load Profiles



5.2.2 System Summer And Winter Maximum Demand Forecast

Factors that influence load forecasts include climatic conditions, economic and demographic trends, and emerging technologies such as solar PV generation, battery storage systems, electric vehicle charging, instantaneous hot water heating systems, energy efficiency schemes, and the increase in the number of all-electric dwellings (particularly apartment buildings).

Evoenergy calculates load forecasts based on 10%, 50% and 90% probability of exceedance. Network planning is based on the medium 50% POE forecast and an additional capacity allowance to cater for credible network contingencies. Evoenergy's summer and winter maximum demand forecasts for the ten-year period 2024–33 are presented in **Figure 24**.

There is a forecast increase in demand which exceeds the trend from historical data. One factor is the predicted significant increases in data centre loads, particularly the construction of Harman Zone Substation which is a customer-initiated project which will be purpose built to supply a large data centre. Another factor is the predicted increase in load from the charging of electric vehicles as numbers increase in the ACT.

System forecast

10-year forecasts based on historical system data estimate a change in peak summer demand of 8 MW per annum and a change in peak winter demand of 12 MW per annum.

Based on forecast 2024[15] peak demand values, this corresponds to an expected change of +12% over the next 10 years in peak summer demand, and +16% over the next 10 years in peak winter demand.

The higher uncertainty of the summer forecast is due to the summer demand being very volatile due to the high variation in weather conditions, whereas winter weather conditions are generally more stable.

The overall projected demand growth is moderate. No new capacity limitations are expected at the system level.

15 2024 forecasts were used this year instead of 2023 actuals as the actuals for both summer and winter were outside one in ten-year events which skewed the comparisons

Figure 24. 10-year whole-system summer and winter maximum demand forecast

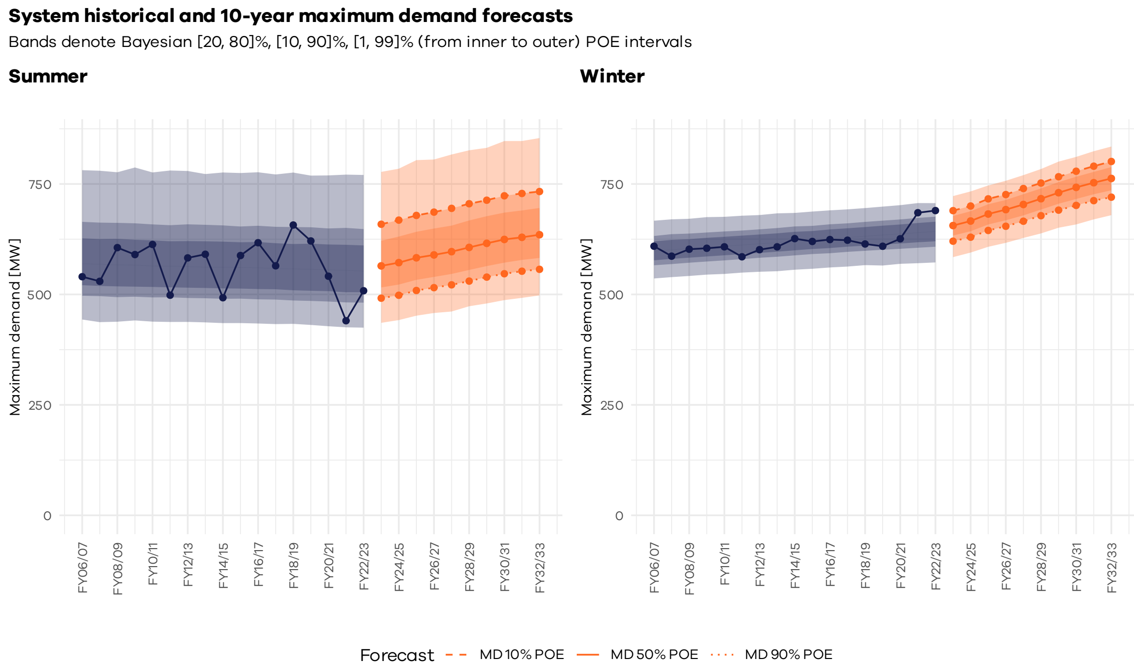


Table 3 provides summer and winter forecast demand (MW) numerical values for three probability of exceedance levels to complement **Figure 24**.

Table 3. 10-year summer and winter maximum demand (MW) forecast.

Year	Summer			Winter		
	POE90	POE50	POE10	POE90	POE50	POE10
2024	491	565	659	620	656	690
2025	489	572	668	630	666	700
2026	509	583	679	645	682	716
2027	515	589	686	654	692	726
2028	522	597	695	666	704	740
2029	530	606	705	678	717	752
2030	539	616	713	691	730	766
2031	547	624	723	701	742	779
2032	552	629	728	712	753	790
2033	557	635	733	720	762	801

Some of the system demand forecast highlights are:

- Historically, the summer maximum demand has fluctuated significantly due to weather conditions. This is why the spread between 90% PoE and 10% PoE of summer forecasts are much wider than the winter forecasts in **Figure 24**.
- Winter maximum demand is forecast to significantly grow over the next 10 years and may further accelerate as we see the likely impacts of higher uptake of electric vehicles and transition away from gas.
- Summer maximum demand is also forecast to grow significantly over the next 10 years although less than winter. This difference is primarily due to the lesser impact of electric vehicle and gas transition growth on the summer peak when compared to the winter peak.

5.2.3 System Summer And Winter Minimum Demand Forecast

In AEMO's 2023 Electricity Statement of Opportunities[16] (ESOO) it is forecast that short term (0-5 years) minimum operational demand across the NEM, including in NSW (which contains the ACT) rapidly declines because forecast uptake of distributed PV grows faster than projected underlying demand.

Medium to long term (5-30 years) minimum operational demand is forecast to continue to decline for the next decade across all scenarios, after which non-coordinated EV update, battery capacity changes, and electrification have a greater impact on the changes in minimum demand.

Figure 25 shows Evoenergy's projection of minimum demand in the system over the 10-year period, to be supplied from Transgrid's transmission network. Evoenergy is required to prepare the minimum forecast for grid stability assessment.

Minimum Demand

Minimum demand is analysed for both day and night[17]. This is because daytime minimum demand is significantly impacted by distributed generation resources, particularly solar photovoltaics whereas the night-time demand is impacted by organic growth.

The total capacity of PV has grown by around 90 MW during the past year. Continual growth in PV installations has led to a decreasing day time minimum demand. If this trend continues, we can expect a net system export in approximately 2035. Noting the high uncertainty in daytime minimum demand forecasts and recent rapid declines, acceleration to this timeline is highly plausible.

Management of the network will become more challenging as synchronous conventional generation is replaced with asynchronous wind, large-scale PV and rooftop PV generation which are subject to intermittency. At times asynchronous sources of generation could exceed the demand. The challenges relate to how the system behaves during disturbances, and how much generation can be dispatched in order to match supply and demand. Power quality issues that could result from an increase in asynchronous generation include voltage regulation, voltage stability, and frequency stability due to a lack of system inertia, and low fault levels which could impact protection schemes.

16 AEMO 2023 Electricity Statement of Opportunities available here: https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2023/2023-electricity-statement-of-opportunities.pdf?la=en
17 Day/night separation is in agreement with AEMO's new point forecasting methodology

Figure 25. 10-year whole-system summer and winter minimum demand forecast

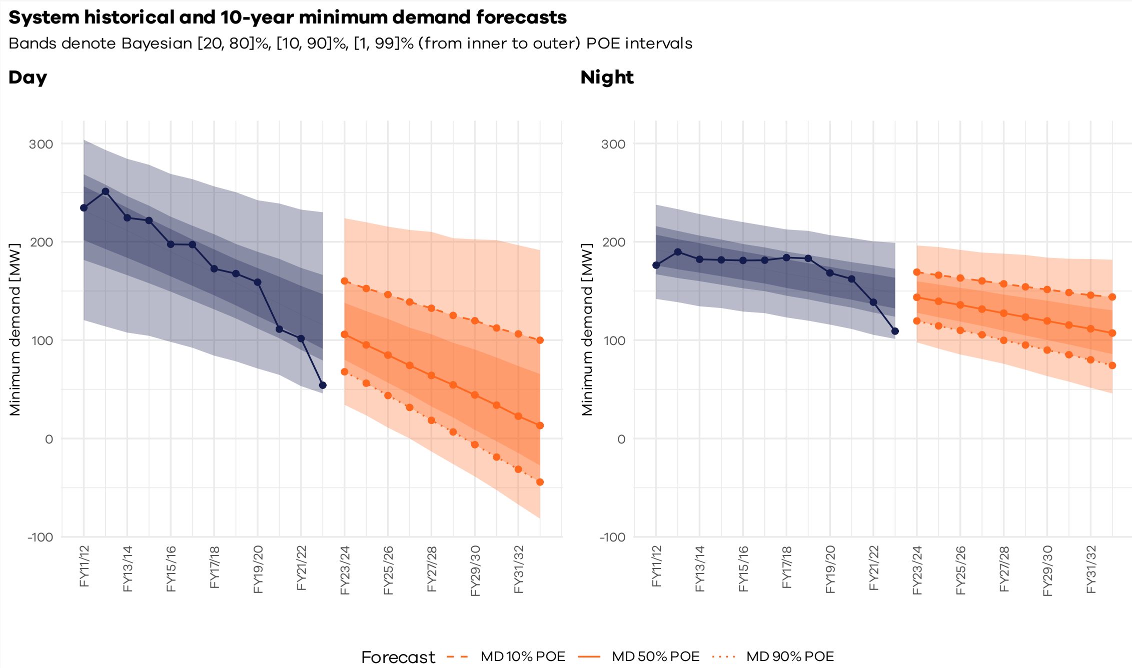


Table 4 provides minimum demand (MW) numerical values to complement the minimum forecast **Figure 25**.

Table 4. 10-Year Whole-System Day And Night Minimum Demand Forecast (MW).

Year	Day			Night		
	POE90	POE50	POE10	POE90	POE50	POE10
2024	68	106	160	120	144	169
2025	56	95	153	115	140	166
2026	44	85	146	110	136	163
2027	32	41	139	105	132	160
2028	18	64	132	100	127	157
2029	7	55	125	95	123	154
2030	-6	44	120	90	120	152
2031	-19	34	112	85	115	148
2032	-31	23	106	80	112	146
2033	-44	13	100	74	107	144

Evoenergy additionally undertakes export forecasting at the system and zone substation level. Evoenergy does not expect any constraints to occur at a zone substation or system level due to export volumes.

A summary of the information is provided in **Appendix E**.

5.3 Zone Substation Load Forecasts

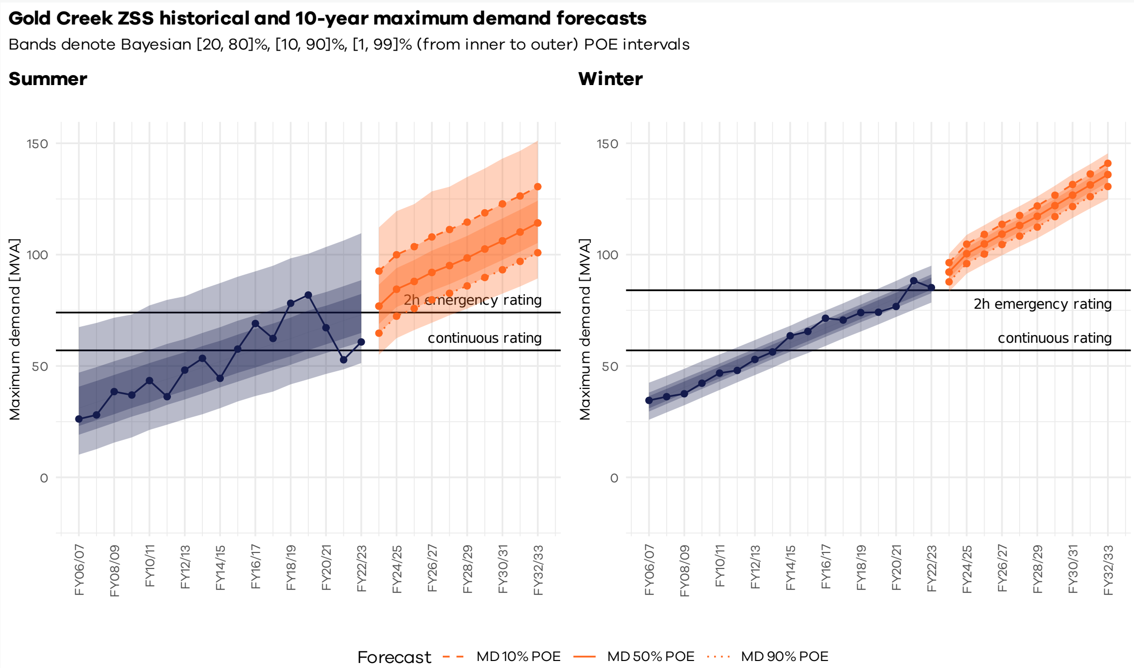
This section provides the highlights of the zone substation demand forecast. The figures below show summer and winter ten-year forecast for selected zone substations shown against substation two-hour emergency rating. **Appendix E** contains the full set of forecast graphs and figures for zone substations.

5.3.1 Gold Creek Substation

Zone substation limitation

Updated forecasts indicate that the winter 50% POE forecast is expected to continue to exceed two-hour emergency ratings on an ongoing basis. Evoenergy has published the draft project assessment report for this constraint as part of a RIT-D process. See **Section 7.6.4** for more detail.

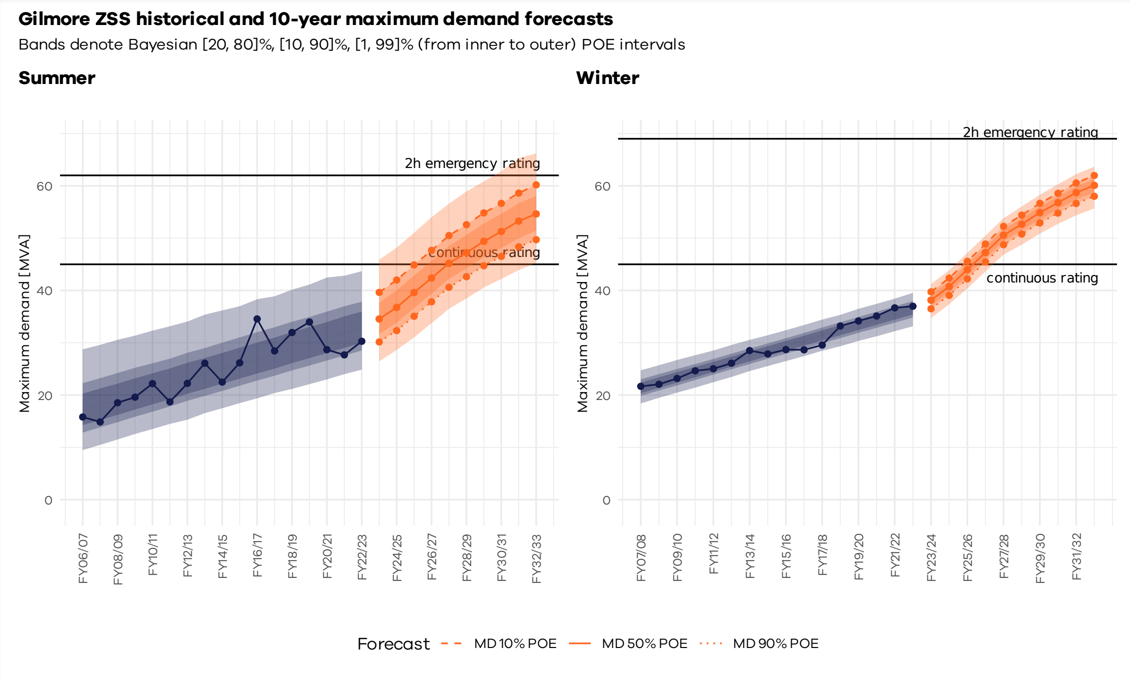
Figure 26. Gold Creek Substation 10-year forecast



5.3.2 Gilmore Substation

Gilmore Zone Substation (ZSS) forecast (**Figure 27**) is expected to have significant load growth in the next 10 years due to the expansion of commercial load in the Hume area, primarily the data centres. It is forecast that the demand will exceed the continuous rating late in the 2024-29 regulatory period. This additional load along with the aged assets in the zone substation and the requirement for additional 11kV circuit breakers due to customer redundancy requirements have triggered work at this zone substation. Please see **Section 7.6.8** for further detail.

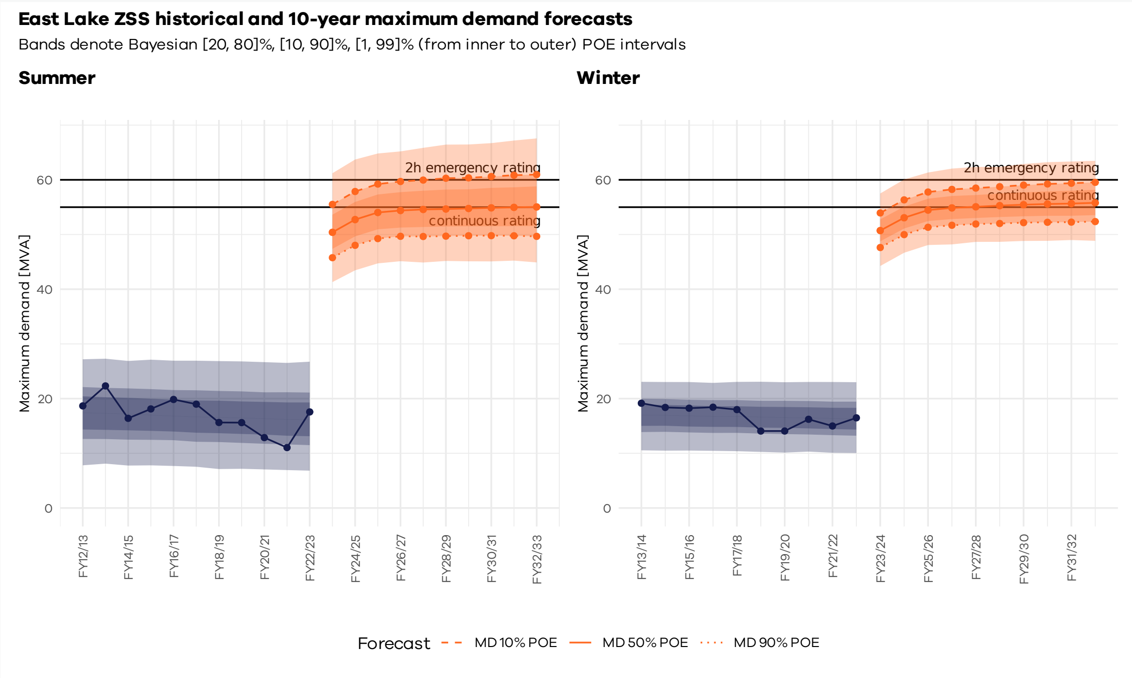
Figure 27. Gilmore Substation 12-year forecast



5.3.3 East Lake Substation

In the forecast shown in **Figure 28** we see a step-change in demand at East Lake Zone Substation. The primary driver for this jump is the transfer of all load currently on Fyshwick Zone Substation to East Lake Zone Substation to enable the decommissioning of Fyshwick Zone Substation. Please see **sections 6.1.4.2** and **7.6.5** for further detail. The other driver of load growth in this area is the increase in commercial load from consumers in the Fyshwick, Causeway and Canberra Airport areas, in particular data centres. It is not anticipated that additional augmentation of East Lake Zone Substation will be required within the 10-year planning horizon.

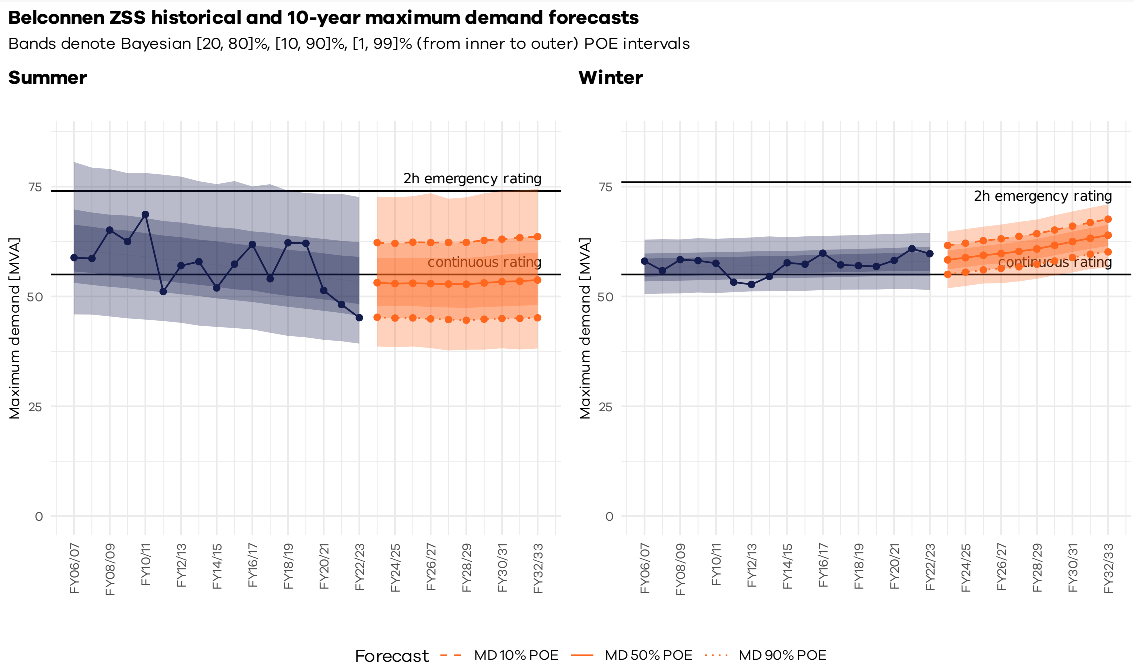
Figure 28. East Lake Substation 12-Year Forecast



5.3.4 Belconnen Substation

Belconnen Zone Substation has been consistently operating above the continuous rating during both the summer and winter peak demand periods for several years. Despite this there is minimal load growth expected during the 10-year planning horizon, with load transfer capacity available in the event of a credible contingency event, so it is not forecast that the zone substation will operate above the emergency 2-hour rating. Should additional load growth occur, Belconnen Zone Substation may require an additional transformer in the 2029-2034 regulatory period. This potential constraint will be monitored. For further detail please see **Section 7.9.2**.

Figure 29. Belconnen Substation 12-Year Forecast

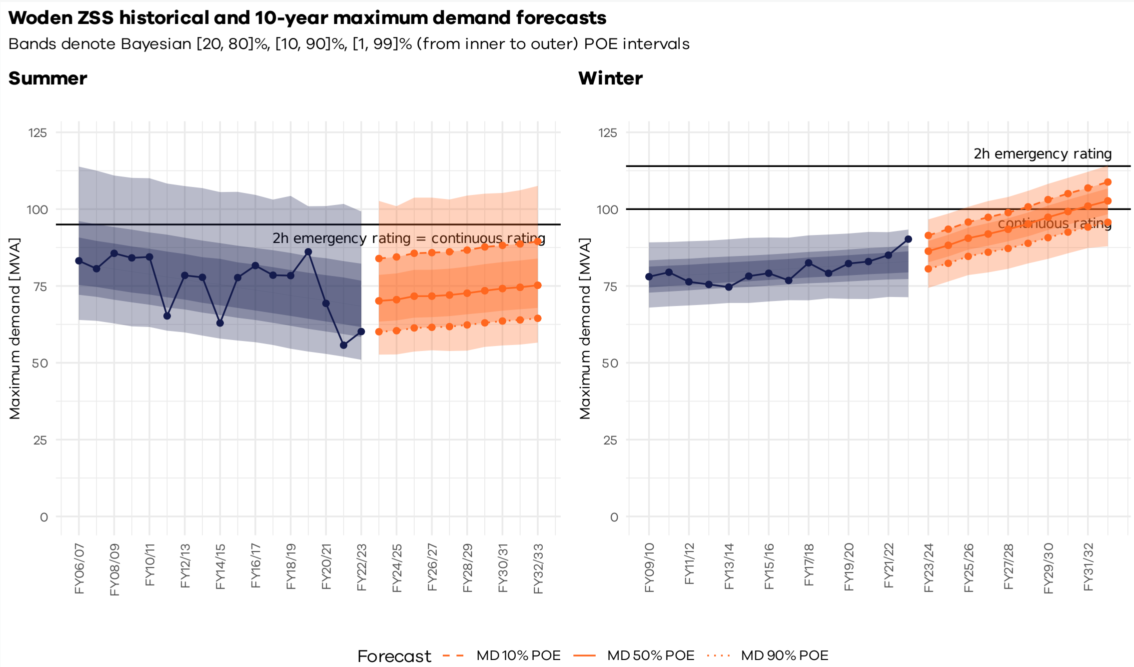


5.3.5 Woden Substation

There is significant load growth expected in the area currently supplied by Woden Zone Substation due to significant redevelopment and urban intensification in the Woden Town Centre areas as well as major residential development in the Molonglo Valley. The growth in the Molonglo Valley will initially be supplied by the proposed Molonglo battery and then the Molonglo Zone Substation. For further detail on this project and the associated RIT-D please see **Section 7.6.1**.

The growth in the Woden Town Centre is expected to cause constraints in the 2029-2034 regulatory period and Evoenergy has proposed a potential new zone substation in the South of Canberra. Please see **Section 7.9.4** for further detail.

Figure 30. Woden Substation 12-Year Forecast



5.4 Load Transfer Capability

Table 5 and **Table 6** show the load transfer capability (MW) between Evoenergy's Zone Substations. Transfer capability is calculated based on 2-hour emergency rating of each zone substation and spare (thermal) capacity of interconnecting 11 kV feeders between substations.

Table 5. Load Transfer Capability (MW) between Evoenergy's Zone Substations in Summer

Zone Substation		To												
		Belconnen	City East	Civic	East Lake	Fyshwick	Gilmore	Gold Creek	Latham	Telopea Park	Tennent	Theodore	Wanniassa	Woden
From	Belconnen		8.5	10.7				13.2	10.1					
	City East	1.0		18.6	0.0					17.6				
	Civic	5.0	20.7					1.9	5.5	11.2				3.6
	East Lake		3.7							11.1				
	Fyshwick				3.5		1.6							
	Gilmore									2.6		2.3	14.5	
	Gold Creek	9.4		1.5					2.7					
	Latham	13.6		6.4				2.2						
	Telopea Park		12.5	6.5	2.7		3.0						3.4	14.9
	Tennent													
	Theodore						5.1						6.2	
	Wanniassa						10.7			5.3		8.4		18.0
	Woden			2.8						8.0			20.0	

Table 6. Load Transfer Capability (MW) between Evoenergy's Zone Substations in Winter

Zone Substation (From)	To: Belconnen	City East	Civic	East Lake	Fyshwick	Gilmore	Gold Creek	Latham	Telopea Park	Tennent	Theodore	Wanniassa	Woden
Belconnen		6.2	5.8					8.0					
City East	1.4		17.1	2.9					22.1				
Civic	6.2	21.0						4.0	6.6				
East Lake		4.9							10.1				
Fyshwick		3.3		11.7		3.0			2.8				
Gilmore											2.6	17.1	
Gold Creek	7.2		1.5					3.4					
Latham	11.9		3.8										
Telopea Park		15.8	11.7	6.9		3.6						3.9	15.8
Tennent													
Theodore						5.3						6.4	
Wanniassa						13.8			1.9		9.6		18.9
Woden			3.4						8.6			21.3	

Chapter 6: Managing Existing Assets

Evoenergy manages network assets on the whole of life cycle basis to optimise network investment and therefore maximise value for our consumers. Asset retirement and renewal decisions are designed to maximise asset utilisation and optimise asset life. A coordinated approach is applied to planning, designing, constructing, operating, maintaining, renewing, and decommissioning our assets. Our Asset Management System is certified against ISO 55001, an internationally recognised standard for asset management.

Risk management is integrated with Evoenergy's asset management decisions. Asset retirement and maintenance decisions are made to manage risk based on health (condition), age, and criticality of assets. Whenever practicable, the whole-of-life asset costs including maintenance are considered to optimise the timing of asset renewal/replacement. Risk centred maintenance philosophy underpins our maintenance regime. Two dominant risk categories in terms of assessed value of risk are reliability and safety.

Furthermore, asset retirement or renewal decisions are coordinated with current and future network development plans to identify possible savings. Asset renewal decisions also support power quality strategy and reliability strategy. This chapter provides information on the primary system assets, the electronic and communications systems (referred to as secondary systems) and information technology applications which are essential to the support of network management and operations.

Chapter 3 provides an overview of the Evoenergy's asset management approach and **Appendix D** includes information on certification of the Evoenergy's Asset Management system against *ISO55001*.

6.1 Primary Systems

6.1.1 Existing assets - what are the main investment drivers?

Network assets are monitored and their asset management strategies reviewed as new information becomes available in relation to asset condition, performance or failure rates. The assets are being inspected, monitored, tested, and maintained to identify and mitigate risk, and address existing and emerging asset needs. The data is used in the revision and updating of the Asset Portfolio Strategies.

The key observations and drivers reflected in the planning outcomes discussed in this chapter include:

- Continuing focus on aging network assets particularly to identify increased risk of failure of critical assets
- The risk profiles of key asset groups are revised upwards (e.g. underground distribution cables and zone substations switchboards)
- Reliability risk remains a dominant driver for investment for most asset classes
- For selected asset classes (e.g. switchboards, earthing), the dominant risk driver is safety of people or property

6.1.2 Portfolio Strategy

Evoenergy prepares asset portfolio strategies (APS) in alignment with the asset management policy, strategy, and objectives. Our APSs address groups of assets and are grouped by asset type and delivery portfolio.

To maximise value for consumers from our assets over the entire asset lifecycle, our APSs consider:

- **Asset Class Overview** – describes the asset type, its function, population of assets and data sources available to develop the plan.
- **Service and Performance** – outlines the service and performance requirements and monitoring needed to meet the asset management objectives.
- **Asset Failure Modes** – Assessing how assets can fail, the likelihood and consequences of failure (FMECA - Failure Mode, Effects & Criticality Analysis) to forecast the risk associated with our assets facilitating reliability centred maintenance to our assets.
- **Asset Class Strategy** – outlines the optimal asset class lifecycle strategy and alternative options considered.
- **Asset Health and Expenditure** – forecasts expenditure (capital expenditure and operating expenditure) for the optimal asset class lifecycle strategy and desired future health of our assets.

Evoenergy's assets are managed by the groups listed in **Table 7**.

Table 7. Asset Groups

Asset Group(s)	Asset Type(s)	Asset Qty	Average Age
Distribution Overhead Network			
Poles	**Total**	**48,726**	**36**
	Concrete Pole	11,568	22
	Fibreglass Pole	4,477	9
	Timber Pole	26,421	50
	Steel Pole	5,874	21
	Cement Fibre reinforced	30	2
Pole Substations	**Total**	**1,379**	**38**
	Pole Substation	1,379	38
Overhead Lines and Pole Hardware	**Total**	**2199 km**	**43**
	Overhead HV Conductors	990 km	35
	Overhead LV Conductors	1,209 km	49
Overhead Switchgear & Automation	**Total**	**12,653**	**15.44**
	Gas Switch	126	7
	HV Link	5,738	9
	Surge Diverter	2,865	8
	Fault Passage Indicator	766	6
	Drop-out Fuse	1,601	33
	Auto-Recloser	48	18
	Air Break Switch	1,503	41
	Load Break Switch	6	9
Overhead Service Conductors	Total	1127 km	30.7
	Overhead Service Cable	1127 km	30.7

Asset Group(s)	Asset Type(s)	Asset Qty	Average Age
Distribution Underground Network			
Distribution LV Switch board Assembly	**Total**	**N/A**	**N/A**
	LV Circuit Breaker	1,489	18
	LV Switchboard	3,833	28
Underground LV Cables	**Total**	**3,805 km**	
	Underground Service Cable	2,172 km	33
	Underground LV Cable	1,633 km	31
LV Pillars	**Total**	**19,068**	
	LV Pillar	15,329	27
	Point of Entry Cubicle	3593	36
Earthing	**Total**	**27,100**	**31**
	Distribution Pole Earthing	14,660	25.5
	Ground Substation Earthing	3,791	31
	Overhead Substation Earthing	1,381	38.7
	Overhead Switch Earthing	1,636	39
	Underground to Overhead Connection Earthing	4,506	43
	Subtransmission Line Earthing	1,126	40
Distribution Substation/ Switching Station Sites	**Total**	**3,791**	**31**
	Padmount Substation	2,558	29
	HV Switching Station	362	35
	Chamber Substation	504	28
	Stockade Substation	6	37
	Kiosk Substation	361	39
HV Switchgear	HV Circuit Breaker	473	22
	HV Switchboard	20	28
Ground Mounted Transformers	**Total**	**3,880**	**29**
	Ground Transformer	3,880	29
Underground HV Cables	**Total**	**N/A**	**N/A**
	Underground HV Cable	1,696 km	39
	Underground HV Feeder	242	36
Ring Main Units	**Total**	**3997**	**27**
	Ring Main Unit	3997	27
HV & LV Pits	**Total**	**3926**	**-**
	HV & LV Underground Pit	3926	-

Asset Group(s)	Asset Type(s)	Asset Qty	Average Age
Zone Substations			
132 kV & 66 kV Air Insulated Switchgear	**Total**	**569**	**34**
	132 kV & 66 kV Circuit Breakers	39	40
	132 kV & 66 kV Current Transformers	144	28
	132 kV & 66 kV Isolators	149	39
	132 kV & 66 kV Voltage Transformers	89	31
	132 kV & 66 kV Earth Switches	37	37
	132 kV Surge Diverters	111	35
Zone 11 kV Switchboard Assembly	**Total**	**458**	**33**
	11 kV Oil Circuit Breakers	129	44
	11 kV Vacuum Circuit Breakers	243	26
	11 kV Earth/Test Trucks	58	36
	11 kV Switchboards	23	35
Power Transformer Assembly	**Total**	**167**	**33**
	Power Transformers	34	35
	Power Transformer 132kV & 66kV Bushings	99	32
	Online Tap Changers	34	37
Other Transformers	**Total**	**53**	**36**
	Auxiliary Transformers	23	34
	Neutral Earthing Transformers	30	38
Gas Insulated & Mixed Technology Switchgear (GIS & MTS)	**Total**	**227**	**8**
	132kV GIS/MTS Voltage Transformers	36	8
	132kV GIS/MTS Earth Switches	62	8
	132kV GIS/MTS Circuit Breakers	27	8
	132kV GIS/MTS Isolators	18	8
	132kV GIS/MTS Current Transformers	84	8
Backup Generator Auxiliary	**Total**	**28**	**15.5**
	Standby Generators	14	14
	Automatic Transfer Switches	14	17

Asset Group(s)	Asset Type(s)	Asset Qty	Average Age
Zone Substations			
Overhead Subtransmission Structures	**Total**	**1514**	**35**
	Concrete Pole	899	28
	Timber Pole	407	45
	Steel Tower	200	47
	Steel Pole	8	3
Overhead Subtransmission Lines	**Total**	**214 km**	**42**
	Overhead conductors	214 km	42
Underground Subtransmission Lines	**Total**	**6.1 km**	**15**
	Underground cables	6.1 km	15

6.1.3 What We Have Achieved During The Year

During the last year, Evoenergy asset replacement focused mainly on the grouped programs for smaller assets. Additionally, power transformer assembly work occurred at Telopea Park and Gilmore zone substations.

Table 8 provides a summary of Evoenergy's asset replacement completed during the last year.

Table 8. Completed Asset Replacement Program

Asset Specific Plan (ASP)	Task	Number of Replacements
Distribution Overhead Network		
OH Switchgear and Automation	Replace Overhead Gas Switch	1
	Replace Surge Diverter	14
	Replace Recloser	3
Poles	Replace Pole	239
Pole Substations	Replace Single Pole Substation	0
	Replace Two Pole Substation	2
Distribution Underground Network (source POW report)		
Distribution Substations / Switching Station Sites	Replace Padmount	7
HV Switchboard Assembly	Replace HV Distribution Circuit Breaker	0
	Replace HV Switchboard	0
LV Pillars	Replace Pillar	72
LV Switchboard Assembly	Replace LV Board	2
	Replace Circuit Breaker	1
LV Pit	Replace LV Pit	7
HV Ring Main Unit	Replace RMU	13
Underground HV Cables	Replace HV Cable Termination	28
	Replace HV transformer tails	9
Underground LV Cables	Replace LV services	49
	Replace LV Underground Cable	24
Power Transformer Assembly	Replace Telopea Park transformer-3	1
	Added Gilmore transformer-2 (yet to commission)	1

6.1.4 Asset Retirement - Planning Outcomes

This section summarises planning review findings related to the existing network assets. The review identified number of network constraints which relate to asset condition and criticality. The review amended previous plans and reprioritised planned asset retirements based on the most recent asset data and the corresponding risk assessment. Evoenergy's plans to retire assets are determined on the basis of assets reaching the end of their economic life in accordance with the *National Electricity Rules (NER) schedule 5.8 (b1).* The section addresses requirements of major assets and separately asset groups.

6.1.4.1 Retirements of major assets

Table 9 below summarises review outcomes which relate to sub transmission and distribution with the value above $200 000 (as per *NER, schedule 5.8(b2)*). Evoenergy portfolio strategy apply a ten year planning horizon for the sub transmission and distribution assets. The table summarises specific assets set for retirement over the next five years. The specific constraints will be subject to further investigations and when appropriate consultations with interested parties with respect to non-network and demand side management solutions. The plans are regularly reviewed and updated to account for the most recent asset performance, condition monitoring and testing information.

Table 9. Identified retirements of major assets

Area	Network Element	Primary Driver	RIT-D	Estimated Cost ($ million)	Consult	Decision	Date Required
Fyshwick Zone Substation	66 kV Assets	Asset condition & performance	No	$2.1m	Jun 2021 complete	Dec 2021 complete	Jun 2024
Latham Zone Substation	Substation Switchboard	Asset condition & performance	No	$3.1m	Dec 2022	Jun 2023	Jun 2025
Wanniassa Zone Substation	Substation Switchboard	Asset condition & performance	No	$3.1m	Dec 2022	Jun 2023	Jun 2026

Interested parties are invited to propose alternative solutions to our asset retirement plan including options to defer investment. Parties considering an alternative investment option to this replacement plan should contact Evoenergy for specific details and up to date information.

Chapter 1 provides information on how interested parties can engage with Evoenergy.

6.1.4.2 Decommissioning Of Fyshwick Zone Substation 66kV Assets

Fyshwick Zone Substation was constructed and commissioned in 1959. It is supplied radially from Transgrid's Queanbeyan 132/66 kV Substation via two single-circuit wooden pole 66 kV sub transmission lines. Fyshwick Zone Substation is the only zone substation on Evoenergy's network that comprises 66 kV assets, with Evoenergy's other 12 zone substations all connected to Evoenergy's 132 kV meshed network.

Primary assets at and supplying Fyshwick Zone Substation are at the end of their economic lives. The two 66 kV sub transmission lines from Queanbeyan to Fyshwick (3.6 km) were constructed in 1959 with wooden poles and Lemon 30/7/3.00 ACSR/GZ conductor. Most of the 52 x 66 kV poles have been reinforced and will require replacement within the next 5 years. The steel core of the ACSR conductor is expected to corrode over time so the Lemon conductor will also require replacement in the near future with AAC, AAAC or similar type conductor.

The 66 kV circuit breakers at Fyshwick are ASEA type; four are 1971 vintage and one 1985. These are nearing the end of their economic lives and will require replacement within the next 5 years. Oil water contamination is likely to impact these units as there are issues with leaking seals due to deterioration. There are no spare units available and Evoenergy is unable to sufficiently maintain the units to extend their life.

Secondary assets such as 66 kV protection relays are also at the end of their economic lives and a risk assessment has shown a high risk of mal-operation which has significant reliability impacts.

Approximately $9.7 million would need to be expended over the next 5 years to upgrade / replace these 66 kV assets.

A project is underway to decommissioning the 66 kV assets at Fyshwick and supply the 11kV from express feeders from East Lake zone substation. See **Section 7.6.5** for further detail on this project.

Figure 31 illustrates the condition of existing assets at Fyshwick 66/11 kV Zone Substation.

Figure 31. Fyshwick Zone Substation: Outdoor wooden pole strung busbars. Indoor 66kV electromechanical protection relays

6.1.4.3 Latham Zone Substation Switchboard Replacement

Latham zone substation was commissioned in 1971 and supplies over 25,000 consumers in the Belconnen district. The original oil filled 11 kV indoor metal clad switchgear remains in service and is approaching the end of its economic service life.

This 11 kV switchgear is increasing in risk to Evoenergy, our consumers and the community. The switchgear contains oil-filled circuit breakers designed in the 1970s which have a history of breakdowns causing unplanned outages to consumers. The condition these assets continues to deteriorate resulting in increasing risk to the health and safety of Evoenergy staff, and reliability of supply to consumers.

It is proposed to replace one 11 kV switchboard at Latham Zone Substation with modern equivalent at an estimated cost of $3.1 million in the period 2024-29. The second Latham 11kV switchboard is planned to be replaced in the period 2029-34.

6.1.4.4 Wanniassa Zone Substation Switchboard Replacement

Wanniassa zone substation was commissioned in 1971 and supplies over 28,000 consumers in the Tuggeranong district. The original oil filled 11 kV indoor metal clad switchgear remains in service and is approaching the end of its economic service life.

This 11 kV switchgear is increasing in risk to Evoenergy, our consumers and the community. The switchgear contains oil-filled circuit breakers designed in the 1970s which have a history of breakdowns causing unplanned outages to consumers. The condition these assets continues to deteriorate resulting in increasing risk to the health and safety of Evoenergy staff, and reliability of supply to consumers.

It is proposed to replace one 11 kV switchboard at Wanniassa Zone Substation with modern equivalent at an estimated cost of $3.1 million in the period 2024-29. The second Wanniassa 11kV switchboard is planned to be replaced in the period 2029-34.

6.1.4.5 Grouped Asset Retirement Plan

This section describes our grouped asset retirement plans. These plans include groups of asset retirements of the same type where individual asset replacement costs are less than $200,000 in accordance with *NER schedule 5.8 (b2).*

Our grouped asset retirement plan is predominantly asset replacement with like for like replacement with modern equivalent solutions.

Although most asset retirements require replacement, the option to decommission the asset is also assessed. Evoenergy has been successful at decommissioning assets which have reached retirement by augmenting the network with non-like-for-like solutions at a lesser cost. For example, distribution substations may be decommissioned where the LV and HV network can be augmented without the need for the substation and retain adequate network reliability.

Our grouped asset retirement plan, as determined in our 5 year Program of Works (POW), is shown in **Table 10**. **Sections 6.1.5**, **6.1.6** and **6.1.7** provide further commentary on respective programs.

Table 10. Identified Group Asset Retirements

Asset Group(s)	2024		2025		2026		2027		2028		Total	
	Qty	Cost ($m)	Qty	Cost ($m)	Qty	Cost ($m)	Qty	Cost ($m)	Qty	Cost ($m)	Qty	Cost ($m)
Ground Assets												
Distribution HV Circuit Breakers	2	0.12	5	0.31	3	0.18	8	0.49	6	0.37	24	1.47
Distribution LV Circuit Breakers	22	0.84	9	0.34	17	0.65	9	0.34	10	0.38	67	2.55
Padmount Substations	4	0.84	4	0.84	4	0.84	4	0.84	4	0.84	20	4.2
LV Pillars	35	0.24	37	0.25	36	0.24	36	0.24	37	0.25	181	1.22
HV underground cables (1)	186	0.39	186	0.39	186	0.39	186	0.39	186	0.39	930	1.95
LV underground cables (2)	8	0.84	8	0.84	8	0.84	8	0.84	8	0.84	40	4.2
HV transformer tails (2)	7	0.06	7	0.06	7	0.06	7	0.06	7	0.06	35	0.3
Underground service cables (2)	18	0.28	18	0.28	18	0.28	18	0.28	18	0.28	90	1.4
	18	0.28	18	0.28	18	0.28	18	0.28	18	0.28	90	1.4
Overhead Assets												
OH Lines and Pole Hardware	872	1.8	511	1.11	511	1.11	511	1.11	511	1.11	2555	5.56
OH Switchgear & Automation	122	0.852	52	0.63	52	0.63	52	0.63	52	0.63	260	3.14
Overhead Subtransmission Lines	6	0.245	8	1.02	20	1.02	20	1.02	25	1.21	81	5.29
Pole Substations	2	0.162	8	0.4	9	0.51	9	0.51	9	0.51	43	2.33
Poles	240	4.55	285	4.55	310	4.949	358	4.715	414	6.609	1652	25.373

1-Quantity in metres

2- Quantity in number of projects

6.1.5 Distribution Overhead Network

This section provides a brief explanation of each grouped program listed in the above table.

6.1.5.1 Overhead Lines and Pole Hardware

Evoenergy's overhead lines and pole hardware replacement program comprises largely pole top replacements. Pole tops include crossarms, insulators and hardware, and they are replaced when these components are defective, but the pole structure is in good condition with years of service life available.

6.1.5.2 Overhead Switchgear and Automation

Asset replacement in the overhead switchgear and automation program is primarily defect driven. This program replaces auto-reclosers, air break switches, drop-out fuses, HV links and surge arrestors that fail in-service or are defective. This is usually due to wear and tear, or damage caused by lighting, wind or vegetation.

6.1.5.3 Pole Substations

Pole substations are replaced when they reach their end-of-serviceable life. Replacement drivers include poor condition of the supporting pole or pole top, and transformer defects such as oil leaks. This program includes replacement of single and two-pole substations. Two-pole substations are of early design (built between 1952 and 1966) constructed using many steel brackets and bolts. These structures are experiencing high levels of corrosion. Thus, most replacements in this program are two-pole substations.

6.1.5.4 Poles

The distribution poles replacement program is a risk-based replacement or refurbishment program. Asset risk is determined from an assessment of the assets' likelihood and potential consequence of failure. This assessment is undertaken following the ground or aerial inspection programs to determine asset condition.

6.1.6 Distribution Ground Network

6.1.6.1 Distribution LV Switchboard Assembly

Distribution LV switchboard assemblies includes LV switchboard panels and LV circuit breaker assets. The program is predominantly driven by operational risk and therefore, is targeting the replacing LV switchboards containing Capstan Links, which are notable because of their exposed live components. Capstan Link switchboards were installed in Evoenergy's network prior to 1975 and may have circuit breakers that utilise asbestos material. These particular switchboards have been prioritised, followed by chamber substation switchboards.

Following the Capstan Link program, older LV Boards containing either exposed live components or types of circuit breakers with known operational and maintenance issues, including those with hazardous materials, will be replaced on risk based assessment.

6.1.6.2 Distribution Substation/ Switching Station Sites

The distribution substation and switching station replacement program is informed by a risk assessment process, with asset condition of switchgear and transformers being a major driving factor influencing replacement. The program only targets ground mounted substations and switching stations.

Some switchgear designed to legacy standards, that have since been superseded with new technical requirements, have a reduced operational reliability and require additional safety management procedures when being operated , such as operating and maintenance restrictions. Reyrolle, Yorkshire, J&P, Statter, Long and Crawford, and MI Australia are examples of legacy HV switchgear that are being targeted for replacement..

6.1.6.3 LV Pillars

The LV pillar replacement program prioritises aged pillars in poor condition. These pillars usually fall in to two categories, the first are streetlight column pillars, owned by Transport Canberra and City Services (TCCS) and colloquially referred to as "Pregnant Columns" and "Henley Pillars", that derive their name from the manufacturer. Henley Pillars usually supply large consumers (mostly commercial) and given the size of the cables connected, require a site-specific replacement solution, which is now possible to be achieved through the use of modern configurable LV pillar installations.

6.1.6.4 Underground LV Cables

The LV cable replacement program is designed to mitigate risk relating to the failure of LV cables. During the last financial year most replacements of in-service cables was unplanned in nature, generally due to degradation, or third-party damage. However, Evoenergy is considering a condition monitoring and testing program which will provide additional data on asset failure rates, life span and risk, including safety risk. Evoenergy intends to utilise these results to develop a structured risk-based approach to LV cable replacements.

6.1.6.5 Underground HV Cables

Evoenergy manages a distribution network with HV cables that are reaching their original design life span. Some of the oldest cables may be of a Paper Insulated Lead Covered Cables (PILC) or XLPE type construction. PILC cables are often present in some of Canberra's older suburbs such as Yarralumla, Reid, Griffith, Barton, Civic, Turner, Reid and Deakin. The oldest XLPE cables include those of the first-generation XLPE, which have shown a shorter lifespan than the more modern generations of XLPE cables and have been identified as a potential operational risk. Initial trials of condition assessment, using on-line partial discharge (PD) testing, has been performed with some success. However, existing methods of prioritisation which considers cable vulnerability and network criticality have remained due to their success at identifying HV cables for replacements.

6.1.7 Subtransmission Network

The subtransmission poles replacement program is a risk-based replacement or refurbishment program. Asset risk is determined from an assessment of the assets' likelihood and potential consequence of failure. This assessment is undertaken following the ground or aerial inspection programs to determine asset condition.

6.1.8 Asset De-rating

NER Schedules 5.8 (b1) and (b2) require Evoenergy to report on asset retirements and de-ratings. **Table 9** summarises identified retirement of assets above $200,000. **Table 10** identifies programs for grouped small asset renewals and replacements.

During the last year Evoenergy did not de-rate any distribution or subtransmission assets.

6.1.9 Vegetation Management

Vegetation management is an important part of Evoenergy operations which promotes safety and reliability of network assets.

An amendment was made to the *Utilities (Technical Regulation) Act 2014* via the *Utilities (Technical Regulation) Amendment Bill 2017*, which became effective on 1 July 2018. This amendment transferred the responsibility for vegetation management from ACT Government department Transport Canberra City Service (TCCS) to Evoenergy.

Vegetation coming into contact with overhead power lines can cause transient or permanent disruption to supply. Transient faults are usually caused by short-term contact of vegetation with conductors and are normally cleared by the actions of automatic reclosers.

Evoenergy has also installed several pulse-close intelligent reclosing devices with a "bushfire algorithm" designed to detect high impedance "lines down" events to help to prevent bushfires due to vegetation on lines.

6.2 Secondary Systems

Secondary systems support operation of the primary network assets. This section addresses the following key secondary systems:

- Supervisory Control and Data Acquisition (SCADA) system which enables network operation, control or switching, monitoring and data acquisition.
- Telecommunication system which supports network protection, SCADA, telephony, video, and corporate data services
- Protection systems which enable fault clearing, isolation and protection of network equipment, and enhance safety of operations.
- This section provides information on the current challenges, main secondary system projects progressed or completed over the last year, and projects proposed for the forthcoming period.

The future programs are developed within the Evoenergy Asset Management framework. **Chapter 3** and **Appendix D** describes the Evoenergy Asset Management Framework and the approach to asset management. **Appendix H** includes additional description of the network technical parameters and systems.

6.2.1 Secondary Assets - What Are The Main Challenges?

Evoenergy is regularly monitoring network secondary assets and assessing operational risks, compliance requirements, and future network needs. Compliance requirements are derived from the NER, technical codes, and Australian standards.

The main current challenges and drivers of the Evoenergy investment in secondary systems are:

- Compliance with the NER requirements in relation to the fault clearance times and duplicate systems for subtransmission assets
- Concerns in relation to reliability of some of the existing protection assets in zone substations given their obsolescence
- The need to replace old damaged and failing pilot cables used for 11 kV feeder unit protection and SCADA communications
- The need for increased speed, capacity, and reach of the telecommunication systems to support our operations
- Increased SCADA data requirements for effective management of DER in the low voltage network
- Protecting secondary assets from cyber security threats.

6.2.2 SCADA

SCADA, which stands for Supervisory Control And Data Acquisition, is becoming an increasingly key component of Evoenergy's day to day electrical network management.

SCADA provides essential remote monitoring and control of electrical assets to Evoenergy's 24/7 Control Room, allowing the control team maintain an overview of the network state and respond to electrical outages, load constraints and power quality issues in real time. It also provides key historical data to engineering teams to inform decisions on future network augmentation requirements, proactive power quality remediation programs and asset health condition assessment for targeted asset replacement.

SCADA systems are deployed at all of Evoenergy's zone substations, providing monitoring and control of all transformers, switchgear and other supporting substation auxiliary systems. Evoenergy's recent transition to IEC61850 based digital substation automation systems has provided additional SCADA data and capability for zone substation assets to assist with overall network management. Additional information on Evoenergy's IEC61850 digital substation approach for zone substations can be found in **Section 6.2.6**

SCADA is also increasingly being installed on a distribution substation level within both Chamber and Padmount distribution substations. This is primarily driven by the need for additional monitoring and control on a LV network level to effectively manage the challenges of increased embedded generation penetration, connection of residential batteries and charging of electrical vehicles. Evoenergy currently has SCADA monitoring at around 10% of distribution substations with the aim to increase this to 20% over the next few years. Recent

technological developments in low-cost retrofittable SCADA monitors have provided the capability to efficiently incorporate SCADA within older substations in older ACT suburbs. Additional details on Evoenergy's distribution substation monitoring program can be found in **Section 6.2.5**.

6.2.3 Protection

Protection assets are located within Evoenergy zone substations, switching stations, and distribution substations, and are used to isolate faults with electrical equipment, subtransmission lines and distribution feeders. The protection systems ensure reliable and safe operation of the network by isolating faulty sections of the network. The correct operation of the protection systems limits impact of faults on the system stability and potential damage to network infrastructure.

Evoenergy has identified the need to replace a number of protection relays that have reached end-of-life. These relays are integral to the safety and security of the network.

While asset condition is the primary driver supporting protection replacement projects, there are additional benefits from the installation of modern numerical relays including automated condition monitoring, distance to fault measurement, comprehensive power measurement, and combined protection and control in one device.

Evoenergy's 2023-27 protection renewal program includes the following:

- Upgrade protection and install 132 kV line differential protection using the new OPGW optical fibre network at Belconnen ZSS (completed in 2021), Wanniassa ZSS, Woden ZSS and Gilmore ZSS.
- Condition-based replacement of 11 kV feeder protection at Woden ZSS, Wanniassa ZSS City East ZSS, and Theodore ZSS.
- Condition-based replacement of transformer protection at Telopea ZSS, City East ZSS Theodore ZSS, Gilmore ZSS and Belconnen ZSS.
- Condition based replacement of 132kV bus protection at Gilmore, Wanniassa, City East, Theodore, Gold Creek and Belconnen ZSS
- Voltage Regulation System Upgrades at zone substations.

6.2.4 Telecommunication Systems

Evoenergy's telecommunication systems are required to service a wide range of business requirements including network protection, SCADA, metering, security, telephony, video, and corporate data services. The telecommunications strategy is developed around delivering a unified communications network to provide multiple services while maintaining cyber security and meeting individual service performance requirements.

The primary purpose of the telecommunications network is the support of ADMS/SCADA and protection of network assets.

Evoenergy has established an optical fibre network to replace aged communications bearers, such as copper pilot cables and radio. This network uses hybrid OPGW (optical fibre ground wire) cables, ADSS (aerial dielectric self-supporting) and UG (underground) optical fibre cable. Installation of OPGW involved replacing the existing overhead earth wire on 132 kV subtransmission lines to provide optical fibre communications capability. The optical fibre network is required to meet the following regulatory and business needs:

- Upgrading our 132 kV subtransmission line and 11 kV feeder protection systems to meet current NER network performance standards, ensuring regulatory compliance, and safety for the community.
- Providing SCADA communications for zone substations and distribution switching stations.
- Providing communications for security monitoring of substations.

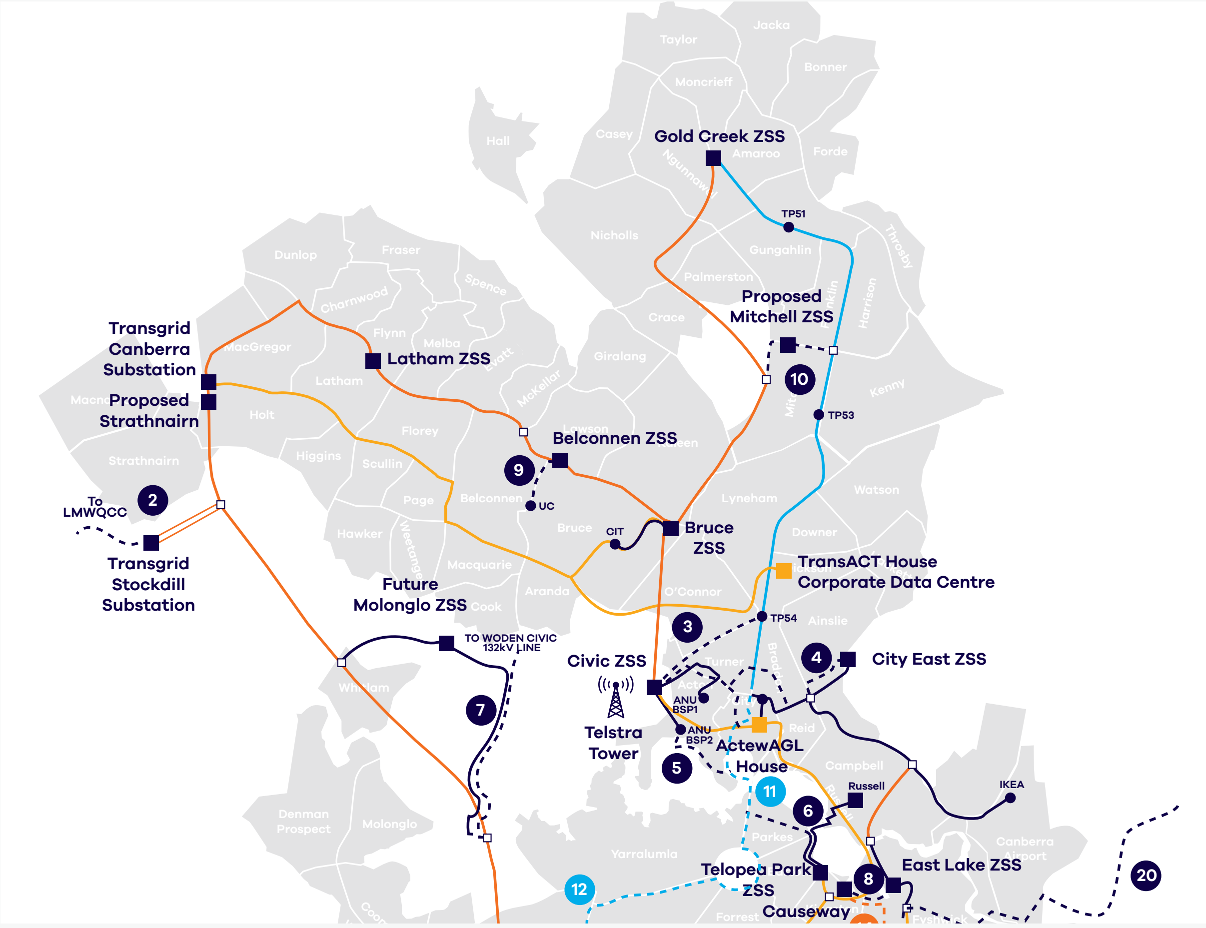
Other telecommunications upgrade programs include:

- Replacement of aging communications assets used in operational networks, providing improved visibility/control and reliability for ADMS/SCADA.
- Progressive replacement of radio equipment in the SCADA Digital Data Radio Network (DDRN) and migrating radio systems to Mobile Network Carriage such as the 4G/5G network, or optical fibre where it exists. This program will replace SCADA data radios as they reach the end of their serviceable life and is nearing completion.

Figure 32 and **Figure 33** show current and proposed communications network fibre projects as follows:

- Current UG Fibre Projects
  3. Dooring Feeder Fibre
  4. City East Redundancy Fibre
  9. Belconnen–UC Fibre
  15. Soward–LDK Fibre
  16. Fyshwick Express Feeders Fibre
  17. Canberra Av to Bonshaw Fibre
- Proposed UG Fibre Projects
  5. ANU–Nishi Fibre
  6. Kings Av to National Library Fibre
  8. Causeway Decommissioning 132 kV line & Fibre
  10. Mitchell ZSS UG 132kV line & Fibre
  19. Wanniassa–Woden Bus Interchange Fibre
  20. Eastlake–Pialligo Fibre
  21. Civic–CBD West/East Fibre
- Proposed Light Rail UG Fibre Projects
  11. Stage 2A City–Commonwealth Av
  12. Stage 2B Commonwealth Av – Woden
- Current OPGW Fibre Projects
  13. Canberra Av 132 kV line (dual)
- Proposed OPGW Fibre Projects
  14. Canberra Av to Jerrabomberra Creek
  18. Woden–Wanniassa 132 kV line replacement & Fibre

Figure 32. Fibre Optic Network – Northern ACT



Legend

- Existing OPGW
- Proposed OPGW
- Existing UG Optical Fibre
- Proposed UG Optical Fibre
- Existing Leased Fibre
- Existing UG Metro Optical Fibre
- Proposed UG Metro Optical Fibre
- External splice point
- Zone Substation
- Chamber Substation
- Office Data Centre
- Radio Communications Site

Current UG Fibre Projects

2 Stockdill-LMWQCC Fibre

3 Dooring Feeder Fibre

Upcoming UG Fibre Projects

4 City East Redundancy Fibre

Proposed UG Fibre Projects

5 ANU-Nishi Fibre

6 Kings Av to National Library Fibre

7 Molonglo ZSS UG 132kV line & Fibre

9 Belconnen-UC Fibre

10 Mitchell ZSS UG 132kV line & Fibre

20 Eastlake-Airport UG Fibre

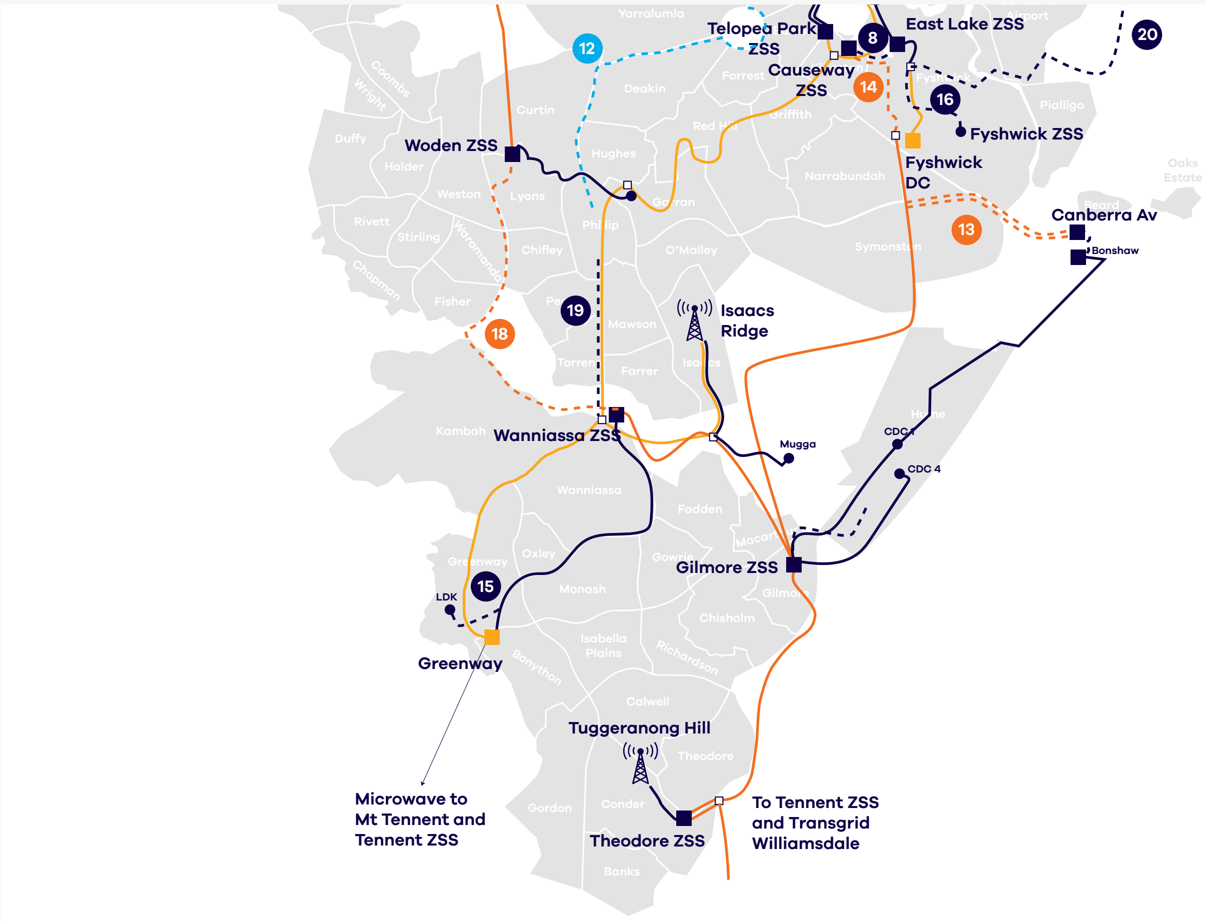
21 Civic-CBD UG Fibre

Proposed Light Rail UG Fibre Projects

11 Stage 2A City-Commonwealth Av

12 Stage 2B Commonwealth Av - Woden

Figure 33. Fibre Optic Network – Southern ACT



Legend

- Existing OPGW
- Proposed OPGW
- Existing UG Optical Fibre
- Proposed UG Optical Fibre
- Existing Leased Fibre
- Existing UG Metro Optical Fibre
- Proposed UG Metro Optical Fibre
- External splice point
- Zone Substation
- Chamber Substation
- Office Data Centre
- Radio Communications Site

Upcoming UG Fibre Projects

- 15 GDC-LDK Fibre
- 16 Fyshwick Express Feeders

Proposed UG Fibre Projects

- 8 Causeway Decommissioning UG 132kV line & Fibre
- 19 Wanniassa-Woden Bus Interchange UG Fibre
- 20 Eastlake-Airport UG Fibre

Proposed Light Rail UG Fibre Projects

- 12 Stage 2B Commonwealth Av – Woden

Upcoming OPGW Fibre Projects

- 13 Canberra Av 132kV line (dual)
- 14 Gilmore-Causeway Line (extension Canberra Av to Causeway)

Proposed OPGW Fibre Projects

- 18 Woden-Wanniassa 132kV line replacement & Fibre

6.2.5 Distribution Substation Monitoring

In 2019 Evoenergy installed 150 IoT low voltage distribution monitors within existing padmount distribution substations to provide better visibility of voltage and load in the low voltage network. Evoenergy is continuing the distribution monitoring program in 2023 and 2024 with the installation of additional monitors in strategically selected areas of the network. These are typically substations towards the end of 11kV feeders where voltage dip and rise is more prevalent and also substations that are highly loaded or with high levels of PV and other distributed energy resources.

The program will address emerging network constraints and voltage issues arising from consumers' energy generation, storage, and emerging technology use. The program will provide opportunities, through improved visibility, to efficiently remediate problems proactively, avoid unnecessary augmentation and asset replacements in brownfield areas, and deliver better network planning and investment outcomes in new developments. Inputs from the monitoring will feed into the ADMS state estimation and load flow functionality and provide better view of the overall network load and power quality performance. More information on power quality and the challenges Evoenergy has with maintaining voltage compliance can be found in **Section 4.2**.

6.2.6 Substation Automation Systems - IEC 61850

Evoenergy is currently working on upgrading the substation automation systems for numerous Zone Substations across the ACT. These systems will utilise the latest industry developments in protection and SCADA technology and will be based on the IEC 61850 international standard. The IEC 61850 standard provides tools which assist in the implementation of substation automation systems including communications protocols that allow Intelligent Electronic Devices (IED) such as protection relays to exchange high speed messages and standard data structures that allow IEDs from different vendors to be easily integrated.

The IEC 61850 approach provides many benefits over a conventional approach including:

Safety Benefits

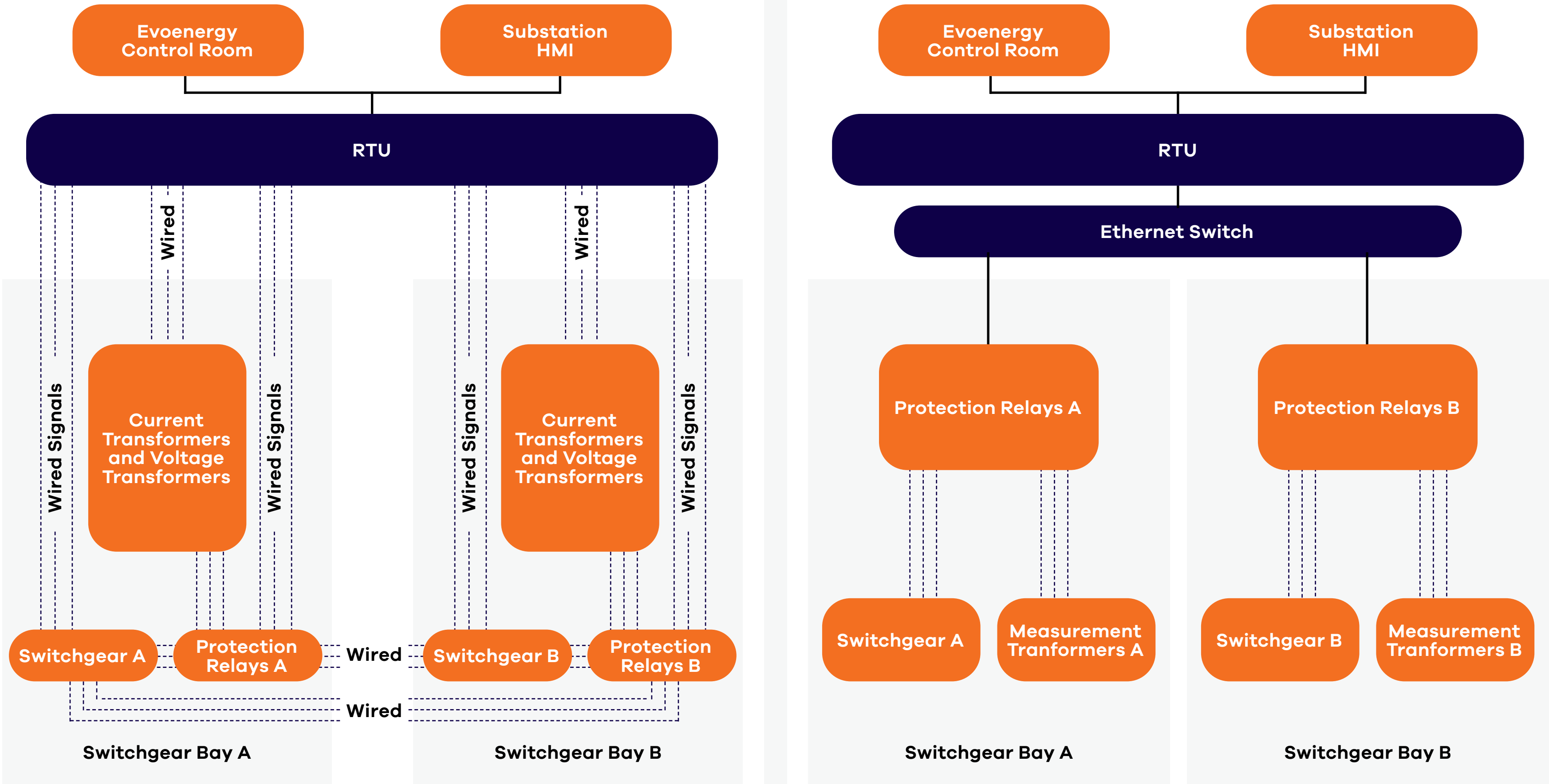
- Reduced requirement for DC wiring in protection panels. Communication between IEDs (Intelligent Electronic Devices) within the substation utilise fibre optic ethernet networks rather than hardwiring
- Increased visibility and reporting on communications and overall system health
- Additional controls to avoid errors during testing and maintenance activities.

Financial Benefits

- Reduced material costs due to less hardwiring
- Reduced design time due to simplified drawings and schematics
- Reduced engineering time due to standard file types and templates (defined by the IEC 61850 standard)
- Greater flexibility and reduced cost in upgrading existing schemes – existing IEDs within the substation can be updated/reconfigured with software rather than having to run additional physical wiring or introduce new devices
- Greater support and system longevity as vendors and other DNSP/TNSPs are also moving towards modern digital substation approaches utilising IEC 61850.

The following diagram provides a simplified overview of the differences between Evoenergy's conventional approach compared to our new digital approach utilising IEC 61850.

Figure 34. Representation of IEC 61850 substation compared to legacy scheme



Legacy Scheme

Extensive substation wiring:

- Between RTU and switchgear bays (for SCADA applications)
- Between switchgear bays (for protections applications

Digital Substation Utilising IEC 61850

IEC61850 protocol communications for signals over ethernet networks for both SCADA and protection applications, eliminating the need for wiring external to individual switchgear bays.

6.2.7 Advanced Fault Detection and Auto-Reclosing Schemes

Electricity distribution networks inherently involve bushfire risk to the environment and the community. Evoenergy is trialling a new type of switchgear primarily to reduce the risk of bushfires. Our bushfire management plan includes trailing this new type of switchgear to reduce bushfire risk on overhead distribution lines traversing high bushfire risk areas.

This includes installation of pulse closing S&C Intellirupters /or Nojas Reclosers(as applicable) on overhead 11 kV feeders as an option to replace or supplement traditional reclosers. A recloser automatically opens and recloses upon the passage of a high-level fault current. The high level of fault current passage during the reclose operation can cause localised heating of line conductors and generation of sparks that could potentially start a grassfire or bushfire. This is a risk to the community especially during extremely dry summer months.

This technology sends a low energy pulse of current down the line to detect if the fault has cleared before initiating a reclose operation. This significantly reduces the amount of current during reclosing and thus reduces the possibility of a resulting bushfire. This also reduces the possibility of damage to cable sections of a feeder. Evoenergy and the switchgear supplier have jointly developed a Voltage supervised Sensitive Earth Fault (V-SEF) protection "bushfire algorithm" that will detect very low energy earth faults to isolate and clear such faults. Such faults are typically caused by vegetation contacting overhead conductors and can cause localised heating that could lead to a bushfire.

In addition, a series of reliability improvement projects are being undertaken which would involve installing the new NOJAs reclosers on feeders subjected to high frequency of fault occurrences. .

6.2.8 What We Have Achieved In The Last Year

During last year Evoenergy completed or progressed and number of secondary system projects including:

1. Continued developing and implementing next generation IEC 61850 digital zone substation secondary systems with zone substation and distribution substation projects.
2. Implemented SCADA and protection systems for new and upgraded connections at three customer sites with large scale embedded generation. Moreover, entire SCADA and protection scheme has been replaced at one of the legacy large scale embedded generation sites.
3. Installed SCADA monitoring and control for 28 new distribution substations improving visibility and remote switching capability in the 11 kV network.
4. Installed on-load tap changers for 15 new distribution transformers, improving voltage stability in areas with high penetration of rooftop solar.
5. Installed 126 network analyser devices to provide remote monitoring and capture of power quality data and events.
6. Installed new human machine interface and remote terminal unit at Gilmore zone substation to prepare for future IEC61850 digital zone substation system upgrade.
7. Gilmore zone substation installation of Transformer-2 and related primary gear, 11kV switchboard and ongoing works for related secondary systems integration.
8. Replaced Gold creek zone substation legacy remote unit and Woden zone substation remote terminal unit digital output card.
9. Migrated 50 sites from legacy communications to 4G or fibre.

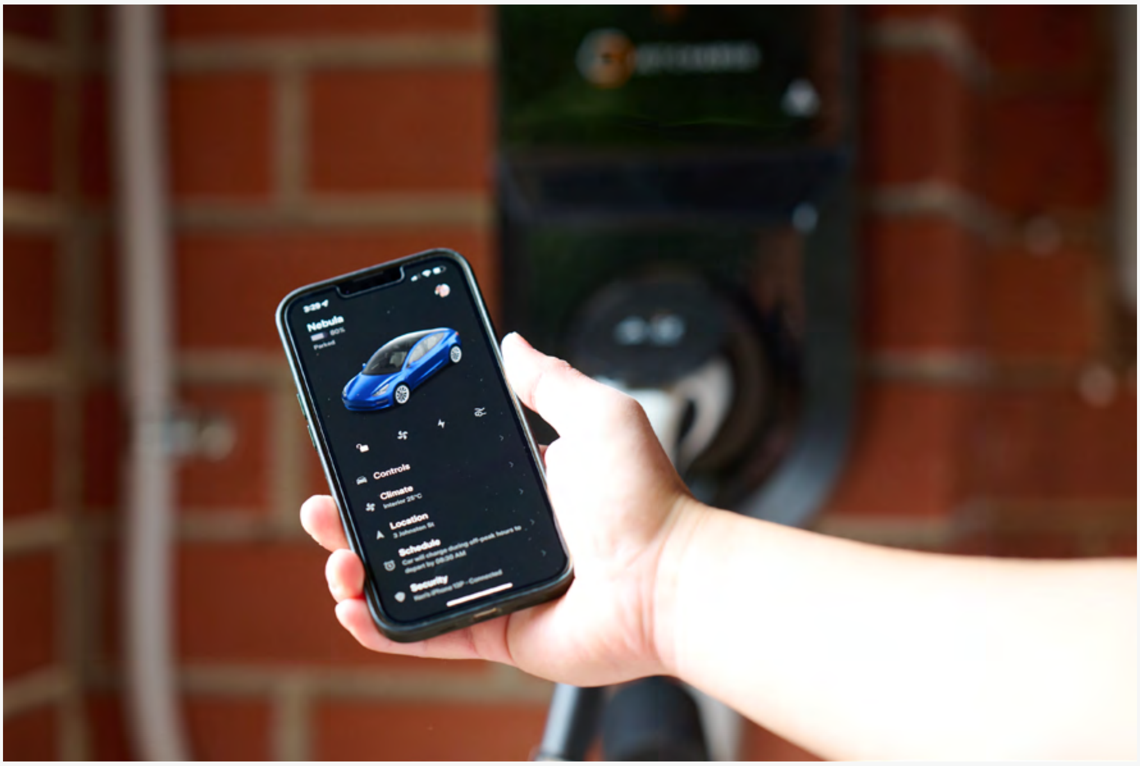
6.2.9 Secondary System - Planning Outcomes

Evoenergy assesses secondary assets needs and risks considering asset conditions, performance, compliance, criticality, and safety. The structured analysis of the needs is conducted in accordance with the Evoenergy Asset Management System Requirements and documented in the Portfolio Strategy. **Chapter 3** provides more details on the Evoenergy Asset Management approach. **Appendix H** includes additional description of the network technical parameters and systems.

Table 11 provides a summary of the secondary system projects systems planned for the five-year period. The program is being continually review and updated in accordance with the most recent data and information.

Table 11. Secondary System Projects

Constraint/Need	System	Timeframe	Driver	Total Cost ($ million)
Distribution Substation Monitoring	SCADA, Communications	2022-29	Quality Reliability	$2.7m
Voltage Regulation System Upgrades	SCADA, Protection	2022-29	Quality Reliability	$1.6m
Secondary Systems Cyber Security Program	SCADA, Communications	2021-25	Safety Reliability	$1.9m
Woden ZSS Protection Replacement	Protection	2021-24	NER compliance Safety Reliability	$2.08m
Woden ZSS HMI and IEC61050 Automation Upgrades	SCADA	2021-23	Safety Reliability	$0.25m
Telopea Park ZSS Protection Replacement	Protection	2021-24	NER compliance Safety Reliability	$2.08m
Telopea ZSS HMI and IEC61050 Automation Upgrades	SCADA	2021-24	Safety Reliability	$0.25m
Gilmore ZSS Protection Replacement	Protection	2024-29	Reliability NER compliance Safety	$2.4m
Gilmore ZSS HMI and IEC61050 Automation Upgrades	SCADA	2024-29	Safety Reliability	$0.25m
Belconnen ZSS Protection Replacement	Protection	2024-29	NER compliance Safety Reliability	$2.4m
Theodore ZSS	Protection	2024-29	NER compliance Safety Reliability	$2.4m
City East ZSS	Protection	2024-29	NER compliance Safety Reliability	$2.4m
Belconnen ZSS RTU, HMI and IEC61050 Automation Upgrades	SCADA	2024-26	Safety Reliability	0.45m
Wanniassa ZSS Protection Replacement as part of switchboard replacement	Protection	2024-29	NER compliance Safety Reliability	$1.6m
Latham ZSS Protection Replacement as part of switchboard replacement	Protection	2024-29	NER compliance Safety Reliability	$1.6m
Wanniassa ZSS HMI and IEC61850 Automation Upgrades	SCADA	2028-29	Safety Reliability	$0.45m
Distribution Network Pilot Cable Replacement (optical fibre)	Communications	2021-25	NER compliance Safety Reliability	$1.3m
SCADA Network Radio Replacements	Communications	2021-23	Safety Reliability	$0.4m
Zone Substation WAN Router Upgrades	Communications	2021-24	NER compliance Safety Reliability	$0.6m
Chamber Substations RTU Replacements and Upgrades	SCADA	2024-29	Safety Reliability	$1.2m



6.2.10 Consumer Metering

The primary purpose of meters is to record energy consumption for billing purposes.

In 2017, the Australian Energy Market Commission (AEMC) introduced the Power of Choice regulatory reforms governing electricity metering arrangements in the ACT. All new and replacement meters installed post 1 December 2017 are required to be smart meters (classified as Type 4 meters under the NER). The new regulations also shifted responsibility of replacing or installing meters to electricity Retailer's and their nominated metering co-ordinator (MC). Under the new regulations Evoenergy, is no longer permitted to install or replace meters.

Evoenergy continues to manage a fleet of approximately 135,000 (Type 6 basic) revenue meters. These meters are managed in accordance with NER requirements, and Evoenergy's Metering Asset Management Plan. Under the plan, Evoenergy's role is to maintain and test the existing meter fleet, but not to install new meters or replace existing meters.

The number of Evoenergy's meters continues to reduce each year as existing meters are replaced, due to malfunction, age and other factors. This is occurring at a rate of approximately 1,000 per month. Under the AEMC's smart meter roll out proposal, all Type 6 basic meters are required to be removed from the distribution network by 2030. The proposed rule change is set to come into effect on 1 July 2025. To assist Retailers and their MC's meet the defined 2030 target, Evoenergy is tasked with developing a Legacy Meter Replacement Plan (LMRP) that will co-ordinate the replacement program.

6.3 Information and Operational Technology – Planning Outcomes

Our Information Technology (IT) programs are focused on extending and enhancing our long-term strategic technology capabilities ready to adapt to a net zero future and maintaining the quality of our services to our customers. Our architecture incorporates the adoption of new technology through upgrade cycles for existing systems and new system implementations when required. The investments we have undertaken in 2023, or plan to undertake over the forward planning period 2024-2028, are outlined below.

6.3.1 Customer engagement

Our IT customer engagement initiatives seek to deliver more control to customers making it easier to communicate and work with Evoenergy.

In 2023, we replaced our end-of-life contact centre and interactive voice response system (IVR). Our new solution improves our ability to provide timely information to the community regarding the status of our energy networks. In addition, the new solution enhances the redundancy and reliability of the contact centre solution.

In 2024, we are continuing to invest in our customer channels with the release of an updated website and further enhancements in our digital communication with the community.

6.3.2 Network operations

Following the completion of our major ADMS system upgrade, we are planning for upgrades to our geospatial systems commencing 2023. Our upgrade path will lead towards the adoption of a utility network model, and a simplification of our architecture through system consolidation and the adoption of modern integration techniques.

A key component of the GIS upgrade is the adoption of a modern Web-GIS based self-service architecture referred to as the ArcGIS Enterprise Platform. This allows web applications and maps to be easily created, managed, and deployed, and enables the sharing of content with partner agencies and third parties in a modern service-oriented manner. The increased flexibility in data sharing supports our strategic objective to integrate flexibly with stakeholders.

In upgrading our GIS solution, we will be adopting the GDA 2020 geospatial datum.

6.3.3 Metering and billing

We continue to make incremental improvements to our metering and billing system and provide updates to the system tariffs each year to incorporate annual changes. In 2024, more substantial tariff changes will be made within the billing system to reflect the introduction of new tariffs for the 2024 – 2029 period.

Throughout the early stages of the 2024 – 2029 period, we will be working with our metering and billing system provider to understand options to transition from our existing on-premise version of the system to the recently released cloud hosted platform. It is likely that a major upgrade will occur later in the 2024 – 2029 period.

6.3.4 Asset management

Upgrades to our asset management system through 2023 have ensured our ability to apply updated configuration to support enhancements to data capture and workflows associated with enhancing the granularity of data available to inform asset planning. Through 2024 we will continue to evolve our asset management systems with a view to further optimising asset planning.

6.3.5 Works management

In 2023 we have completed the first in a series of version upgrades to our works management system, as we seek to significantly simplify the platform and remove customisations. These upgrades will facilitate the adoption of modern works management capabilities within the core product suite. The upgrades will support the continuing evolution of digital workforce tools and mobility, reducing the need for 'add-on' solutions.

In 2024, as further version upgrades are completed, we will be seeking to enhance works planning processes leveraging our works management system.

6.3.6 Supporting systems

During 2023, we commenced implementation of a new financial information management system, which is replacing an end-of-life system with a Software as a Service solution. The new financial information management system will provide an efficient platform for processing and reporting on financial transactions, and support improvements in reporting and analytic capabilities, and procurement processes. Implementation activities will continue into 2024.

6.3.7 Technology infrastructure

Evoenergy operates a hybrid IT infrastructure environment between virtualised data centres and cloud hosted systems. Our hybrid IT infrastructure enables us to assess the optimal hosting solution for each of our systems.

Our data centre infrastructure was updated in 2023, with end-of-life compute and storage replaced by modern hardware. In parallel with updates to our data centre infrastructure, we enhanced our network perimeter controls, and network management tools.

As we mature our cloud infrastructure environment, we are expanding our use of cloud-native tools. In 2024, we will continue to modernise our system integrations utilising the Microsoft Azure integration services.

6.3.8 Cyber security

In 2023, Evoenergy continued to mature cyber security controls, incorporating critical infrastructure risk management program activities introduced through the Security of Critical Infrastructure Act 2018. The Evoenergy cyber security program is seeking to improve the confidentiality, integrity and availability of network assets and data from cyber threats, implementing controls from the Essential Eight and the Australian Energy Sector Cyber Security Framework.

As we continue to enhance controls across 2024, we will be strengthening our resilience to cyber threats and related disruptions. Our cyber security investment will be made across people, process, and technology in accordance with the four objectives identified in our Cyber Security Strategy FY24 - FY26:

- **Governance and Compliance** – Ensure compliance with cyber security regulatory obligations
- **Culture and Capability** – Enhance cyber security front line of defence and reinforce through deployment of emerging technology solutions
- **Data Protection** – Enable secure data sharing to support safe, efficient, and scalable energy transition solutions
- **Respond and Recover** – Evolve the ActewAGL Joint Venture cyber security response and recovery processes.

We will strengthen our compliance with best practice frameworks and standards and partnering with industry and government to contribute to the security of the broader energy sector.

Chapter 7: System Planning

This chapter summarises network limitations identified as the result of the system planning review undertaken by Evoenergy. It describes those limitations that are proposed to be addressed over the planning period. The identified limitations will be subject to further investigations including demand side management, non-network, or embedded generation support required to defer the emerging need for network investment.

System planning is the process of investigating present and future system capability, optimising asset utilisation, identifying, evaluating, and initiating system solutions where required and where economically justified to do so. System planning is necessary to ensure that security of the power system is maintained, capacity is available to meet the future needs of consumers, and the operation is within specified technical parameters.

The planning methodology draws on various data sources including demand forecasts, consumer connections, demographic, and economic data. System planning studies are undertaken to assess the adequacy of the subtransmission and distribution network to meet current and forecast demands whilst meeting the quality of supply criteria stipulated in the NER. The key performance criteria that are addressed include supply security, power quality, safety, and reliability.

Evoenergy applies a structured system planning methodology within the Asset Management Framework certified to ISO55001. Evoenergy employs risk based probabilistic methods to assess the prudency of investment.

Other parts of this report provide additional information which is highly relevant to the system planning including:

Network limitations tables in accordance with the AER requirements for each identified network limitation are published on the Evoenergy website.

Chapter 3 and **Appendix D** on the certification of the Evoenergy's Asset Management System to ISO55001.

Chapter 4 and **Appendix F** and **Appendix G** provide information on network performance with respect to reliability and power quality.

Chapter 5 and **Appendix E** provide additional discussion of the demand forecast for the system and zone substations.

7.1 Network Planning - What Are The Main Challenges

Evoenergy plans its energy network to cater for existing and future demand. At the system level the projected summer and winter maximum demand is forecast to increase significantly due to the net zero transition. The network minimum demand is forecasted to reduce significantly over a decade with increasing possibility of ACT exporting power to NSW within the next 20 years. **Chapter 5** and **Appendix E** provide more information on the system and zone substations demand forecast. There are no significant system level constraints identified during the planning review. The network constraints identified in the planning process are localised and relate to distribution system and zone substation capacity limitations. They correspond to the areas of higher residential and commercial growth.

Evoenergy's current network development drivers and challenges are:

- Urban infill of medium density residential, high density residential and commercial developments pushing the capacity limits within the distribution system in several established areas
- Urban intensification is also being driven in the light rail corridors both for the existing light rail stages and the planned future stages.
- Increasing proportion of medium and high-density residential developments in the greenfield areas which increases electrical load density within serviced areas in line with the ACT Planning Strategy 2018 which states that 70% of new housing will be built within the existing urban footprint
- Continuation of greenfield developments and expansion into the areas with minimal existing infrastructure including the Molonglo Valley and Ginninderry
- Distributed energy resources such as rooftop PV impacting voltage regulation on LV distribution network and therefore creating network constraints (usually within low voltage network)
- The short, medium to long term impacts of the ACT Government energy policies which includes 2045 zero emission target, Zero Emission Vehicle Strategy and perpetual neutral carbon target for electricity.
- The impacts of electrification of the existing gas network and the implications of this for the peak demand of the electricity network.
- Need for optimising network investment, demand management, non-network solutions and network support including use of new technologies (e.g. network batteries, embedded generation, and distributed energy resources).
- The decarbonisation of the transport sector in the ACT including the impacts on the electricity network from the increase in numbers of electric vehicles and rollout of related infrastructure as the ACT reduces carbon emissions from transport.
- Evoenergy is also part of the ACT Government Utilities Working Group, an initiative led by the Chief Engineer, which aims to aid in holistic master planning between utilities and other major stakeholders across the ACT.

7.2 Joint Planning With Transgrid

Evoenergy and Transgrid hold formal joint planning meetings annually and also meet on specific projects and constraints as required. The joint planning process ensures that the most economic solutions to issues are implemented, whether they are a network or non-network option, transmission, subtransmission or distribution option. The joint planning process covers:

- Evaluation of relevant limitations of both networks and progression of joint planning activities to address these limitations
- Demand and energy forecasts
- Non-network development proposals
- Long term transmission and distribution developments
- Annual planning reports
- Public consultation and presentations to community groups.

This year's joint planning meeting was held in Canberra in March 2023.

Transgrid has recently completed the following projects relating to Evoenergy's network:

- Installation of SmartValve technology at the Stockdill substation. SmartValves work by detecting areas of congestion in the network and automatically redirecting flows to less congested lines, helping remove bottlenecks on the grid.

Planned Transgrid projects impacting Evoenergy's network include:

- Supply to Strathnairn area – 2028 – To facilitate the supply to Evoenergy's proposed Strathnairn Zone Substation to be able to meet the projected load growth due to new residential development in Canberra

Transgrid and Evoenergy are also closely monitoring the ACT net-zero journey to understand the load growth impacts and subsequent required infrastructure upgrades.

Evoenergy liaises closely with Transgrid throughout the implementation of these projects to ensure continuity and security of supply to the ACT is maintained. For further details refer to Transgrid's Transmission Annual Planning Report 2023[18].

18 https://www.transgrid.com.au/tapr

7.3 Inter-Regional Impact of Projects & Relevant National Transmission Flow Path Developments

National Transmission Flow Paths (NTFPs) are those portions of transmission networks used to transport large amounts of electricity between generation and load centres. These are generally transmission lines of nominal voltage 220 kV and above. The Australian Energy Market Operator (AEMO) published an updated Integrated System Plan[19] (ISP) in June 2022. The ISP identifies investment choices and recommends essential actions to optimise consumer benefits as Australia experiences what is acknowledged to be the world's fastest energy transition. That is, it aims to minimise costs and reduce the risk of events that can adversely impact future power costs and consumer prices, while also maintaining the reliability and security of the power system.

The 2022 ISP highlights the challenges as Australia works towards net zero emissions.

The below is an extract from the executive summary of the 2022 ISP:

> *The 2022 ISP and its optimal development path support Australia's complex and rapid energy transformation towards net zero emissions, enabling low-cost firmed renewable energy and essential transmission to provide consumer in the NEM with reliable, secure and affordable power.*
>
> *The ISP's optimal development path recognises and guides the significant investment needed in the physical infrastructure and intellectual capital of the NEM. That investment is needed to:*
>
> - *Meet significantly increased demand as homes, vehicles and industrial applications switch to electricity from existing energy sources. Without coal, this will require a nine-fold increase in utility-scale variable renewable energy (VRE) capacity, and a near five-fold increase in distributed solar photovoltaics (PV)…*

AEMO is expecting that by 2050 the amount of electricity delivered annually to approximately double from 180 TWh to 320 TWh. It is also expecting close to five times the distributed PV capacity and substantial growth in distributed storage.

7.4 Urgent And Unforeseen Need

NER clause, schedule 5.8(g) requires Evoenergy to identify any projects above $2 million committed which are the result of urgent and unforeseen needs. For avoidance of the doubt, Evoenergy confirms that the forward program provided in this report, does not include projects which belong to this category.

7.5 Planning Outcomes - Network Constraints And Limitations

Table 12 lists identified locations where the network is constrained or limited or where the network limitations are likely to emerge. The identified network limitations are subject to further investigations and engagement with interested parties in relation to demand management/non-network solutions. **Chapter 1** provides more information on the stakeholder consultation process.

Generally, Evoenergy does not prepare distribution feeder load forecasts. However, Evoenergy assesses different locations and parts of the network in terms of the available capacity, existing load and projected future loads including upcoming developments.

7.5.1 Upcoming Developments

7.5.1.1 Residential Developments

Planned residential developments cause some of the anticipated network limitations summarised in **Table 12**. The following is the list of the major residential developments planned within the five-year planning horizon which have identified during the planning review from the ACT Government Indicative Land Release Program or consumer enquiries:

19 https://aemo.com.au/-/media/files/major-publications/isp/2022/2022-documents/2022-integrated-system-plan-isp.pdf?la=en

1. Ginninderry Estate, West Belconnen – Projected growth of approximately 300 dwellings per year throughout planning period. MacNamara and Strathnairn currently in progress.
2. Jacka Estate, Gungahlin –Stages 2 and 3 currently in progress for a total of approximately 700 dwellings.
3. Denman Prospect Estate, Molonglo Valley –Future stages totalling approximately 4,000 dwellings in various stages of development. Expected release of approximately 300-400 dwellings per year.
4. Whitlam Estate, Molonglo Valley – residential development. Stages 1 & 2 have been constructed and energised with Stage 3 in progress. Future stages to come up to 2300 dwellings. Expected release of approximately 300-400 dwellings per year.
5. Molonglo Suburb- mixed development with 800 dwellings and commercial developments of approximately 40,000m² space within next 6 years.
6. Kenny Estate, Gungahlin – 1000 dwellings expected with land release beginning in 2024.

7.5.1.2 Commercial and Mixed Developments

Planned commercial and mixed developments cause some of the anticipated network limitations summarised in **Table 12**. The following is the list of commercial and mixed developments identified during the planning review:

1. Gungahlin Town Centre East – multiple high-rise residential developments with 3,100 dwellings and commercial development with approximately 165,000m² space in next 5 years.
2. Lyneham – mixed development with 5,000 dwellings and commercial developments of approximately 32,000m² space within next 10 years.
3. Dickson– several residential developments with 2,000 dwellings and commercial developments of approximately 9,500m² space in the next 5 years.
4. Canberra Central Business District North – high-rise commercial development with 72,300 m2 space within next 10 years.
5. UNSW, Parks – commercial development with 20,000m² and further 119,000m² will be developed over the next fifteen years.
6. Canberra Central Business District West – commercial development with 75,000m² space in next 5 years
7. Molonglo Group Centre - mixed development with 1500 dwellings and commercial developments of approximately 10,000m² space within next 5 years.
8. Canberra Airport precinct - various commercial developments and data centre in next 5 years period.
9. Kingston - Kingston Arts Precinct & Kingston Foreshore – multiple high-rise residential developments with 4,600 dwellings and commercial developments of approximately 62,000m² space
10. Woden – numerous private and public (ACT Government) development projects comprising a mix of residential, commercial, education, health and transport profiles.
11. Hume – multiple data centre developments and new connections at New West Industry Park (Hume West)
12. Tuggeranong Town Centre – Aspen Development, 2,700m² commercial space and 571 residential units and Electric Bus Depot project.
13. Fyshwick Section 38 (Dairy Road) – Estate Development Plan (EDP) currently in progress to further develop the site to house more commercial spaces and 4 residential apartment buildings.
14. Woden Valley – diplomatic estate development
15. Yarralumla – brickworks development
16. Barton – State Circle and nearby developments
17. CBD – Canberra Theatre developments
18. Mitchell – Electric bus depot

7.5.1.3 Large Scale Embedded Generation Projects

A number of consumers have submitted Embedded Generation Special Connection Request (SCR) forms to Evoenergy, and are in various stages of the connection process. Evoenergy considers all embedded generation over 1.5 MW to be connected to the network to be large scale. The following projects are currently under consideration[20]:

20 Note: Backup generators have not been included in this summary

1. A 11.5 MW Battery Energy Storage System in the Molonglo Valley implemented in two stages[21]
2. An expansion of a landfill gas generator from 4 MVA to 20 MVA including a potential battery energy storage system

In addition to these projects, in 2020 the ACT government held a recent renewable electricity auction delivering up to resulting in 200 MW of wind power from two different successful bidders as well as 50 MW of batteries. Both the wind and battery connections are connected to the transmission network outside the ACT and will not directly impact Evoenergy's network.

In addition to this, the ACT Government is planning to facilitate the implementation of least 250 MW of batteries as part of the Big Canberra Battery[22] project. The expression of interest process for this project closed in February 2022 with Eku Energy contracted to deliver a large-scale battery storage facility in Williamsdale. The 250-megawatt (MW), 500 megawatt-hour (MWh) battery energy storage system (BESS) is expected to commence construction in late 2024 with completion expected in 2025.

Appendix B provides more information on existing embedded generation connected to the Evoenergy and on installed capacity of small-scale PV generation.

21 More information can be found in Section 7.6.1
22 https://www.environment.act.gov.au/cc/big-canberra-battery

Table 12. Network Limitations

Location	Network Element	Limitation	RIT-D	MVA Required (cumulative)** 2024	2025	2026	2027	2028	Dates Consult	Decision	Required / (estimate completion)	Estimated Cost***	Project Driver(s)	Project Reference
Molonglo Valley	Zone Substation & Feeders	Capacity	Yes	9.4	10.4	13.8	16.9	22.6	Complete	Complete	(Apr-25)	$30.5m	See section 7.5.1.1.3, 7.5.1.1.4, 7.5.1.1.5 & 7.5.1.2.7	See Section 7.6.1
Denman Prospect	Feeder	Capacity	No	1.2	8.9	8.9	8.9	8.9	Complete	Complete	(Apr-24)	$1.8m	See section 7.5.1.1.3	See Section 7.6.2
Dickson - Dooring St	Feeder	Capacity	No	2.8	4.1	4.1	4.1	4.1	Complete	Complete	(Jun-24)	$3.8m	See section 7.5.1.2.3	See Section 7.6.3
Gold Creek Zone	Zone Substation	Capacity / Reliability	Yes	-	-	-	-	-	Nov-23	Feb-24	(Jul-25)	$8.6m	See section 7.5.1.1.2, 7.5.1.1.6 & 7.5.1.2.1	See Section 7.6.4
Fyshwick	Feeder	Capacity	No	39	40	40	40	40	Complete	Complete	(Jun-24)	$5.5m	See section 6.1.4.2	See Section 7.6.5
Pialligo	Feeder	Capacity	No	7.3	8	8	8	8	Complete	Complete	(Jul-24)	$4.8m	See section 7.5.1.2.8	See Section 7.6.6
CBD West (S63)	Feeder	Capacity	No	0.0	0.5	2.6	5.6	5.6	Complete	Complete	(Apr-25)	$5.1m	See section 7.5.1.2.6	See Section 7.6.7
Gilmore	Zone Substation	Capacity / Reliability	No	-	-	-	-	-	Complete	Complete	(Jun-24)	$2.5m	See section 6.1.4.6	See Section 7.6.8
Braddon - Donaldson	Feeder	Capacity	No	0.0	0.6	1.3	1.3	1.3	Complete	Complete	(Apr-25)	$4.3m	See section 7.5.1.2.4	See Section 7.6.9
Strathnairn	Feeder	Capacity	No	0.2	1.2	1.2	1.2	1.6	Complete	Complete	Apr-24	$2.5m	See section 7.5.1.1.1	See Section 7.8.1
Kingston^^	Feeder	Capacity	No	-	-	-	0.9	1.3	Dec-24	Jun-25	Apr-27	$1.1m	See section 7.5.1.2.9	See Section 7.8.2
Fyshwick Dairy Road	Feeder	Capacity	No	0.1	2.1	5.2	7.1	9.1	Complete	Complete	Apr-25	$0.7m	See section 7.5.1.2.12	See Section 7.8.3
Lyneham	Feeder	Capacity	No	0.0	0.4	0.4	0.8	0.8	Dec-24	Jun-25	Apr-27	$4.1m	See section 7.5.1.2.2	See Section 7.8.4

				MVA Required (cumulative)**					Dates					
Location	**Network Element**	**Limitation**	**RIT-D**	**2024**	**2025**	**2026**	**2027**	**2028**	**Consult**	**Decision**	**Required / (estimate completion)**	**Estimated Cost*** **	**Project Driver(s)**	**Project Reference**
Curtin (diplomatic)^^	Feeder	Capacity	No	-	-	-	-	1.3	Dec-25	Jun-26	Apr-28	$5.1m	See section 7.5.1.2.10, 7.5.1.2.14, 7.5.1.2.15	See Section 7.8.5
Woden/Phillip^^	Feeder	Capacity	No	-	-	-	-	-	Dec-26	Jun-27	Apr-29	$4.1m	See section 7.5.1.2.10	See Section 7.8.6
Fairbairn South^^	Feeder	Capacity	No	0.9	2.6	3.6	3.9	4.1	Complete	Complete	Apr-25	$1.8m	See section 7.5.1.2.8	See Section 7.8.7
Hume West	Feeder	Capacity	No	-	-	-	1.2	2.8	Dec-24	Jun-25	Apr-27	$2.3m	See section 7.5.1.2.11	See Section 7.8.8
Greenway^^	Feeder	Capacity	No	0.2	0.2	0.2	0.2	0.3	Dec-25	Jun-26	Apr-28	$2.7m	See section 7.5.1.2.12	See Section 7.8.9
CBD South (Parkes)^^	Feeder	Capacity	No	-	-	1.1	1.1	1.7	Dec-23	Jun-24	Apr-26	$5.1m	See section 7.5.1.2.5	See Section 7.8.10
Gungahlin Town Centre	Feeder	Capacity	No	-	1.1	2.5	4.3	4.8	Complete	Complete	Apr-25	$5.1m	See section 7.5.1.2.1	See Section 7.8.11
Barton	Feeder	Capacity	No	-	1.1	2.2	2.2	2.2	Complete	Complete	Apr-25	$3.0m	See section 7.5.1.2.16	See Section 7.8.12
CBD	Feeder	Capacity	No	-	-	0.6	1.2	2.4	Dec-23	Jun-24	Apr-26	$3.2m	Various (multiple minor)	See Section 7.8.14
Franklin	Feeder	Capacity	No	-	1.2	1.3	1.5	1.7	Complete	Complete	Apr-25	$5.2m	Various (multiple minor)	See Section 7.8.15
Braddon^^	Feeder	Capacity	No	-	-	0.1	0.9	1.7	Dec-25	Jun-26	Apr-28	$3.8m	Various (multiple minor)	See Section 7.8.16
Watson^^	Feeder	Capacity	No	-	-	-	-	1.0	Dec-26	Jun-27	Apr-29	$5.4m	Various (multiple minor)	See Section 7.8.17

				MVA Required (cumulative)**					Dates					
Location	**Network Element**	**Limitation**	**RIT-D**	**2024**	**2025**	**2026**	**2027**	**2028**	**Consult**	**Decision**	**Required / (estimate completion)**	**Estimated Cost*****	**Project Driver(s)**	**Project Reference**
Ainslie^^	Feeder	Capacity	No	-	-	-	0.3	1.5	Dec-26	Jun-27	Apr-29	$5.4m	Various (multiple minor)	See Section 7.8.18
Campbell^^	Feeder	Capacity	No	-	-	-	0.5	0.5	Dec-26	Jun-27	Apr-29	$1.2m	Various (multiple minor)	See Section 7.8.19
Ginninderry (Strathnairn)	Zone Substation & Feeders	Capacity	Yes	0.2	1.2	1.2	1.2	1.6	Dec-24	Jun-25	Apr-28	$42.0m	See section 7.5.1.1.1	See Section 7.8.20
Molonglo Valley^^	Zone Substation	Capacity / Reliability	Yes	-	-	-	-	-	Jun-26	Feb-27	Apr-29	$9.1m	See section 7.5.1.1.3, 7.5.1.1.4, 7.5.1.1.5 & 7.5.1.2.7	See Section 7.8.21
North Canberra	Subtrans-mission	Voltage	No	2029-2034 period									See Section 4.2.2	See Section 7.9.1
Belconnen Zone	Zone Substation	Capacity / Reliability	Yes	2029-2034 period									-	See Section 7.9.2
Mitchell	Zone Substation & Feeders	Capacity	Yes	2029-2034 period									See section 7.5.1.1.2, 7.5.1.1.6, 7.5.1.2.1 & 7.5.1.2.2	See Section 7.9.3
Curtin	Zone Substation & Feeders	Capacity	Yes	2029-2034 period									See section 7.5.1.2.10	See Section 7.9.4
East Lake Zone	Zone Substation	Capacity / Reliability	Yes	2029-2034 period									See section 7.5.1.2.8, 7.5.1.2.12 & 6.1.4.2	See Section 7.9.5
Gold Creek Zone	Zone Substation	Voltage	No	2029-2034 period									See Section 4.2.2	See Section 7.9.6

* Network is operated beyond firm rating prior to the construction of new feeder.

** Cumulative MVA required represents a shortage of capacity required to supply forecasted load for a zone substation or group of distribution feeders. Based on the load forecast.

*** Direct capital cost of credible solution identified by preliminary NPV analysis, FY23 dollars

^ Where options analysis has determined that there is no viable non-network option, no public consultation was initiated for projects below the RIT threshold

^^Constraint forecast beyond 2028 planning horizon

Table 13. Locations Where Constraints Are No Longer Applicable

Location	Reason for Revision
Whitlam	Extension of the Belconnen Way South feeder complete

7.6 Projects Currently In-Progress

7.6.1 Molonglo Zone Substation

The Molonglo Valley is a major greenfield development in the ACT, which, at capacity, is planned to accommodate approximately 55,000 new residents over the coming decades. The development is located approximately 10 km from the Canberra CBD with suburbs being developed to the south and north of Molonglo River.

When complete, the suburbs of North Weston, Coombs, Wright, Denman Prospect, Whitlam, and other new suburbs north of Molonglo are expected to comprise 21,000-24,000 dwellings plus shopping centres, schools, and community facilities. Currently approximately one third of the Molonglo Valley development has been completed with 8,000 dwellings and businesses connected to the electricity network. Evoenergy plans for further development of 11,500 dwellings by 2032[23].

Initial supply is being provided to these developments through two extended 11 kV feeders from Woden Zone Substation and two extended 11 kV feeders from Civic Zone Substation.

In the short term there is a rapidly approaching constraint in the 11 kV distribution network. Peak demand is forecast to exceed the combined thermal capacity of the existing 11 kV feeders supplying the area by Winter of 2025. Evoenergy is extending the Streeton feeder from Denman Prospect to connect to the Belconnen Way South Feeder in order to shift some load and utilise spare capacity. Over the longer term, the load in the Molonglo Valley will be sufficient to fully utilise a large zone substation with multiple transformers. This proposed Zone Substation is known as the Molonglo Zone Substation.

In 2020, Evoenergy undertook long term capacity planning and a RIT-D process to cater for the projected demand. The outcome of the process set up the following steps:

- Initial supply was to be provided from the distribution feeders originating at Civic Zone Substation and Woden Zone Substations.
- Installation of the BESS Stage 1 and Stage 2 by late 2023 and late 2024 respectively.
- Relocation of the mobile 132/11 kV single transformer 15 MVA substation from Angle Crossing to Molonglo Zone Substation by June 2023
- Deferment of the single 132/11 kV 55 MVA transformer at Molonglo ZS to at least 2025
- Installation of the second transformer at Molonglo ZS in 2029

In late 2020, changed circumstances compelled Evoenergy to review the network planning, due to two major factors:

- An electrical fault of the mobile substation which rendered substation un-operational before the substation was moved to Molonglo site.
- The implementation of the battery energy storage system was materially delayed by the contracted service provider.

Due to the above change in operational circumstances and the continuing growth in Molonglo electrical demand Evoenergy was compelled to review long term plans. Consequently, Evoenergy set out the following revised steps:

- Continuation with the implementation of the BESS system of 14.9 MWh for stages 1 and stage 2 (new target date in late 2024)
- Installation of the 1st transformer at Molonglo ZS by winter 2025
- Installation of the 2nd transformer at Molonglo ZS by winter 2029

To enable the delivery of electricity from the substation to loads in the Molonglo Valley, Evoenergy will install new underground 11 kV cable feeders (including the undergrounding and reconfiguration of a section of the Black Mountain feeder) from the Molonglo zone substation during 2024-29 as well as an extension and reconfiguration of the Streeton feeder to supply Denman Prospect from the new zone substation.

23 Based on the ACT Government land development program and information obtained from The ACT Government Suburban land Agency.

Interacting with this project, as part of the proposed residential developments, the Suburban Land Agency has requested the replacement of sections of two Evoenergy 132 kV subtransmission lines that traverse the Molonglo Valley with underground cables. The underground cable sections will be approximately 9.1 km long on the Canberra–Woden line and 5.6 km long on of the Civic–Woden line. The undergrounding project will be carried out in two stages as follows:

- Stage 1: Canberra–Woden line section. Currently in commissioning phase, energisation in December 2023
- Stage 2: Civic–Woden line section. Approximately 2030.

Stage 1a of the BESS, a 6.9MW/7.45MWh system, is underway and anticipated to be operational by January 2024. Enablement of this Stage 2 of this BESS is underpinned by Evoenergy undertaking construction of an 11 kV switching station and extension of the Belconnen Way South and Streeton feeders to the BESS.

Design and construction of the Molonglo Zone Substation as a single transformer first stage and associated 11kV feeder works are well progressed, with estimated expenditure for completion in the 2024-29 regulatory control period totalling $24.5M. This project remains on track for expected delivery prior to winter 2025.

7.6.2 Supply to Denman Prospect

Over the next 30 years, substantial greenfield development is expected to occur in the Molonglo Valley District., When complete, the newly developed suburbs of North Weston, Coombs, Wright, Denman Prospect and Whitlam in this region are expected to support an estimated 21,000 dwellings, plus shopping centres, schools, and community facilities.

Supply is being provided to the existing stages of the suburbs of Wright and Denman Prospect in the Molonglo Valley District from the Streeton feeder from the Woden zone substation and the Black Mountain feeder from the Civic Zone Substation. Initial supply will be provided to Whitlam through a connection to the Belconnen Way South feeder extension. Supply is being provided to the suburbs of Coombs and Weston through the Hilder feeder from Woden Zone Substation.

Significant greenfield load growth in the Molonglo Valley was to be addressed by the implementation of the stage 1 of Molonglo BESS in early 2023 and extension of Belconnen Way South feeder in mid-2022, in return deferring the construction of the Molonglo Zone Substation until 2024. The existing feeder demands combined with additional forecast loads and minimal load transfer capability requires additional capacity for the Molonglo Valley to maintain supply reliability.

Capacity constraints and load growth from greenfield development will cause three feeders to operate above 95% of their thermal ratings in winter 2023, two feeders exceed their thermal capacities in winter 2024, three existing feeders to exceed their thermal capacities in winter 2025. In addition to that Molonglo BESS does not have adequate capacity to provide additional demand required in winter 2025.The value of unserved energy at 100% load forecast is $1,165 in 2023 rising to $3,253,506 million in 2024 and $23,204,510 in 2025.

Evoenergy has considered minimum cost options to increase capacity in the Molonglo Valley while providing longer term value to the network as outlined in **Table 14** Demand management has previously been deemed unsuitable as part of the RIT-D process that identified the Molonglo BESS. Feeder extensions with adequate capacity were identified and assessed for lowest cost, heritage and environmental complication. Of the two viable feeder extensions, the preferred option provided the lowest cost and minimal complications.

Table 14. Options for supplying capacity to Molonglo Valley

Ref	Option	Total indicative cost ($ millions)	Evaluation Summary
0	Do Nothing	-	**Not Recommended** • Network security and reliability in the Molonglo Valley will be at risk • Significant value of unserved energy
1	Extend Streeton Feeder	1.8	**Recommended** • Defer Molonglo ZSS construction completion to December 2024 • Best utilisation of Molonglo BESS stage 1&2 and Belconnen Way South feeder extension. • This will be used as a new 11kV feeder from Molonglo ZSS to Denman Prospect.
2	New 11kV feeder from Woden ZSS	5.8	**Not Recommended** • Defer Molonglo ZSS construction completion to June 2025 • As per firm ratings, 5.5MVA capacity available in winter • Significant higher cost than Option 1 • This will not be fully utilised after construction of 11kV feeders from Molonglo ZSS to Denman Prospect. • Woden ZSS will not have adequate capacity to supply Molonglo Valley development.

The preferred option is to extend Streeton feeder from Denman Prospect to Molonglo zone substation, along John Gorton Dr. This will provide additional capacity for increasing load in Denman Prospect suburb thus maintaining network reliability with the Molonglo Battery Energy Storage Systems (BESS), until the Molonglo Zone Substation (ZSS) is implemented.

The cost of this option is **$1,792,351** including corporate overheads and contingency, excluding GST.

The project is underway, with planned completion prior to winter 2024.

7.6.3 Supply to Dickson

The Canberra City North area, including Lyneham and Dickson suburbs, is experiencing significant load growth, driven by development around the light rail corridor as well as the ACT Government's Urban Renewal program. This involves the demolition of a large number of old single level flats and office buildings (e.g. the Motor Vehicle Registry and MacArthur House) and their replacement with multi-storey apartment and commercial buildings.

It is forecast that additional load requirements of these developments will approach 14 MVA by 2024. Some capacity can be provided by existing feeders but the proposed new feeder, Civic zone substation to Dooring Street is required to make up the shortfall.

Evoenergy has considered two options to supply the additional load as shown in **Table 15**:

Table 15. Options for supply to Dickson

Option	Option type	Description	Cost	Evaluation
1	Network	Construct a new 11 kV cable feeder from Civic Zone Substation to Dooring St, Dickson	**$3.8m**	Preferred
2	Non-network	Demand side management and embedded generation	**N/A**	Not preferred as does not meet need

Option 1 involves constructing a new 11 kV feeder from Civic Zone Substation to SOHO stage 1 development at B3 S12, Dickson, establish a 4-way switching station with SCADA and remote-control function at Dooring Street verge. With the proposed network augmentation solution of construct new 11 kV cable feeder from Civic Zone Substation to Dooring Street will fully mitigate the network capacity and unserved energy risks.

Option 2 considers non-network initiatives including:

- Incentives to realise the potential of latent demand management within the customer base
- Incentives to encourage the uptake of additional demand management within the customer base.

To defer the Dooring feeder to the next regulatory control period (beyond 2024), it is estimated that non-network solutions would need to provide a maximum demand of approximately 3.8 MVA within the next two years.

Latent demand management within the existing customer base was investigated, with a maximum estimated capacity of 0.24 MVA. This does not meet the minimum capacity to enable the new feeder to be deferred.

This feeder project interacts with the Haig feeder extension (completed) and the Donaldson feeder project outlined in **Section 7.6.9** which together form part of a master plan for the area.

The Dooring Feeder cable augmentation work is complete. The switching station is expected to be energised by June 2024.

7.6.4 Gold Creek 3rd Transformer

The maximum demand in the Gungahlin District is forecast to increase over the next ten years with land release in the residential suburbs of Jacka and Kenny, along with several commercial and residential developments in the Gungahlin Town Centre area, including commercial, retail and residential developments as well as community facilities.

Mitchell is a light industrial and commercial suburb in the Gungahlin District to the east of the Gungahlin Town Centre. Peak demand at Mitchell is also growing rapidly.

Based on the requirements of the ACT Electricity Transmission Supply Code 2016 there is currently insufficient redundant capacity at Gold Creek Zone Substation for short but increasing periods of time and minimal coincident opportunity to transfer load to neighbouring zone substations.

Table 16. Gold Creek Zone Substation Load Forecast

Season	Case	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Summer	MD 50% PoE	**77**	**84**	**88**	**92**	**95**	**98**	**103**	**106**	**110**	**114**
Winter	MD 50% PoE	**92**	**100**	**105**	**109**	**113**	**117**	**122**	**127**	**131**	**136**

Note: Red denotes exceedance of 2-hour emergency summer and winter limits for a single transformer (all values in MVA)

Evoenergy has considered three network options to supply this redundant capacity as shown in **Table 17**:

Table 17. Options for addressing Gold Creek Zone Substation Capacity

Network Option	Description	NPC ($M)
Base case (not credible)	Do Nothing – utilise existing network	-1.46
Option 1 (preferred)	Install third transformer at Gold Creek Zone Substation	-5.74
Option 2	Accelerate Mitchell Zone Substation	-21.43
Option 3	Install three feeders from Latham Zone Substation (Defers 3rd Tx at Gold Creek by 3 years)	-12.04

The base case would see no investment in capacity improvement at Gold Creek resulting in non-compliance with Evoenergy's obligation under the ACT Electricity Transmission Supply Code. In the event of a single contingency such as a transformer fault or similar, network reliability and security in the Gungahlin district would be compromised. Should a failure occur, it could lead to large scale unplanned outages during times of peak demand.

The preferred network option is to install and commission an additional (third) 57 MVA transformer at Gold Creek zone substation.

The scope of work includes connection to the existing 132kV bus, 132kV circuit breaker, 132kV CTs and surge diverters, 11kV transformer cables, 11kV switchboard and associated protection, monitoring and communications equipment. Should this be selected as the preferred solution, these works are expected to be completed and commissioned prior to summer 2026. Should there be a transformer failure prior to commissioning the third transformer, Evoenergy would utilise load transfer capacity to minimise the impacts of unserved energy during this time. This is the preferred option for the following reasons:

- Lowest NPC of acceptable network options
- Effectively doubles Gold Creek ZSS continuous and 2-hour emergency ratings
- Increases the capacity and flexibility of Gold Creek ZSS to manage the ACT government Net Zero by 2045 target and the associated load growth from full electrification and EV charging
- Lowest level of complication and community disruption from land access and construction/civil works
- Does not adversely impact redundancy at nearby zone substations

Evoenergy has identified the need to increase the redundant capacity of the electrical supply for the Gungahlin district. The preferred network option for the proposed increase in capacity is in excess of the $6m threshold under the NER and therefore subject to a RIT-D.

As part of the RIT-D Evoenergy has published the Gold Creek Capacity Draft Project Assessment Report. This is available on the Evoenergy website[24]. The consultation period for the draft project assessment report will close on the 19th January 2024. Evoenergy aims to publish the final project assessment report in February 2024 with the preferred option to be operational by summer 2025.

24 https://www.evoenergy.com.au/emerging-technology/engagement-opportunities-for-interest-parties

7.6.5 Feeders from East Lake Zone Substation to Fyshwick Zone Substation

One of the original drivers for the establishment of East Lake Zone Substation in 2013 was to transfer the Fyshwick load to East Lake to enable Fyshwick Zone Substation to be retired and the 66 kV assets decommissioned. This is still an Evoenergy strategic objective which is proposed to be achieved by installing some high capacity express 11 kV feeders (i.e. feeders with no intermediate loads) from East Lake to Fyshwick, and converting Fyshwick to an 11 kV switching station only. Cables proposed are 11 kV 3C/400 mm2 Cu XLPE and these would replace the existing transformer incomer cables at the three Fyshwick 11 kV switchgear groups. These express cables would be rated at approximately 10.5 MVA each continuous, providing 31.5 MVA maximum capacity to Fyshwick and 21 MVA firm capacity. Other feeders would be run from East Lake to the Fyshwick and Majura areas (under separate projects), to reduce the maximum demand on the Fyshwick 11 kV switchboard to less than 21 MVA.

Two options were considered for this work:

- Option 1: Three express 11kV Feeders via Rail Corridor
- Option 2: Three express 11kV Feeders via Newcastle street

Option 2, following the Newcastle St route was selected due to a shorter route length and lower cost.

The proposed cable route length from East Lake to Fyshwick is approximately 2.7 km. Estimated cost is $5.7 million.

Feeder installation is complete, with energisation subject to completion of nearby feeder works in the airport area, and timing for decommissioning of the Fyshwick zone substation.

7.6.6 Supply to Pialligo

The maximum demand in the Pialligo area near Canberra Airport is forecast to increase primarily due to commercial development in the area including the Brindabella Business Park, Majura Park and Fairbairn precincts. The maximum demand of the area is forecast to increase by 8 MVA over the next 5 years.

The Pialligo area is currently supplied by the Aero Park feeder from City East Zone Substation, the Airport and Pialligo 11 kV feeders from Fyshwick Zone Substation, and the Dairy North 11 kV feeder from East Lake Zone Substation.

This project interacts with 7.6.5, helping to enable the decommissioning of the Fyshwick Zone Substation 66kV equipment.

This project will install new 11kV feeders from the East Lake Zone Substation in two parts:

- Part 1 involves the installation of a new 3.7km 11kV feeder from East Lake Zone Substation to S 11456 at Brindabella Business Park. This would provide approximately 4 MVA capacity to meet the growing load demand in the Canberra Airport precinct. The proposed feeder would provide ties to Airport and Pialligo feeders and would be named the "Brindabella Feeder".
- Part 2 involves the installation of 3 x 11kV cables from East Lake Zone Substation towards the Molonglo River to intersect with Airport, Pialligo and Whyalla feeders with the proposed utilisation:
  - Cable 1 – Airport Feeder – This would enable cutover of most of the Airport feeder load to East Lake Zone Substation while allowing backup supply from Fyshwick
  - Cable 2 – Pialligo Feeder – This would enable cutover of part of the Pialligo feeder to East Lake Zone Substation, enabling the decommissioning of the Fyshwick Zone Substation and also improving reliability to the area
  - Cable 3 – Whyalla Feeder – This third cable would enable the connection of the Whyalla feeder to East Lake Zone Substation, helping to enable the decommissioning of the Fyshwick Zone Substation.

Other options (as outlined in **Table 18**) considered include the construction of a new 11kV feeder from City East Zone Substation and 3 new cables from East Lake Zone Substation in line with option 1. Demand management was not considered feasible due to the insufficient existing capacity such that there is a requirement for 60% of new demand to be offset. The grid battery was excluded due to a higher net present cost and the relative certainty of the demand increase (noting grid batteries and other modular solutions deliver a higher options value in the context of uncertain demand).

Table 18. Options for supply to Pialligo

Option	Option type	Description	Cost	Evaluation
0	Base Case	Utilise existing network infrastructure	$0	Not credible as does not meet load requirements
1	Network	Construct two new 11 kV feeders from East Lake Zone Substation, and link Dairy North and Abattoir feeders	$4.85m	Preferred
2	Network	Construct one new 11 kV feeder from Fyshwick Zone Substation, one new 11 kV feeder from East Lake Zone Substation and link Dairy North and Abattoir feeder.	$4.95m	Not preferred due to higher NPC
3	Non-network	Demand side management	N/A	Not preferred as does not meet need

This project is currently in progress, with planned completion by July 2024.

7.6.7 11kV Feeder from Civic ZS to CBD West Section

This project is driven by the need to provide supply to support load growth in a particular block and section of Canberra CBD West, to account for a cumulative incremental load increase of approximately 17.2MVA by 2029.

Evoenergy's existing network supplying the area will be unable to service the expected load growth during the 2024-29 regulatory period, even with optimised load allocations among the existing 11kV feeder network. If no action is taken, the gap between the demand forecast and existing feeder capacity is expected to arise from 2024.

Accordingly, there is a need to provide additional supply capacity to meet the expected demand from these new customers.

The assessment of the options considered to address the need are provided in **Table 19**.

Table 19. Options assessment and preferred option identification - 11kV Feeder from Civic ZS to CBD West Section

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	11kV feeder from Civic zone substation	$5.08	$184.79	**Recommended** – Highest NPV technically feasible option
2	11kV feeder from City East zone substation	$5.31	$184.61	Not selected due to lower NPV
3	Grid Battery to defer network option	$13.22	$178.57	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is Option 1, as this meets the requirements of the need, is technically and economically feasible, and has the highest net present value (NPV).

A preliminary cost estimate for the recommended option is **$5.08m in FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST.**

This project is in its design & development phase and the recommended option is planned to be completed by winter 2025.

7.6.8 Gilmore Zone Substation Spare Transformer and Third Switchboard

Gilmore zone substation is a two-transformer, two-11kV switchboard site commissioned in 1985. The original design catered for the site to be upgraded to a 3-bay site as demand within the Tuggeranong region increased.

Load forecasts indicate that Gilmore zone is projected to breach its continuous rating within the 2024-29 regulatory period therefore losing the zone substation requirement to maintain N-1 redundancy. In addition to this the power transformers at Gilmore Zone Substation are approaching end of life. To combat this, a transformer will be relocated from Telopea zone (TX3) and installed within the central vacant bay at Gilmore zone. This will provide redundancy in the event of a transformer failure. A third 11kV switchboard is required in order to provide the 11kV circuit breakers (feeders) necessary for this power transformer to support load.

The primary driver for this increasing load can be attributed to large commercial loads requesting 11kV supply which are predominately due to come online in late FY22/23.

Gilmore zone currently does not have spare 11kV circuit breakers or capacity to double-bank feeders (two feeders fed by one 11kV circuit breaker) in the numbers required to service these new customers. Previously double-banking was the strategy to cater for new feeders at this site however this option lowers the reliability of supply and is not possible for all circuit breakers.

This project is in-progress. The 132kV isolator has been energised, with the switchgear and transformer placed on-site and awaiting installation & commissioning.

7.6.9 11 kV Feeder from Civic ZS to CBD East Section

The latest Evoenergy demand forecast shows rapid load growth associated with the planned high-density redevelopment of a car-parking site located in the east of Canberra CBD, commenced in 2023. While there are other minor sources of load growth expected, this is the dominant source of new load during the regulatory period.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with load-shifting to optimise the existing 11kV feeder network. Without action, the gap between the demand forecast and existing feeder capacity is expected to arise from 2025.

Accordingly, there is a need to provide additional supply capacity to meet the expected demand from these new customers and to meet the expected demand for standard control services.

The assessment of the options considered to address the need are provided in **Table 20**.

Table 20. Options assessment and preferred option identification - 11 kV Feeder from Civic ZS to CBD East Section

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from City East zone substation to CBD East Section	$4.64	$113.93	Not selected due to lower NPV
2	New 11kV feeder from Civic zone substation to CBD East Section	$4.59	$114.18	**Recommended** – Highest NPV technically feasible option
3	Grid Battery to defer network option	$6.22	$112.78	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is Option 2, as this meets the requirements of the need, is technically and economically feasible, and has the highest net present value (NPV).

A preliminary cost estimate for the recommended option is $4.59m in FY22/23 dollars with **$4.33m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST being spent in the 2024-2029 period.**

This project is in its design & development phase and the recommended option is planned to be completed by winter 2025.

7.6.10 Other Projects Currently In Progress

This section provides a brief description of other projects which are in progress:

- 132 kV Subtransmission line relocations in the Molonglo Valley - Approximately 14.7 km of overhead 132 kV subtransmission lines that currently traverse the Molonglo Valley (sections of Canberra–Woden and Civic–Woden lines) are to be relocated and replaced with underground cables to provide space for a major residential development. Coupled with this proposed project, the site for the future Molonglo Zone Substation has been relocated. The Canberra–Woden component of this project is in the commissioning phase with forecasted energisation by December 2023. This project is entirely customer funded.
- Proposed Harman 132/11 kV Zone Substation and 2.2 km of 132 kV overhead subtransmission line to supply increased load in the surrounding area. This is a customer-initiated project entirely funded by the external parties. Energisation planned for January 2024.
- Denman North:
  - Stages 1, 2A & 2B Complete and energised in September 2023
  - Stages 3, 4, 5 & 7 Significantly progressed and targeting staggered energisation dates between December 2023 and May 2024.
  - Stage 6, 8 & 9 Reticulation not commenced. Developer requirement for energisation dates: December 2024 – March 2025
- Jacka stage 2 - Stages 1a, 1b & 1c well progressed. Targeting energisation by January 2024.
- Macnamara:
  - Stage 1 A, B & D Reticulation is well progressed. Targeting staggered energisation by April 2024.
  - Stage 1 C, E & F Reticulation not yet commenced. Developer requirement for energisation dates: April to August 2024.
- Whitlam 3:
  - 3A & 3C - Reticulation complete. Targeting energisation by end November 2023.
  - 3B – Reticulation complete. Targeting energisation by end November 2023.
- New Supply (2 x 11kV feeders from East Lake ZS) to Data Centre in Airport Precinct. Design & development phases are completed, with delivery on hold based on customer's request.
- Causeway SWS decommissioning & 132kV & 11kV relocation at Kingston Area (100% funded by Customer) - In design & development phase and is planned to be completed by Oct 2027.
- Embedded Generation (bio-generation) Large Scale (2 x 10MVA) connection (2 x 11kV connections with Gilmore ZS) connecting to the Gilmore Zone Substation. In construction phase and is planned to be connected to Evoenergy network by June 2024.

7.7 Projects Completed

Significant projects completed during the year include:

- Extension of the Belconnen Way South feeder to supply the greenfield development of Whitlam. Energisation planned for January 2024.
- Supply upgrade (11kV, 2 additional feeders from Woden ZS) of Canberra Hospital at Garran. Energisation planned for December 2023.

7.8 Proposed Network Developments

7.8.1 11 kV Feeder from Latham ZS - extend Weir feeder cable to supply Strathnairn

This project is driven by the need to provide reliable supply to service new development in the Strathnairn area.

The latest Evoenergy demand forecast shows rapid load growth in the suburb of Strathnairn, which is part of the Ginninderry greenfield development in the West Belconnen District.

Without action, the existing 11kV feeder network will be unable to service the expected load growth, resulting in thermal overloading of feeders from winter of 2024.

There is therefore a need to provide additional supply capacity to meet the expected demand from these new customers and to meet reliability requirements.

The assessment of the options considered to address the need are provided in **Table 21**.

Table 21. Options summary - 11 kV Feeder from Latham - extend Weir feeder cable to supply Strathnairn

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	11kV Weir feeder extension	$3.42	$1,337.03	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from Latham zone substation	$3.94	$1,335.82	Not selected due to lower NPV
3	Grid Battery to defer network option	$11.87	$1,330.31	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is Option 1, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV. The recommended option will commence construction during the 2019-24 regulatory period and be completed during 2024/25.

A preliminary cost estimate for the recommended option is $3.42 million in FY22/23 dollars, excluding corporate overheads, contingency and GST with **$2.45 million in FY22/23 dollars, proposed to be spent in the 2024-2029 period.**

7.8.2 11kV Feeder from East Lake to Kingston

This project is driven by the need to provide reliable supply to service anticipated load growth in the Kingston area.

The latest Evoenergy demand forecast shows rapid load growth associated with the planned high density commercial and residential developments in Kingston Foreshore Area and redevelopment of a former 132kV switching station between 2026 and 2029.

There is a risk that the existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from winter of 2027.

There is therefore a need to provide additional supply capacity to meet the expected demand from these new customers and to meet reliability requirements.

The assessment of the options considered to address the need are provided in **Table 22**.

Table 22. Options assessment and preferred option identification - 11kV Feeder from East Lake to Kingston

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from East Lake Zone Substation to Section 68 Kingston	$1.05	$171.99	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from Telopea Park Zone Substation to Section 68 Kingston	$1.83	$171.40	Not selected due to lower NPV
3	Grid Battery to defer network option	$1.95	$171.34	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is Option 1, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV. The recommended option is required to be commissioned during 2027.

A preliminary cost estimate for the recommended option is **$1.05m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.3 11kV Feeder from East Lake ZS to Fyshwick Sec 38

This project is driven by the need to provide supply to support load growth in Fyshwick Sec 38.

The latest Evoenergy demand forecast shows rapid load growth associated with the planned high-density redevelopment of a site in Fyshwick, with stage one of the development commencing in 2024.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with load-shifting to optimise the use of existing 11kV feeder network. Without action, the gap between the demand forecast and existing feeder capacity is expected to materialise in 2025.

Accordingly, there is a need to provide additional supply capacity to meet the expected demand from these new customers and to meet the expected demand for standard control services.

The assessment of the options considered to address the need are provided in **Table 23**.

Table 23. Options assessment and preferred option identification - 11kV Feeder from East Lake ZS to Fyshwick

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from East Lake Zone Substation to Fyshwick	$0.72	$3,808.23	**Recommended** – Highest NPV technically feasible option
2	Grid Battery to defer network option	$8.98	$3,801.56	Not selected due to lower NPV
3	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^The capital cost of the option in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is **Option 1**, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV.

A preliminary cost estimate for the recommended option is **$0.72m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.4 11kV Feeder from Civic ZS to Lyneham

This project, supply to the Lyneham area, is driven by the need to provide supply to service anticipated load growth in the Lyneham area.

The latest Evoenergy demand forecast shows rapid load growth associated with the planned high-density commercial and residential development along with the light rail project in Lyneham.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with optimising the existing 11kV feeder network. Without action, the gap between the demand forecast and existing feeder capacity is expected to arise from 2027.

Accordingly, there is a need to provide additional supply capacity to meet the expected demand from these new customers and to meet the expected demand for standard control services.

The assessment of the options considered to address the need are provided in **Table 24**.

Table 24. Options assessment and preferred option identification - 11kV Feeder from Civic ZS to Lyneham

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from Civic Zone substation	$4.15	$16.04	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from Belconnen Zone substation	$6.98	$13.88	Not selected due to lower NPV
3	Grid Battery to defer network option	$6.41	$14.45	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^The capital cost of the option in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is **Option 1**, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV. Construction would commence in 2026 and be completed in 2027.

A preliminary cost estimate for the recommended option is **$4.15m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.5 11kV Feeder from Woden ZS to Diplomatic Development - Curtin

This project is driven by the need to provide supply to service anticipated load growth in Curtin, Yarralumla & Weston areas including planned diplomatic development in Curtin.

The latest Evoenergy demand forecast shows steady load growth associated with the planned development in Curtin for 32 different embassies, combined with a range of nearby developments in Yarralumla & Weston.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with optimising the existing 11kV feeder network. Without action, the gap between the demand forecast and existing thermal feeder capacity is expected to arise from 2028.

Accordingly, there is a need to provide additional supply capacity to meet the expected demand from these developments to meet the expected demand for standard control services.

The assessment of the options considered to address the need are provided in **Table 25**.

Table 25. Options assessment and preferred option identification - 11kV Feeder from Woden ZS to Diplomatic Development - Curtin

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from Woden Zone Substation	$5.12	$548.99	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from Telopea Park Zone Substation	$10.03	$547.04	Not selected due to lower NPV
3	Grid Battery to defer network option	$12.23	$543.96	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is **Option 1**, as this meets the requirements of the need, is technically and economically feasible, and has the lowest cost and highest NPV. Construction is planned to commerce in 2027 with project completion targeted 2028.

A preliminary cost estimate for the recommended option is **$5.12m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.6 11kV Feeder from Wanniassa ZS to Woden Town Centre

The maximum demand in the Woden area is forecast to increase steadily over the next ten years with multiple large residential and commercial developments along with Transport Canberra's new Woden bus depot to support the progressive roll-out of its electric bus fleet.

Evoenergy's existing network supplying Woden Town Centre has insufficient capacity to service the associated load growth during the 2024-29 regulatory period. Without action, the gap between the demand forecast and existing thermal feeder capacity is expected to arise from 2029.

Accordingly, there is a need to provide additional supply capacity to meet the expected demand from these developments.

The assessment of the options considered to address the need are provided in **Table 26.**

Table 26. Options assessment and preferred option identification - 11kV Feeder from Wanniassa ZS to Woden Town Centre

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from Woden Zone substation	$5.09	$5.90	Not selected due to lower
2	New 11kV feeder from Wanniassa Zone substation	$4.10	$6.60	**Recommended** – Highest NPV technically feasible option
3	Grid Battery to defer network option	$8.69	$3.48	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^The capital cost of the option in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is **Option 2**, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV.

A preliminary cost estimate for the recommended option is **$4.10m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.7 11kV Feeder from East Lake ZS to Fairbairn

This project is driven by the need to provide reliable supply to service anticipated load growth in the Fairbairn South area, near Canberra airport.

The latest Evoenergy demand forecast shows rapid load growth associated with planned commercial development in Fairbairn South, with the full load expected to come online by 2029.

There is a risk that the existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise starting from summer 2024.

There is therefore a need to provide additional supply capacity to meet the expected demand from these new customers and to meet reliability requirements.

The assessment of the options considered to address the need are provided in **Table 27.**

Table 27. Options assessment and preferred option identification - 11kV Feeder from East Lake ZS to Fairbairn

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from East Lake Zone Substation to Substation 11502	$1.97	$128.89	**Recommended** – Highest NPV technically feasible option
2	Grid Battery to defer network option	$7.46	$124.50	Not selected due to lower NPV
3	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is **Option 1**, as this meets the requirements of the need, is technically and economically feasible, and has the lowest cost and highest NPV.

A preliminary cost estimate for the recommended option is **$1.97m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.8 11kV Feeder from Gilmore ZS to Hume West

The maximum demand in the Hume area is forecast to increase rapidly in the coming years, with significant load growth occurring at the southern end of the existing industrial precinct that characterises the suburb.

Evoenergy's existing feeders supplying the precinct are at or near capacity and unable to service the associated load growth during the 2024-29 regulatory period. Without action, the gap between the demand forecast and existing thermal feeder capacity is expected to arise from 2027.

Accordingly, there is a need to provide additional supply capacity to meet the expected demand from these developments.

The assessment of the options considered to address the need are provided in **Table 28.**

Table 28. Options assessment and preferred option identification - 11kV Feeder from Gilmore ZS to Hume West

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from Gilmore Zone Substation	$2.29	$302.02	**Recommended** – Highest NPV technically feasible option
2	Grid Battery to defer network option	$5.67	$299.53	Not selected due to lower NPV
3	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is **Option 1,** as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV.

A preliminary cost estimate for the recommended option is **$2.29m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.9 11kV Feeder from Wanniassa ZS to Greenway

This project is driven by the need to provide supply to service anticipated load growth in the Greenway area due to planned mixed commercial and high density development.

The latest Evoenergy demand forecast shows rapid load growth associated with proposed developments in the Greenway region.

The existing Evoenergy network does not have sufficient capacity to service the expected load growth during the 2024-29 regulatory period. Without action, the gap between the demand forecast and existing feeder capacity is expected to arise from 2025.

Accordingly, there is a need to provide additional supply capacity to meet the expected demand from these developments.

The assessment of the options considered to address the need are provided in **Table 29.**

Table 29. Options assessment and preferred option identification - 11kV Feeder from Wanniassa ZS to Greenway

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from Wanniassa Zone Substation	$2.74	$0.39	**Recommended** – Highest NPV technically feasible option
2	Grid Battery to defer network option	$3.79	-$0.69	Not selected due to lower NPV
3	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is **Option 1**, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV.

A preliminary cost estimate for the recommended option is **$2.74m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.10 11kV Feeder from Civic ZS to Canberra CBD Parkes

This project is driven by the need to support load growth in the Parkes area. An initial 1 MVA of load growth is anticipated by 2026, rising steadily thereafter to an estimated 6 MVA by 2035.

Evoenergy's existing network supplying the area will be unable to service the expected load growth during the 2024-29 regulatory period, even with optimised load allocations among the existing 11kV feeder network. If no action is taken, the gap between the demand forecast and existing feeder capacity is expected to arise from 2026.

Accordingly, there is a need to provide additional supply capacity to meet the expected demand from these new customers.

The assessment of the options considered to address the need are provided in **Table 30.**

Table 30. Options assessment and preferred option identification - 11kV Feeder from Civic ZS to Canberra CBD Parkes

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from City East Zone Substation to Parkes	$5.72	$61.19	Not selected due to lower NPV
2	New 11kV feeder from Civic Zone Substation to Parkes	$5.15	$61.64	**Recommended** – Highest NPV technically feasible option
3	Grid Battery to defer network option	$8.76	$59.10	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^The capital cost of the option in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is **Option 2**, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV.

A preliminary cost estimate for the recommended option is **$5.15m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.11 11kV Feeder from Gold Creek ZS to Gungahlin Mixed Development

This project is driven by the need to provide reliable supply to service anticipated load growth in the Gungahlin town area, which is within Gungahlin district.

The latest Evoenergy demand forecast shows rapid load growth associated with the planned high density mixed-use development over the next decade, with an estimated 3,937 dwelling releases over the five years between 2021/22 and 2025/26, together with a range of commercial developments.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from winter 2025.

There is therefore a need to provide additional supply capacity to meet the expected demand from these new customers and to meet reliability requirements.

The assessment of the independent options considered to address the need are provided in **Table 31.**

Table 31. Options assessment and preferred option identification -11kV Feeder from Gold Creek ZS to Gungahlin Mixed Development

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from Gold Creek Zone substation to Manning Clark Crescent Gungahlin	$5.13	$184.64	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from Belconnen Zone Substation to Manning Clark Crescent, Gungahlin	$10.03	$180.66	Not selected due to lower NPV
3	Grid Battery to defer network option	$14.85	$176.91	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is **Option 1,** as this meets the requirements of the need, is technically and economically feasible, has the lowest cost, and has the highest net present value (NPV).

A preliminary cost estimate for the recommended option is **$5.13m in FY22/23 dollars excluding corporate overheads, contingency, and GST.**

7.8.12 11kV Feeder from Telopea Park ZS to Barton

This project is driven by the need to provide reliable supply to service anticipated load growth in the Barton area and accommodate upcoming developments in the area.

The latest Evoenergy demand forecast shows rapid load growth associated with the planned high density commercial developments in the Barton area.

There is a risk that the existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from summer of 2025.

There is therefore a need to provide additional supply capacity to meet the expected demand from these new customers and to meet reliability requirements.

The assessment of the options considered to address the need are provided in **Table 32.**

Table 32. Options assessment and preferred option identification -11kV Feeder from Gold Creek ZS to Gungahlin Mixed Development

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	11kV feeder from Telopea Park zone substation	$3.03	$615.30	**Recommended** – Highest NPV technically feasible option
2	11kV feeder from East Lake zone substation	$4.32	$614.26	Not selected due to lower NPV
3	Grid Battery to defer network option	$7.38	$611.87	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The recommended option based on the options evaluation presented in this report is **Option 1**, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV. The recommended option is required to be commissioned during 2026.

A preliminary cost estimate for the recommended option is **$3.03m in FY22/23 dollars, excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.13 Nona Feeder Reliability Improvement

The project proposes to augment Hamer feeder by extending an existing radial leg into a ring and to reconfigure Nona feeder by disconnecting a faulted section of cable and create a tie with Anthony Rolfe feeder. This project will improve network reliability in the Gungahlin area, reducing STPIS costs and risk cost of a prolonged outage.

These two works are proposed as a single project due to their geographical proximity. Combining the two feeder improvement works will reduce cost by allowing efficient use of internal resources and external (contractor) resources.

Table 33 provides a summary and comparison of the two options considered.

Table 33. Options summary - Nona Feeder Reliability Improvement

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	Connect Nona feeder to Anthony Rolfe feeder and extend radial section of Hamer feeder into a ring	$0.63	$0.21	**Recommended** – Highest NPV technically feasible option

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

Comparing the project cost against the annual benefit results in a positive NPV of $0.21 million over the expected life of the asset.

It is recommended that project budget of $0.63 million is approved to connect Nona feeder to Anthony Rolfe feeder and extend radial section of Hamer feeder into a ring, to improve network reliability and reduce STPIS costs in the Gungahlin area.

7.8.14 11kV Feeder from City East to Canberra CBD

This EV-driven 11kV feeder project is driven by the need to provide reliable supply to service anticipated load growth in the Canberra CBD and surrounding suburbs.

The latest Evoenergy demand forecast shows load growth associated with the uptake of electric vehicles and their corresponding requirements for charging infrastructure and several new development projects.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-2029 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from summer 2026.

There is therefore a need to provide additional supply capacity to meet the expected demand and to meet reliability requirements.

Evoenergy considered the following network and non-network solutions to address the identified network need. The options considered are summarised in **Table 34**.

Table 34. Options assessment and preferred option identification -11kV Feeder from City East to Canberra CBD

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from Civic Zone substation	$3.15	$40.89	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from City East Zone substation	$5.02	$39.40	Not selected due to lower NPV
3	Grid Battery to defer network option	$7.04	$37.94	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The Net Present Value (NPV) calculations are based on the cost of each option and reduction of risk relative to the base case. The primary risk assessed is unserved energy due to identified constraint within the network.

Based on the cost-benefit analysis **Option 1** is the recommended option.

Option 1 addresses the network need, is technically and economically feasible, and has the highest NPV. The recommended option requires a construction of 3.7km of 11 kV distribution feeder and the installation of a switching station at the termination point. To address operational needs, the recommended solution to be implemented by 2026.

A preliminary cost estimate for the recommended option is **$3.15 million, in FY22/23 dollars excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.15 11kV Feeder from Gold Creek to Franklin

This EV-driven 11kV feeder project is driven by the need to provide reliable supply to service anticipated load growth in the suburb of Franklin, Harrison and its broader surrounds in the Gungahlin district.

The latest Evoenergy demand forecast shows load growth associated with the uptake of electric vehicles and their corresponding requirements for charging infrastructure, several new development projects, and planned government land release.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-2029 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from winter 2025.

There is therefore a need to provide additional supply capacity to meet the expected demand and to meet reliability requirements.

Evoenergy considered network and non-network solutions to address the identified network need as summarised in **Table 35.**

Table 35. Options assessment and preferred option identification -11kV Feeder from Gold Creek to Franklin

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from Gold Creek Zone substation	$5.18	$159.60	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from Civic Zone substation	$8.62	$156.81	Not selected due to lower NPV
3	Grid Battery to defer network option	$6.86	$158.67	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The Net Present Value (NPV) calculations are based on the cost of each option and reduction of risk relative to the base case. The primary risk assessed is unserved energy due to identified constraint within the network.

Option 1 implements a 5.7km 11kV feeder cable, making use of existing infrastructure for 1.7km of the route, with 4.0km being constructed, with the addition of a new switching station at the termination point. To address operational needs, the recommended solution to be implemented by winter 2025.

A preliminary cost estimate for the recommended option is **$5.18 million, in FY22/23 dollars excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.16 11kV Feeder from City East to Braddon

This EV-driven 11kV feeder project is driven by the need to provide reliable supply to service anticipated load growth in the suburb of Braddon and surrounding suburbs.

The latest Evoenergy demand forecast shows load growth associated with the uptake of electric vehicles and their corresponding requirements for charging infrastructure and several new development projects.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-2029 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from winter 2027.

There is therefore a need to provide additional supply capacity to meet the expected demand and to meet reliability requirements.

Evoenergy considered the following network and non-network solutions to address the identified network need. The options considered are summarised in **Table 36.**

Table 36. Options assessment and preferred option identification - 11kV Feeder from City East to Braddon

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from City East Zone substation	$3.83	$7.00	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from Civic Zone substation	$3.92	$6.93	Not selected due to lower NPV
3	Grid Battery to defer network option	$8.14	$3.96	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The Net Present Value (NPV) calculations are based on the cost of each option and reduction of risk relative to the base case. The primary risk assessed is unserved energy due to identified constraint within the network.

Option 1 addresses the network need, is technically and economically feasible, and has the highest NPV. The recommended option requires a construction of 2.2 km of 11 kV distribution feeder and installation of a new switching station. To address operational needs, the recommended solution to be implemented by winter 2028.

A preliminary cost estimate for the recommended option is **$3.83 million, in FY22/23 dollars excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.17 11kV Feeder from City East to Watson

This EV-driven 11kV feeder project is driven by the need to provide reliable supply to service anticipated load growth in the suburb of Watson, Hackett and surrounding suburbs.

The latest Evoenergy demand forecast shows load growth associated with the uptake of electric vehicles and their corresponding requirements for charging infrastructure, several new development projects and planned government land release.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-2029 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from winter 2028, with significant unserved energy occurring in 2029.

There is therefore a need to provide additional supply capacity to meet the expected demand and to meet reliability requirements.

Evoenergy considered the following network and non-network solutions to address the identified network need. The options considered are summarised in **Table 37.**

Table 37. Options assessment and preferred option identification - 11kV Feeder from City East to Watson

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from City East Zone substation	$5.36	$25.27	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from Civic Zone substation	$6.87	$24.20	Not selected due to lower NPV
3	Grid Battery to defer network option	$10.12	$22.07	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The Net Present Value (NPV) calculations are based on the cost of each option and reduction of risk relative to the base case. The primary risk assessed is unserved energy due to identified constraint within the network.

Option 1 implements a 4.3km 11kV feeder cable with the addition of two new switching station at the termination point and City East zone substation site.

A preliminary cost estimate for the recommended option is **$5.36 million, in FY22/23 dollars excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.18 11kV Feeder from City East to Ainslie

This EV-driven 11kV feeder project is driven by the need to provide reliable supply to service anticipated load growth in the suburb of Ainslie, Downer & Dickson suburbs.

The latest Evoenergy demand forecast shows load growth associated with the uptake of electric vehicles and their corresponding requirements for charging infrastructure, several new development projects, and planned government land release.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-2029 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from winter 2027, with substantial unserved energy occurring from 2029 onwards.

There is therefore a need to provide additional supply capacity to meet the expected demand and to meet reliability requirements.

Evoenergy considered the following network and non-network solutions to address the identified network need. The options considered are summarised in **Table 38.**

Table 38. Options assessment and preferred option identification - 11kV Feeder from City East to Ainslie

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from City East Zone substation	$5.36	$6.17	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from Civic Zone substation	$5.66	$5.96	Not selected due to lower NPV
3	Grid Battery to defer network option	$5.81	$5.99	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The Net Present Value (NPV) calculations are based on the cost of each option and reduction of risk relative to the base case. The primary risk assessed is unserved energy due to identified constraint within the network.

Option 1 is recommended as it has the lowest capital expenditure required and greatest NPV. This option consists of installing a new 3.8km 11kV feeder cable from City East zone substation. This option includes provisions for two new switching station at the City East zone substation site and the end of the proposed feeder. To address operational needs, the recommended solution to be implemented by winter 2029.

A preliminary cost estimate for the recommended option is **$5.36 million, in FY22/23 dollars excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.19 11kV Feeder from City East to Campbell

This EV-driven 11kV feeder project is driven by the need to provide reliable supply to service anticipated load growth in the suburb of Campbell and surrounding suburbs.

The latest Evoenergy demand forecast shows load growth associated with the uptake of electric vehicles and their corresponding requirements for charging infrastructure and several new development projects.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-2029 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from summer 2027, with substation unserved energy arising in 2029.

There is therefore a need to provide additional supply capacity to meet the expected demand and to meet reliability requirements.

Evoenergy considered the following network and non-network solutions to address the identified network need. The options considered are summarised in **Table 39.**

Table 39. Options assessment and preferred option identification - 11kV Feeder from City East to Campbell

Option		Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure – base case option	$0	$0	Not selected due to operational risk
1	New 11kV feeder from City East Zone substation	$5.24	$3.57	**Recommended** – Highest NPV technically feasible option
2	New 11kV feeder from East Lake Zone substation	$5.38	$3.48	Not selected due to lower NPV
3	Grid Battery to defer network option	$7.56	$2.33	Not selected due to lower NPV
4	Demand Management with Behind the Meter Batteries to defer network option	N/A	N/A	Not selected as does not meet minimum requirements

^FY22/23 dollars, excluding corporate overheads, excluding contingency and excluding GST

*NPV is relative to base case – utilise existing network infrastructure.

The Net Present Value (NPV) calculations are based on the cost of each option and reduction of risk relative to the base case option. The main risk corresponds to assessed unserved energy due to identified network constraint.

Based on the cost-benefit analysis **Option 1** is the recommended option.

Option 1 addresses the network need, is technically and economically feasible, and has the highest NPV. The recommended option requires a construction of 4.0km of 11 kV distribution feeder and the installation of a switching station at the termination point. To address operational needs, the recommended solution to be implemented by winter 2029.

A preliminary cost estimate for the recommended option is **$5.24 million, in FY22/23 dollars excluding corporate overheads, excluding contingency, and excluding GST.**

7.8.20 Strathnairn Zone Substation

This project addresses the growth of electricity demand in Ginninderry, a major residential greenfield development. The maximum demand in the Ginninderry area is forecast to increase steadily over the next 30 years as load grows in the new and developing suburbs of Strathnairn, Macnamara, as well as other subsequent currently unnamed suburbs. The development of this area will include around 15,500 residential dwellings, plus commercial and community facilities. The development is located considerable distance from the existing zone substations which could be utilised to support ongoing development of Ginninderry.

Evoenergy considered long-term supply options for this area. It was determined that the existing Latham Zone Substation and 11 kV distribution feeders would be capable of meeting forecast demand in the initial stages of the development. However, over the longer term, a more robust solution is required to support ongoing development.

In 2018, Evoenergy conducted a study with the objective to identify the most efficient options to address the growing demand in the Ginninderry area. The option chosen was a hybrid solution consisting of low-cost feeder extensions coupled with a demand management scheme, involving the procurement of residential battery capacity from Evoenergy customers. Ultimately, this scheme has fallen well below expectations, with around 25% of customers invited by Evoenergy choosing to participate in the scheme.

The studies indicated that the demand growth will be driven by the residential load and that the network will be limited by winter loading conditions. Load forecasting indicates that the capacity provided by the demand management scheme combined with the existing 11 kV feeder network supporting the Ginninderry District will be insufficient to supply the forecast load beyond 2026. The demand after 2025 is projected to exceed thermal capacity of the available distribution network.

We have assessed the projected demand growth against the highly loaded existing network and non-network solutions including grid scale and behind the meter battery storage systems to address the identified capacity constraints.

The options considered included:

- Option 0: Utilise existing network infrastructure (base case).
- Option 1: Grid battery to defer zone substation.
- Option 2: Construct new Strathnairn Zone Substation
- Option 3: Distribution feeders to defer zone substation.
- Option 4: Behind the meter batteries to defer zone substation.

The cost-benefit analysis is based on comparison of costs and benefits and the calculation of the net benefits. The assessment indicates that the main benefit of investment relates to mitigation of operational risks, predominantly the reduction of unserved energy in comparison with the base case option.

The results of the options evaluation are summarised in **Table 40.**

Table 40. Options summary – Strathnairn Zone Substation

Option		Cost^ (millions)	NPV^* (millions)	NPC	Evaluation Summary
0	Utilise existing network infrastructure	$0.00	$0.00	$0.00	Not selected due to high operational risk
1	Grid battery to defer zone substation.	$57.90	$509.44	$39.34	Not selected due to lower NPV and high capital cost
2	New Strathnairn Zone Substation (single transformer)	$42.04	$517.26	$31.53	**Recommended** – Highest NPV technically feasible option. Lowest cost.
3	Distribution feeders to defer zone substation.	$48.53	$514.12	$34.58	Not selected due to lower NPV and higher cost than the recommended option
4	Demand Side Management through behind-the-meter batteries	$48.65	$514.12	$34.66	Not selected as it does not meet minimum requirements.

Option 4 involving use of behind-the-meter batteries was considered in conjunction with Option 2 and Option 3. Behind-the-meter battery resources are not sufficient to achieve adequate reduction in demand and to allow for a deferment of major network investment as a standalone investment or conjunction with other options.

Assessment of network constraints and operational risk point to a need for a zone substation at Strathnairn in the 2024-2029 period. Since the thermal limits of feeders are reached, compliance with regulatory obligations and licence conditions is a key consideration. Option 2, substation with a single transformer, is a solution with the lowest net present cost and the highest NPV. A substation in Strathnairn provides the most efficient long-term solution. Evoenergy communicated with the Strathnairn developer and identified a suitable site for this future zone substation. The project will be subject to the Regulatory Investment Test for Distribution (RIT-D) and consultation with market participants. The RIT-D process will further explore opportunities for the application of other solutions including non-network solutions.

The proposed investment in the Strathnairn Zone Substation is to comprise the following components:

- Land acquisition
- 132/11 kV transformer with an 11 kV switchboard and buildings for housing switchgear
- 132 kV connection to the existing overhead transmission system including 132 kV bus and circuit brakers (diagram)
- initial distribution feeder trunk connections between Strathnairn Substation and the distribution network

The estimated direct cost of the recommended option which includes the above components is $42.04 million (2022/23)[25]. The recommended commissioning date is before winter in 2027/28 financial year.

7.8.21 Molonglo Zone Substation 2nd Transformer

Molonglo Valley is a major residential development area with a population of over 55,000 in the western part of the Australian Capital Territory. The Molonglo Valley load consists of mainly residential load, commercial and community electrical load. The existing load is supplied by distribution feeders from the Woden Zone Substation and the Civic Zone Substation. The valley is to be also serviced by the grid battery (2024) and a single transformer 132/11 kV Molonglo Zone Substation to be installed in 2025 (see **Section 7.6.1**). This project addresses the security of supply in the Molonglo Valley following installation of the Battery Energy Storage System (BESS) and the 1st transformer at Molonglo Zone Substation. The project considers continuing growth in electrical demand post 2025 as the new and existing suburbs continue to develop.

The BESS and single transformer Molonglo Zone Substation commenced as the result of the previous network studies and the Regulatory Test Investment Test for Distribution completed in September 2020. The RIT-D concluded that the installation of the zone substation is the most economic long-term solution, after the initial implementation of the demand management option (BESS) with an aim to defer a major network investment in the zone substation[26]. Evoenergy forecast expenditure includes installation of the first transformer in 2025 followed by the proposed installation of the second transformer in 2029.

Detailed assessment of the network constraints and investment drivers after the installation of the first transformer confirms that from 2025, in the event of an outage of the single transformer installed at Molonglo Zone Substation, the available distribution feeder capacity would not be sufficient to cater for the maximum demand. The projected shortfall is high and projected to grow significantly into the future.

The project considered analysis of alternative solutions including network and non-network options. The non-network options included BESS and use of Distributed Energy Resources (DER) such as behind-the-meter batteries. The result of the options evaluation is summarised in the **Table 41** below.

25 The direct cost in 2022/23 dollars excluding GST, corporate overheads and does not include any contingencies.
26 Evoenergy also considered moving existing mobile substation from Angle Crossing to Molonglo, which was unavailable after the substation was rendered un-operational after major electrical fault.

Table 41. Options assessment and preferred option identification – Molonglo Zone Substation 2nd Transformer

Ref	Option	Capital Cost ($ Millions)	Net present Value ($millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0.00	$0.00	Not selected – not feasible due to high operational risk
1	Grid battery to defer installation of the 2nd transformer	$113.81	-$13.44	Not selected due to very low NPV and very high cost
2	Installation of the 2nd transformer	$9.11	$66.49	**Recommended** – Highest NPV and lowest cost technically feasible option
3	Demand side management based on DER[27]	$9.37	$66.32	Not selected as it does not meet minimum requirements.
4	Distribution feeders to defer zone substation transformer	$19.49	$59.12	Not selected due to lower NPV and higher cost

The analysis concluded that Option 2 (installation of the 2nd transformer) is the most efficient long-term solution as it has the highest NPV and the lower Net Present Cost. The proposed investment is to comprise the installation of the following components:

- Installation of the second 132/11 kV 55 MVA transformer at Molonglo Zone Substation.
- Installation of the 11 kV switchboard and switchroom.
- 132 kV circuit breaker connecting the power transformer to the transmission system.

The proposed installation of the second transformer in 2028/29 is based on the regulatory compliance and operational risk. Under Australian Capital Territory Electricity Transmission Supply Code, Evoenergy has an obligation to provide sufficient capacity to continue supply after credible network contingency. However, in an event of the transformer outage, the projected demand would be too high to be transferred to other zone substations. The proposed timing is the result of combined assessment of operational risk, compliance and deliverability following the failure of mobile substation and delay in grid battery installation.

A preliminary cost estimate for the recommended option is $9.11 million (2022/23 dollars) excluding corporate overheads, excluding contingencies, and excluding GST.

27 Distributed Energy Resources including behind-the-meter batteries.

7.8.22 Decommissioning of Causeway 132kV Switching Stations

Please note that this project is initiated and fully funded by the customer and hence timelines are dependent on the customer.

Causeway Switching Station located in the Kingston suburb at the eastern end of Lake Burley-Griffin, provides a point of 132 kV interconnection between City East, East Lake, Telopea Park and Gilmore zone substations. Connections to Causeway Switching Station comprise three 132 kV underground cable circuits to Telopea Park Zone Substation, a single circuit 132 kV overhead line to Gilmore Zone Substation, a single circuit 132 kV overhead line to City East Zone Substation, and a single circuit 132 kV overhead line to East Lake Zone Substation. Sections of these latter two lines traverse the Jerrabomberra wetlands nature reserve.

The site of Causeway Switching Station is surrounded by new apartment buildings and the Suburban Land Agency (SLA) has indicated their desire to redevelop the switching station site for similar residential purposes. The SLA has requested Evoenergy to convert the 132 kV overhead lines in the vicinity of Causeway to underground cables and decommission the switching station. The proposed scope of works is as follows:

- Install three 132 kV cable circuits comprising one single core cable per phase (each circuit 3 x 1c/630 mm² Cu XLPE) from East Lake Zone Substation through the Jerrabomberra wetlands to Causeway Switching Station to through-joints to the existing Causeway–Telopea Park cable circuits. This route includes directional drilling under the Jerrabomberra Creek. This will create three 132 kV underground cable circuits all the way from East Lake to Telopea Park, each rated at 127 MVA. These existing circuits are currently transformer feeders as there is no 132 kV bus at Telopea Park Zone Substation. It is proposed to retain them as transformer feeders.
- The East Lake–Causeway 132 kV circuit is currently approximately 1.4 km underground cable connected to approximately 1.6 km overhead line. The cable section will be reconnected to the City East line and the overhead section demolished. This will create a new East Lake–City East 132 kV circuit rated at 220 MVA.
- The Causeway–Gilmore 132 kV circuit is currently all overhead. A 132 kV underground cable circuit comprising twin single core cables per phase (6 x 1c/1600mm² Cu XLPE) will be installed approximately 2.9 km from East Lake Zone Substation to connect to the existing overhead line at a new three concrete pole UGOH structure to replace pole no T87 at the corner of Canberra Ave and Monaro Highway. This will create a new East Lake–Gilmore 132 kV circuit rated at 457 MVA.
- Causeway Switching Station will be subsequently decommissioned and dismantled.

Figure 34 shows the existing Causeway 132 kV Switching Station.

Figure 34. Causeway Switching Station

The overhead to underground conversion works including decommissioning of Causeway Switching Station will be funded by the project proponent (developer). The construction works are expected to be undertaken over a period between 2024 and 2028

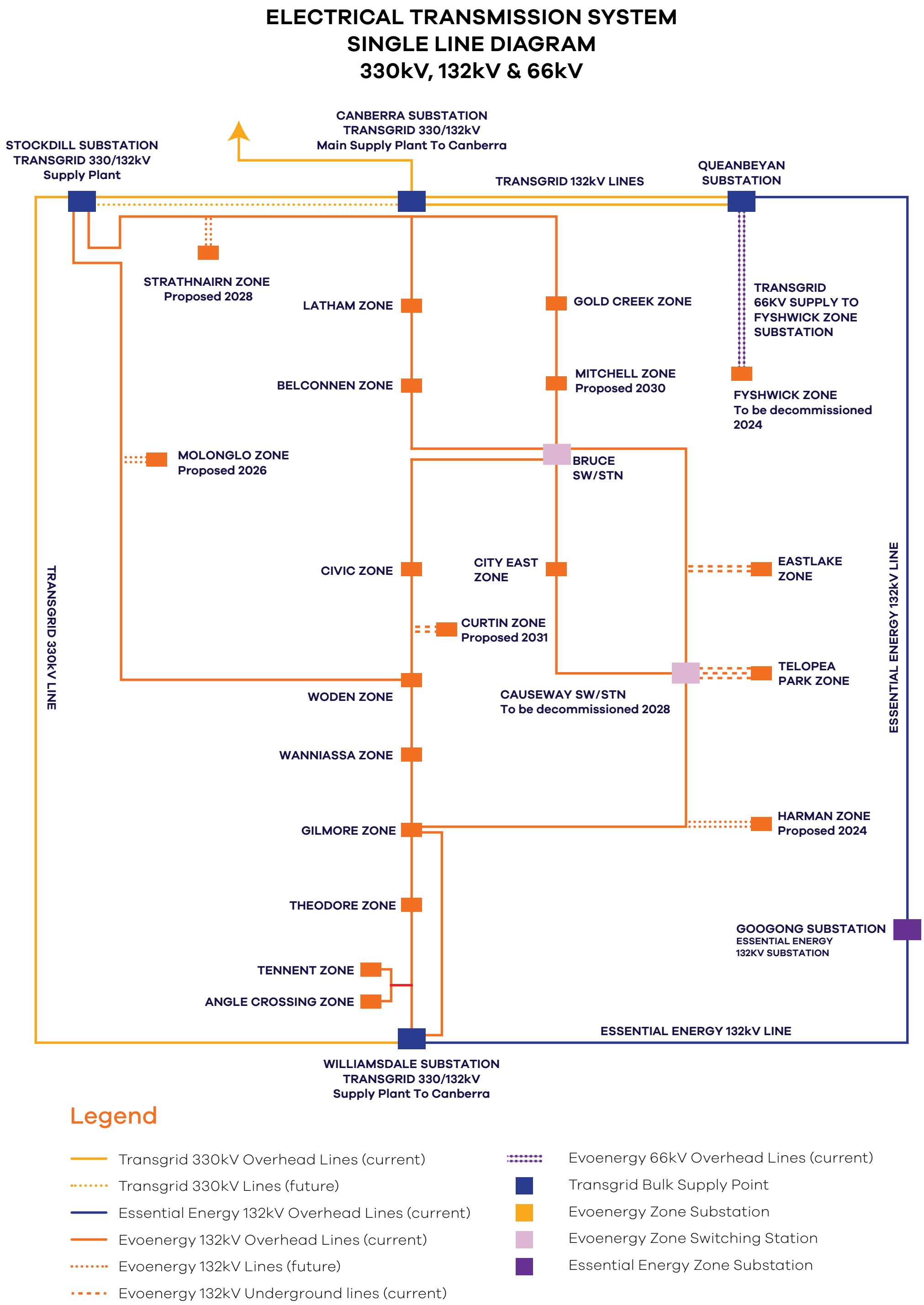
Figure 35 illustrates this proposed development.

Figure 35. Causeway Switching Station – Proposed 132 kV Cabling

7.8.23 Future Subtransmission Network

Figure 36 shows future development of the subtransmission network over the next ten years.

Figure 36. Future (10 years) Subtransmission Network



7.9 Constraints Requiring Detailed Technical Studies

7.9.1 Contingency Voltage Support

During joint planning with Transgrid the voltage levels in the system under the special contingency condition were considered. Analysis showed that in the event of a total Canberra Substation outage, after Stockdill substation commissioning, voltage levels in the northern part of Evoenergy's network could fall below regulation levels.

In order for voltage levels to be maintained for this non-credible contingency event, Evoenergy has investigated the installation of reactive support equipment, with the most cost-effective solution being the installation of an 11 kV 10 MVAr capacitor bank at each of Evoenergy's northern zone substations.

Evoenergy is working closely with Transgrid to determine the most prudent solution for this issue.

This potential constraint will continue to be kept under review due to the increased penetration of distributed energy resources including the large batteries proposed under the ACT Government renewables reverse auction process and other programs.

7.9.2 Belconnen Zone Substation Third Transformer

Most years the peak demand for Belconnen Zone Substation sits between the continuous and 2-hour emergency rating for the substation. Over the next decade the maximum demand is forecast to increase however it is not expected to exceed the 2-hour emergency rating. As we see additional growth in the area as well as the impacts of ACT Government policies around zero emission vehicles and gas transition this may need to be reassessed. If the forecast maximum demand over the decade increases by approximately 10MVA Evoenergy will need to consider the installation of a third transformer at the zone substation. This project has been tentatively marked for the 2029-2034 regulatory period pending review.

7.9.3 Mitchell Zone Substation

Due to the extensive growth in the Gungahlin and North Canberra regions Evoenergy is expecting to require the first stage of a new zone substation to be commissioned early in the 2029-2034 regulatory period with work expected to begin in the 2024-2029 regulatory period. This is in addition to the third transformer proposed to be installed at the Gold Creek Zone Substation.

Evoenergy is currently working with the ACT Government to identify an appropriate site for this future zone substation which is tentatively name the Mitchell Zone Substation due to the proposed location. As well as supplying additional capacity to the Gungahlin region, this zone substation is proposed to alleviate forecast constraints on City East Zone Substation primarily due to net zero load growth.

Evoenergy is expecting to confirm land procurement and complete a RIT-D for this project later in the 2024-2029 regulatory period. This project and RIT-D will progress pending detailed options analysis and the timing is expected to be confirmed in 2027.

7.9.4 Curtin Zone Substation

The Woden Valley is experiencing significant growth primarily due to urban infill and redevelopment. Stage 2B of the Canberra light rail project will run to Woden. This is expected to increase the rate of intensification in the area.

Although the construction of the Molonglo Zone Substation is expected to ease some constraints in the Molonglo Valley which is currently primarily supplied from Woden Zone Substation, development in the Woden Valley is expected to create additional constraints on the Woden Zone Substation. Projects include the Canberra Hospital expansion, Transport Canberra Electric Bus Depots, expansion and redevelopment of the Woden CIT campus and redevelopment of several government offices. In addition to this will be the sale of flat car parks and infill developments in Curtin and Yarralumla. The constraints arising from this development will be exacerbated by net zero load growth, particularly the increased uptake in electric vehicles and associated charging infrastructure.

Evoenergy is expecting to require an additional zone substation in the Woden Valley region early in the 2029-2034 period. Evoenergy will be working with the ACT Government to identify an appropriate site for this future zone substation. It is tentatively named the Curtin Zone Substation as Evoenergy's 132kV overhead lines pass by Curtin, indicating this may be an appropriate location. This proposed zone substation will also help to offload forecast constraints on the Telopea Park Zone Substation.

Evoenergy is expecting to confirm siting and complete a RIT-D for this project later in the 2024-2029 regulatory period. This project and RIT-D will progress pending detailed options analysis and the timing is expected to be confirmed in 2027. This will include necessary 132kV augmentation work.

7.9.5 East Lake Third Transformer

With the load from Fyshwick Zone Substation being transferred to East Lake Zone Substation as well as growth in the Fyshwick, Airport, Pialligo and Kingston Foreshore area Evoenergy has forecast East Lake Zone Substation to exceed its winter continuous rating in the 2029-2034 regulatory period. Evoenergy will monitor this constraint and review the impacts of block loads as well as net-zero transition in order to determine the timing of the constraint.

7.9.6 Zone Substations Reactive Plant

As penetration of consumer energy resources such as rooftop PV increases we are expecting to see a deterioration of power quality at the zone substations, such as the issues seen at Gold Creek Zone Substation. Evoenergy has identified that reactive plant may be needed at zone substations. This is subject to detailed analysis and proposed investments will be detailed as they are identified.

7.10 Regulatory Investment Test

Under NER projects above $6 million funded by Evoenergy are subject to regulatory investment test. In 2022 Evoenergy published the non-network options report for the Gold Creek Zone Substation Capacity Constraint. The project resulting from the previous Molonglo Valley constraint RIT-D is ongoing. Subject to the outcome of detailed technical studies, currently the network limitations identified during the planning review include additional limitations which are likely to require regulatory investment test: Strathairn Zone Substation, Mitchell Zone Substation, Belconnen Zone Substation Third Transformer and Curtin Zone Substation. Depending on detailed cost estimates there may also be some feeder projects which may qualify for RIT-D.

Chapter 8: Demand Management

8.1 Overview

Demand Management (DM) is deliberate action taken to reduce energy demand from the grid, rather than increasing supply capacity to meet increased demand.

Historically, DM has been focused on addressing network constraints resulting from a growth in demand using non-network options. These options are increasingly capable of being leveraged to address additional constraints, such as thermal or quality of supply issues, resulting from increased DER penetration. The drivers of network constraints, including DER, are outlined in **Chapter 4** and **Chapter 5**.

In the modern context, DM may also theoretically unlock more rooftop solar PV, other DER or new services (e.g.: batteries/ virtual power plants (VPPs), electric vehicles (EVs), energy markets, etc) and provide improved flexibility to customers. It can therefore be considered a planning and operational approach which ultimately facilitates the Distribution System Operator (DSO) paradigm, where DNSPs provide a customer-centric "platform" for energy services, adding value to customers through cost reduction, emissions reduction, and flexibility.

In the context of the Australian NER investment funding regulations, DM traditionally represents operational expenditure for network businesses, who contract for, and otherwise support, DER and other non-network solutions as an alternative to investing capital in new or augmented network infrastructure. However, as regulation evolves and technology matures and reduces in price, DM may be provided by economical and regulatory compliant capex options such as batteries to shift demand peaks.

DM is an important part of efficient and sustainable network operations. Effective use of DM reduces the cost to maintain the network and helps lower electricity charges for the customer base.

We encourage all customers interested in participating in demand management to engage with Evoenergy through the pathways outlined in Chapter 1

8.2 Demand Management Challenges

There are a number of challenges for both Evoenergy and proponents of demand management that affect the proliferation of DM within the network. Some of the key challenges for Evoenergy include:

- **Identification of Need** – the ability to identify the demand management opportunities driven by factors impacting future network development (as outlined in **Chapter 2**) with sufficient time to establish a non-network solution. This is especially evident on small-to-medium scale constraints where the timeframe from need identification to implementation is reduced.
- **Communication of Need** – communicating the constraint and relevant information to proponents in a way that is targeted, timely and effective to enable proponents to engage with DM opportunities.
- **Availability of Options** – there are a limited number of established DM options that can be deployed in targeted network locations where a localised constraint is identified.
- **Commercial Considerations** – the implementation of technology-based DM requires robust commercial arrangements where the proponent is satisfied and

Evoenergy can ensure that risks related to the safe, reliable, and secure management of the network are appropriately managed.

- **Regulations** – the regulatory framework restricts Evoenergy's ability to effectively deploy some DM solutions to address network constraints. The review of the framework and associated market rules currently being performed by governing bodies may address these challenges or pose additional regulatory challenges.

Some of the current challenges for proponents of DM solutions include:

- **Cost** – the cost of technology-based DM solutions and establishment remains prohibitive for a number of scenarios, such as community batteries.
- **Assurance of Investment** – proponents of DM solutions want to minimise the risk to returns on invested capital. This is difficult with potential changes to market structures occurring in over the medium term.[28]
- **Technology** – although technology is evolving rapidly, a number of DM-capable solutions are yet to mature or adhere to common standards required for application. This is expected to change in the near term.

Evoenergy is working to address these challenges and maintaining an awareness of the challenges facing proponents to ensure that the full scale of DM options is addressed against network needs.

8.3 Demand Management Initiatives

Evoenergy have several existing mechanisms to promote demand management and address key challenges as outlined below:

Need Identification

- Planning processes for the distribution network consider non-network options within business cases and project justification reports. This provides assurance that the optimal solution is identified and overall cost benefit impact for both network and non-network options are evaluated.
- Proactive engagement with consumers in large greenfield estates, such as Ginninderry, have resulted in DM solutions being implemented.

Communication

- Evoenergy has developed a Demand Side Engagement Strategy (DSES) that is published on our website[29]. This strategy outlines the approach to building and promoting a constructive working relationship between Evoenergy and non-network solution providers.
- Forecast network constraints are published in the Annual Planning Report (**Chapter 7**).
- Evoenergy maintains a Demand Side Engagement Register[30] where network service providers can register as an interested party.

28 Energy Security Board post 2025 market review http://www.coagenergycouncil.gov.au/energy-security-board/post-2025
29 https://www.evoenergy.com.au/emerging-technology/demand-management/demand-side-engagement
30 https://www.evoenergy.com.au/emerging-technology/demand-management

- We maintain direct engagement with major customers to identify and implement DM solutions where required.

Availability of Options

- Through arrangements with aggregators, the use of virtual power plants to address network constraints is developing wider coverage across the network.
- Evoenergy engages in a number of DM innovation projects, as outlined below, to support the development and application of non-network options.

Commercial Considerations

- Evoenergy has established contracts with aggregators and is increasingly engaging more proponents in the DER Aggregation program.
- Large customers have been engaged under DM contracts to reduce peak demand.

Regulations

- Evoenergy maintains active participation in industry bodies to support advocacy in pursuit of the national electricity objective.
- Our network management processes include maintaining visibility of, and responding to, rule change proposals and consultations from electricity governing bodies such as the AEMC, AER and AEMO as well as jurisdictional bodies such as the UTR and ICRC that address regulatory barriers associated with DM implementation.

These mechanisms are supported by a number of projects demonstrating application of different demand management solutions on the network:

- **Ginninderry Residential Battery Trial** - exploring the DM capabilities of smart residential battery systems in managing local network constraints in this fully electric, 100% solar uptake greenfield developments.
- **Molonglo RIT-D** - a greenfield development where load is rapidly approaching network capacity and a battery energy storage system has been assessed as a credible option as a result of the RIT-D process.
- **Peak Demand Tariffs** – Peak demand tariffs were introduced as the default option for customers with smart meters in December 2017. Uptake has been monitored and will be analysed for resulting DM effects.
- **Tariff Trials** – As the uptake of battery technology (both residential and large-scale) increases, these trials aim to explore the suitability of highly cost reflective tariffs for customers with batteries and modern energy technologies. The tariffs are designed to provide energy customers who have batteries with sharper pricing signals, and the opportunity to better manage their load on the network and their network bill. This includes sending customers a price signal about the costs of importing and exporting energy at peak and non-peak times and incentivising efficient use of the distribution network. This has the potential to improve network utilisation and allow for the efficient integration of DERs, as battery technology becomes more widespread.
- **Project Converge** - The project researches and demonstrates Shaped Operating Envelopes (SOE) and their ability to provide demand management capabilities such as:
  - Reducing peak demand.
  - Deferring asset augmentation using non-network options.
  - Maintaining supply reliability.
  - Maximising integration of renewable generation in LV network through managing operating envelopes.

This project showcases how Evoenergy, and by extension other DNSPs, can implement DM with potential to reduce long-term network costs caused by increased DER through SOE's.

Chapter 7 and **Chapter 9** contain additional details regarding these projects.

8.4 Demand Management Future

Evoenergy is committed to continue actively seeking implementation of non-network solutions to replace or complement the need for network investment where this delivers a lower cost outcome that benefits all consumers.

In addition to the existing mechanisms Evoenergy is currently employing to develop our interaction with consumers and DM proponents, we are aiming to:

- Enhance our publication of network constraint reporting by developing our ability to identify network constraints, including those originating from DER, and publish these to proponents.
- Grow our DER aggregation program both by supporting consumer uptake of DER and by engaging DER aggregators to provide

DM and data services. Under the Next Generation Energy Storage program (Next Gen)[31], the ACT Government is supporting up to 5,000 battery storage systems in ACT homes and businesses. To be eligible for the program, battery systems are required to have the capability to send real-time data to the ACT Government. This is usually achieved through capabilities provided by a DER aggregator. Evoenergy is actively engaging with Next Gen providers with the intention of growing the Aggregation program by procuring data and DM services, especially in areas where a network need is identified.

- Invest in, prepare for, and leverage future technologies. Through strategic initiatives and innovation projects, Evoenergy is ensuring that the DM opportunities presented by these technologies are effectively leveraged to manage network constraints. Additional detail regarding current innovation projects is included in **Chapter 9**.
- Further advocacy and engagement with stakeholders. Evoenergy is proactively engaging with local government to identify upcoming DM opportunities such as land releases, urban infill incentive schemes and changes to government policies.
- Review the network tariff structures to ensure they incentivise efficient use of the network to help integrate increasing numbers of batteries, solar, electric vehicles and other DER related technologies.

Evoenergy aims to utilise the outcomes from these activities to support existing planning and operational processes to facilitate the application of DM on the network.

31 https://www.actsmart.act.gov.au/what-can-i-do/homes/discounted-battery-storage

Chapter 9: Future Ways Of Working

9.1 Overview

Evoenergy has many innovative projects currently underway that investigate the impact and coordination of distributed energy resources with the electricity network. Evoenergy conducts these projects through network funding and in close collaboration with state and federal governments who partner with Evoenergy as well as with research institutions. The projects underway are largely a continuation of projects from previous years in the DER space along with EV related projects. Leveraging these smart DER technologies to efficiently manage and operate the network would be critical as Evoenergy transitions into a Distribution System Operator (DSO) role.

Projects that coordinate Solar PV systems with the electricity network are becoming increasingly prevalent for distribution networks, reflecting their importance. To this end, Evoenergy has initiated an orchestration project for DER which covers all eligible systems within the whole of ACT called Project Converge. Evoenergy's existing VPP program has been utilised to accelerate this new initiative, in addition to using the VPP data for various network planning and constraint identification and mitigation analyses. Other existing projects such as the Ginninderry Residential Battery Trial have also progressed which has been detailed in the section below.

9.2 Project Converge

Project Converge is an ARENA sponsored project structured as a collaboration between Evoenergy, ANU, Zepben and other aggregators such as Reposit Power and Evergen. As lead participant Evoenergy has been key to delivering a successful trial, with the project's close scheduled for March 2024 after three years of development.

Project Converge addresses the problems of a congested network through a novel Shaped Operating Envelope (SOE) methodology building upon the existing methodology of Dynamic Operating Envelopes (DOEs). A network operating at its physical or operational limits is said to be congested because it cannot accommodate additional flows of energy. When congestion occurs within the distribution network, the ability to incorporate DER while also supporting energy reliability and energy security is diminished. New technology capabilities, regulations and market mechanisms are necessary to support the integration and participation of DER in markets for energy and ancillary services without risking congestion.

Project Converge demonstrates how DER can provide network ancillary services while also bidding into energy markets. These capabilities are expected to allow DER to alleviate grid constraints caused by power quality or physical network constraints and thereby unlock further network capacity without the need for additional network investment.

Project Converge aims to:

- design and develop a system to support the integration of higher penetrations of DER into the ACT distribution network;
- deploy new software systems to demonstrate the Shaped Operating Envelope concept for DER;
- integrate hardware, software and systems to pilot capabilities with over 1,000 existing customer-owned DER assets;
- deliver open-source, royalty free designs and models which can be adopted by other Australian DNSPs;
- deliver a range of knowledge sharing reports and webinars to share lessons with industry.

Project Converge is expected to:

- demonstrate that Shaped Operating Envelopes can extend dynamic operating envelopes to incorporate locally delivered network services, by use of non-network DER solutions, procured through a real-time investment decision making process;

- demonstrate that dynamic network services procured from DER assets can potentially minimise or defer network augmentation costs
- demonstrate that network capacity can be maximised to enable DER to participate in energy and ancillary services markets;
- identify an approach for DER congestion management and market bidding to inform future regulatory and market changes.

Results and lessons learnt from Project Converge will be open source so as to allow further growth in the industry. These lessons learnt will also feed back into Evoenergy as we develop our strategy and ultimately build a platform that can provide Operating Envelopes to our customers.

9.3 Ginninderry Energy Pilot Project (EPP)

This is a continuing project for Evoenergy that aims to assess the real time implications from an electricity-only neighbourhood with a very high penetration of solar PV systems. The EPP will cover the planning, design and construction/installation of the relevant infrastructure, and post-occupancy data collection in respect of the performance of the residential energy systems and their interaction with the electricity grid within Stage 1 of Ginninderry.

The Ginninderry Joint Venture (JV) has obtained a *Territory Plan Waiver* from the *ACT Government's Environment, Planning and Sustainable Development Directorate (EPSDD)* to allow Stage 1 of the development to be built without gas reticulation to its residents – making it the first ACT neighbourhood to be fully electric with 100% of dwellings having solar PV systems.

Evoenergy has partnered with ACT Government to utilise the *Next Gen Battery Scheme* to maximise the uptake of battery powered systems to trial for the energy pilot in conjunction with the HEMS devices. In line with this objective, in September 2020, Evoenergy received a grant from the ACT Government under the Renewable Energy Innovation Fund (REIF) for the Ginninderry Residential Battery Trial. This grant is being used to provide further subsidies for residential batteries in Stage 1A of the development, in addition to the Next Gen Battery rebates. The Trial is aimed at exploring how HEMS enabled residential battery systems can be leveraged to manage the local network in this fully electric, 100% PV penetration scenario.

Power system modelling has indicated that 100% PV penetration will likely cause undesirable voltage fluctuations due to the difference between the extremes of peak export in the summer months and the peak consumption period in the winter months (which is further exacerbated by the consumers not having access to gas supply). These fluctuations can be managed by adjusting the transformer 'taps' to keep the voltage in the acceptable range. Stage 1 of Ginninderry has been developed by installing automatic On-Load Tap Changer (OLTC) substations and other combinations of technologies are to be trialled in subsequent stages.

Once the construction / installation of the relevant infrastructure is completed, the Ginninderry EPP will provide vital real-time information to the Ginninderry Joint Venture and Evoenergy to inform future stages of Ginninderry and other developments exploring emerging energy options for neighbourhoods and communities.

It is projected that in the coming few years, the majority of new detached dwellings in the ACT will feature rooftop PV installations. These home PV systems will exist alongside EV charging stations, solar farms on the city fringe, in-home batteries and a range of other localised energy generation, management, and storage systems. With these will come the demand for more agile network management, new tariff structures, and new commercial models. The EPP is a collaboration that seeks to address these issues in a collective way – bringing together the Government, energy utility, research institutions, interested parties (developers and product suppliers) and residential interests and concerns. Evoenergy considers optimum network and non-network solutions for Ginninderry development and from the network capacity limitations perspective it is also discussed in **Chapter 7**.

9.4 EVGrid Trial

EV charging or transport electrification has the potential to improve electricity network efficiency by increasing network energy throughput leading to a reduction in network charges to all customers, but the benefit can only be realised if no/limited additional network investment is required to enable EV charging. If not managed efficiently, even non-EV owners will bear the burden of the cost of additional network capacity required to charge EVs.

EVGrid Trial is a continuing project developing demand management capabilities required to manage peak electricity demand from residential electric vehicle (EV) charging. The project objectives are:

- Understand the impact of uncontrolled EV charging on the local network.
- Understand what and when spare capacity is available in the existing network and how the available spare capacity can be used to charge EVs.
- Demonstrate the role that DNSPs can have in managing residential EV charging to derive optimal outcomes for the network and all of its customers.
- Understanding customer behaviour regarding EV charging and willingness for participation in multiple forms of EV charging demand management programs.
- Understanding load forecast for managed EV charging and estimating incremental investment required in the future after spare network capacity is fully utilised.

The project formally commenced in January 2021, following ARENA approval, and concluded in April 2023 when the final report was published. The trial comprised of four milestones.

Through undertaking the trial, Evoenergy and other participating networks have realised the following benefits:

- Understanding of demand reduction gained through holding Demand Response (DR) events.
- Understanding of the level of consumption encouraged during solar generation periods gained through holding Solar Soak (SS) events.
- Greater understanding of the participants' behaviours and preferences.
- Technical capability development.

A major factor for customer participation in the incentivised events was around customer availability and access to their EV charger (for example, if they were at home or not). If events are designed to occur in time periods where participants may not be home, networks should consider providing sufficient timing to allow participants to plan around their schedule if they want to participate, such as allowing time to arrive home to plug-in their charger or to ensure their charger does not charge prior to a SS event. Additionally based on overall results, the project concluded that, a notice period of around two to three days provided the highest rate of event participation.

Any implementation of the lessons learnt will need to consider the applicability for mass market EV adoption given the small scale of the trial's cohort of participants which are likely to reflect highly engaged early adopters, those that are informed and aware of their charging behaviours and those that have other behind the meter technologies such as solar PV. Future EV owners may not be as engaged or technologically aware which may impact the effectiveness of managed charging via DR and SS events and may also impact the network differently to those within the trial.

9.5 Tariff Trials

Undertaking tariff trials is a continuation of Evoenergy's Tariff Structure Statement (TSS) strategy and allows Evoenergy to future-proof its tariff structure, so that it is ready to accommodate a growing number of consumers with batteries, solar, electric vehicles and other advanced energy technologies. Tariff trials offer an important opportunity to test new tariff concepts, refine tariff parameters, and gain valuable feedback from our customers. In turn, this can help inform the future direction of Evoenergy's tariff strategy and provide evidence to support Evoenergy's proposals to the Australian Energy Regulator (AER).

Evoenergy's tariff trials help consumers manage their network bills, improve network utilisation, and reduce long-term costs while helping support a safe and reliable electricity distribution network.

During the 2019–24 period, Evoenergy trialled two new tariffs which were informed by close engagement with consumers and retailers. These were:

1. **Residential Battery Tariff**

   Evoenergy designed a residential battery tariff trial for residential customers with controlled batteries and EVs, supported by modern renewable energy technologies. The tariff trial provided a unique opportunity for Evoenergy to test new network tariffs that could be suitable as the uptake of renewable technologies increases across the network in the future.

   The design of this tariff and stakeholder feedback has informed Evoenergy's proposed residential tariff reforms for the 2024–29 period.

2. **Large Scale Battery Tariff**

   Given that a number of large-scale batteries are expected to be introduced to the ACT electricity distribution network, Evoenergy trialled a tariff designed for large-scale, distributed network-connected, stand-alone batteries.

   The large-scale battery tariff trial provided Evoenergy with an opportunity to test customer responses to highly cost-reflective price signals. The trial was particularly important given that large-scale batteries generally respond to a range of price signals (including wholesale prices and FCAS), not only network price signals.

   This tariff trial has culminated in the proposed introduction of new large-scale battery tariffs as part of Evoenergy's regulatory proposal for the 2024–29 period.

Evoenergy is committed to continuing its collaboration with the AER, consumers, and retailers on opportunities for additional tariff trials in the future. This may include new tariff trials targeting EV charging, including tariffs designed for public charging stations, during the 2024–29 period.

9.6 Innovation Projects

In addition to the targeted activities outlined above, Evoenergy is currently engaged in several innovative projects that will help shape the future working and operation of our business. These projects are in conjunction with universities, private enterprises, retailers, and other network providers who are investigating options to maximise the consumer benefit of the existing infrastructure while unlocking the value generated by consumers. These projects enhance the capabilities of Evoenergy to transition into a Distribution System Operator (DSO) in line with our strategy. **Table 42** and **Table 43** outline some of the key projects we are currently involved in and their proposed timings.

Table 42. Electric Vehicle Based Innovation Projects

Innovation Projects	Timing	Details	Website
Realising Electric Vehicle to Grid Services (REVS)	2020- 23	Demonstrate the economic, technical, and social case for leveraging V2G (Vehicle to Grid) services within the electricity grid, and reduce the complexity and confusion for consumers, business, and policy decision-makers. The deployment of the systems and capabilities outlined by the project, as well as the research and analysis from all parties will provide the roadmap for accelerated V2G adoption both in ACT and nationally	Link
EVGrid Trial	2021- 23	Develop and demonstrate demand management (DM) capabilities required to efficiently manage peak electricity demand from residential electric vehicle (EV) charging in line with consumer expectations. Evoenergy is collaborating with EV owners in the ACT to test the concept of managing EV charging dynamically with real-time assessment of available network capacity. This project aligns with Evoenergy's strategic intent to support rapid uptake of EVs while utilising existing electricity distribution network infrastructure efficiently and avoiding unnecessary network expenditure.	Link

Table 43. Solar PV Based Innovation Projects

Innovation Projects	Timing	Details	Website
DER Lab Project	2019- 23	Establish a test facility at the Australian National University to allow for safe testing of new DER-based technologies, market participation software and other innovative new products under development. This project is now complete and the lab has been operational at ANU	Link
Ginninderry Residential Battery Trial	2021- 24	Develop and implement capabilities for managing demand in fully electric developments and/or areas with high solar PV uptake. With the support of the Ginninderry Joint Venture and the ACT Government's Renewable Energy Innovation Fund, Evoenergy is offering residents of selected blocks within Ginninderry Stage 1A an exclusive offer to receive a subsidy on eligible battery storage systems. This is enabling Evoenergy to collaborate with battery owners to alleviate network congestion. This project will play an important role in helping evolve the way we manage peak demand and excess solar generation on the network and ensure our energy network continues to be resilient, reliable, and cost efficient well into the future.	Link

Innovation Projects	Timing	Details	Website
Battery Tariff Trials	2021 - 24	Develop and implement cost reflective tariffs for residential and grid connected battery storage systems to reduce network congestion caused by high levels of solar exports during the middle of the day and incentivise exports during peak consumption hours when upstream assets are under heavy loads. Evoenergy received approval from the AER to trial the battery tariffs to provide pricing signals to BESS units in the network and encourage efficient utilisation of network assets while promoting uptake in renewable energy systems.	Link
Project Converge	2021 - 24	The project researches and demonstrates Shaped Operating Envelopes (SOE) and their ability to provide demand management capabilities such as: • Reducing peak demand • Deferring asset augmentation using non-network options • Maintaining supply reliability • Maximising integration of renewable generation in LV network through managing operating envelopes. This project showcases how Evoenergy, and by extension other DNSPs, can implement DM with potential to reduce long-term network costs caused by increased DER through SOE's.	Link

Appendix A: Glossary of Terms

Term	Definition
ACT	Australian Capital Territory
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AGGREGATOR	A party that facilitates the grouping of DER to act as single entity in the market
APR	Annual Planning Report
BESS	Battery Energy Storage System
BSP	Bulk Supply Point
CAIDI	Customer Average Interruption Duration Index
CESS	Capital Expenditure Sharing Scheme
DDRN	Digital data radio network
DER	Distributed Energy Resource
DM	Demand Management
DMIS	Demand Management Incentive Scheme
DNSP	Distribution Network Service Provider
DR	Demand Response
DSES	Demand Side Engagement Strategy
DSM	Demand Side Management
DSO	Distribution System Operator
DUOS	Distribution Use of System
ECRC	Energy Consumers Reference Council
ENA	Energy Networks Australia
EOI	Expression of Interest
FCAS	Frequency Control Ancillary Services
FLISR	Fault Location, Isolation and Supply Restoration
HMI	Human Machine Interface

Term	Definition
HV	High voltage
ICRC	Independent Competition and Regulatory Commission
MVA	Mega Volt Amperes
MW	Mega Watts
NPC	Net Present Cost
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
NPV	Net Present Value
NSCAS	Network Support and Control Ancillary Services
NTFP	National Transmission Flow Path
NTNDP	National Transmission Network Development Plan
N-1	Security Standard where supply is maintained following a single credible contingency event
OPGW	Optical Ground Wire
PFC	Power Factor Correction
PoC	Power of Choice
PoE	Probability of Exceedance
PoW	Program of Works
PV	Photovoltaic
QoS	Quality of Supply
RDSE	Register of Demand Side Engagement
REZ	Renewable Energy Zones
RIT-D	Regulatory Investment Test for Distribution
RIT-T	Regulatory Investment Test for Transmission
RTU	Remote Terminal Unit
VPP	Virtual Power Plant
VCR	Value of Customer Reliability
ZS	Zone Substation

Appendix B: Network Physical Characteristics

In addition to the overview provided in Chapter 2, this Appendix provides more details describing Evoenergy's subtransmission and distribution network including capacity, security and ratings of the zone substations, subtransmission lines, and the number of key assets.

Configuration Of The Evoenergy Network

The Evoenergy network consists of an interconnected 132 kV subtransmission network supplying thirteen 132/11 kV zone substations and two 132 kV switching stations. There is also a single 66/11 kV zone substation. All 132 kV and 66 kV connections have N-1 subtransmission security, with the exception of Tennent Zone Substation which is connected via a single circuit 132 kV tee-connection. There are four bulk supply points supplying the Evoenergy network, all owned and operated by Transgrid Limited as follows:

- Canberra 330/132 kV bulk supply substation
- Stockdill 330/132kV bulk supply substation
- Williamsdale 330/132 kV bulk supply substation
- Queanbeyan 132/66 kV bulk supply substation.

Evoenergy's assets include 132 kV subtransmission lines, 66 kV subtransmission lines, 132/11 kV and 66/11 kV zone substations, 22 kV and 11 kV distribution feeders, 22/0.400 kV and 11/0.400 kV distribution substations, low voltage 400 V circuits, and equipment such as distribution pillars and pits to provide connection points to consumers. Evoenergy also owns a 132/11 kV 14 MVA mobile substation that can be deployed as required at short notice (currently out of service while a fault in the transformer is being investigated and repaired).

With the planned decommission of Fyshwick Zone Substations, the Queanbeyan Bulk Supply point will no longer supply ACT and Evoenergy's 66 kV lines will become obsolete.

Tennent zone substation has one permanent power transformer supported by the temporary mobile substation deployed at the adjacent Angle Crossing zone substation. All other zone substations have two or three power transformers, providing some redundancy based on 2-hour emergency rating. In a case of network N-1 contingency such as a transformer outage, Evoenergy would allow remaining transformer(s) to be loaded up to their 2-hour emergency rating for that limited time.

There are currently 243 x 11 kV feeders. Most of these are interconnected with other feeders (i.e. a meshed 11 kV network) and provide links between zone substations. There are also two 22 kV distribution feeders, supplied via 11/22 kV step-up transformers at Woden Zone Substation. Evoenergy constantly monitors loads on all feeders and analyses the impact of proposed new connections. Such analysis is done using the Advanced Distribution Management System (ADMS) software. Transfer capability between zone substations via the 11 kV network is carefully monitored and managed, with open points between feeders changed to cater for load growth whilst avoiding constraints such as thermal loading of conductors.

Approximately 60% of Evoenergy's distribution network and 3% of the subtransmission network is underground.

The network supplies around 221,500 electricity consumers. There are 37 consumers directly connected at 11 kV, two consumers directly connected at 22 kV, and no consumers directly connected at either 66 kV or 132 kV. The remaining consumers are connected to the low voltage network (400 V three phase or 230 V single phase). 11kV / 400 V distribution stations are ground-mounted, pole-mounted, or installed inside buildings such as chamber substations, and range in size from 25 kVA to 2000 kVA.

Consumers are primarily commercial, light industrial or residential connections. There are no major industrial consumers.

Electrical energy consumed in the ACT is generated mainly outside the ACT and enters via Transgrid's transmission network. However, an increasing proportion of demand is being satisfied form internal sources.

Evoenergy owns, operates, and maintains a telecommunications network that supports the operation of the electricity network. It provides bearers for SCADA monitoring and control, protection signalling, telephones and mobile radios for operations and maintenance activities. Telecommunications assets include optical fibres on subtransmission and distribution lines, digital microwave and UHF radios and associated repeater stations.

Chapter 2 includes subtransmission schematics and geographic representation of the Evoenergy subtransmission network.

System Supply Security

Supply is secure when the system capacity is sufficient to cater for the existing and forecasted demand.

A system constraint is a situation where the power flow through a part of the subtransmission or distribution network must be restricted in order to avoid exceeding a known technical limit. Examples of technical limits include the thermal rating of conductors or other equipment such as transformers, operating voltage levels, and equipment protection settings. Some constraints can exist under normal operating conditions; however, they are most likely to occur when an element (such as a subtransmission line or distribution feeder) is out of service.

There is one 132/66 kV bulk supply point and three 330/132 kV bulk supply points interconnecting Evoenergy network to NSW network.

The three 132 kV bulk supply points are Canberra Substation, Stockdill Substation, and Williamsdale Substation. The 66 kV bulk supply point is located at Transgrid's Queanbeyan Substation.

All 132 kV lines have sufficient capacity to supply full capacity to each zone substation without constraint in the event of an outage of a 132 kV subtransmission line.

Any imbalance between generation and load in the electricity transmission grid will result in abnormal variations in system frequency. As the majority of generation and bulk transmission is located externally to the ACT, system frequency is not controllable by Evoenergy. However, in the event of a major system event such as a large generator or 330 kV transmission line contingency, frequency could drop below the normal operating frequency excursion band. Under clause 4.2.6 (c) of the NER, in such an event all affected TNSPs and DNSPs must be able to shed load quickly until frequency is restored to avoid the problem escalating. NER clause 4.3.1 (k) specifies that a DNSP must be able to shed up to 60% of its total load during an under-frequency event to allow for prompt restoration or recovery of the power system. To meet this requirement, Evoenergy has implemented automated under frequency load shedding (UFLS) systems at zone substations.

A summary of Evoenergy's major network assets is shown **Table 44**

Table 44. Evoenergy Network Assets

Asset Type	Nominal Voltage	Quantity
Bulk Supply Points[32]	330/132kV	3
	132/66kV	1
Subtransmission Lines	132kV	200 km Overhead
	132kV	6 km Underground
	66kV	14 km Overhead
Switching Stations	132kV	2
Zone Substations	132/11kV	12 (+ 1 mobile substation)
	66/11kV	1
Power transformers	132/11kV	30
	66/11kV	3
Feeders	22kV	2
	11kV	243
Distribution Substations	22kV/400 V	11
Distribution Substations	11kV/400 V	4,801
Distribution Switching Stations	11kV	361
Number of transmission towers and pole structures	132kV	1,451
	66kV	63
Number of poles	22kV, 11kV and 400 V	48,726
Circuit km of distribution overhead lines	22kV, 11kV and 400 V	2,200 km
Circuit km of distribution underground cables	11kV and 400 V	3,323 km
Number of customer connections	22kV	2
	11kV	37
	400 V/230 V	221,429
Coverage area		2,358 km^2
System maximum demand (FY21/22)		695MW

32 Bulk Supply Point substations are owned and operated by Transgrid

Ratings Of Zone Substations And Subtransmission Lines

Zone Substation Ratings

Evoenergy operates the thirteen 132/11 kV zone substations and one 66/11 kV substation. **Table 45** summarises the total capacity and firm capacity for each substation including the year of commissioning. The firm capacity refers to the continuous capacity of the substations available after a single credible network contingency event (e.g. an outage of one of the power transformers)

Table 45. Evoenergy's Zone Substations

Zone Substation	Year commissioned	Voltage	Total capacity	Firm capacity	No of transformers
Angle Crossing (mobile substation)*	2012	132/11kV	15MVA	12/14 MVA	1
Belconnen	1977	132/11kV	110 MVA	55MVA	2
City East	1979	132/11kV	169MVA	95/110MVA	3
Civic	1967	132/11kV	165MVA	110MVA	3
East Lake	2013	132/11kV	110MVA	50/55MVA	2
Fyshwick	1982	66/11kV	70MVA	28MVA	3
Gilmore	1987	132/11kV	90MVA	45MVA	2
Gold Creek	1994	132/11kV	114MVA	57MVA	2
Latham	1971	132/11kV	150MVA	95/100MVA	3
Telopea Park	1986	132/11kV	150MVA	100MVA	3
Tennent	2017	132/11kV	15MVA	15MVA	1
Theodore	1990	132/11kV	90MVA	45MVA	2
Wanniassa	1975	132/11kV	150MVA	95/100MVA	3
Woden	1967	132/11kV	150MVA	95/100MVA	3

Additional notes on zone substation ratings:

In addition to the ratings listed in **Table 45**, for network planning and operations, Evoenergy is using 2 hour emergency rating of the transformers. 2-hour emergency rating refers to the estimated level of electrical load which transformer could supply for up to two hours.

*Angle Crossing Zone Substation is currently out of service while a fault in the transformer is being investigated and repaired Subtransmission Line Ratings

SUBTRANSMISSION LINE RATINGS

Evoenergy currently operates a number 132kV lines and two 66kV lines. **Table 46** list continuous and emergency ratings of Evoenergy lines.

Table 46. Evoenergy Subtransmission Line Ratings

LINE			CURRENT RATING (AMPS)			
			Summer Day (35°C ambient temperature)		Winter Day (15°C ambient temperature)	
From	To	ID No	Continuous	Emergency	Continuous	Emergency
132kV						
Belconnen	Bruce	A-21	1934	2916	2514	3277
Belconnen	Latham	A-20	1955	2958	2545	3325
Bruce	City East	A-54	967	1463	1259	1644
Bruce	Civic	A-11	1934	2926	2518	3289
Bruce	East Lake	A-45	967	1122	1122	1122
Bruce	Gold Creek	A-30	1934	2916	2514	3277
Canberra	Gold Creek	A-3	1934	2916	2514	3277
Canberra	Latham	A-2	1955	2958	2545	3325
Canberra	Stockdill	9HF	1935	2916	2514	3277
Stockdill	Woden	9HC	1935	2916	2514	3277
Causeway	City East	A-50	968	1458	1257	1638
Causeway	East Lake	A-46	968	1122	1122	1122
Causeway	Gilmore	A-44	1935	2916	2514	3277
Causeway	Telopea Park 1	A-51	390	390	390	390
Causeway	Telopea Park 2	A-52	390	390	390	390
Causeway	Telopea Park 3	A-53	390	390	390	390
Civic	Woden	A-10	1955	2958	2545	3325
Gilmore	Theodore	A-43	968	1458	1257	1638
Gilmore	Wanniassa	A-41	968	1458	1257	1638
Gilmore	Williamsdale	97F	968	1458	1257	1638
Wanniassa	Woden	A-40	1990	3002	2586	3374
Angle Crossing Tee	Theodore	97H/2	968	1458	1257	1638
Angle Crossing Tee	Williamsdale	97H/1	1935	2916	2514	3277
Angle Crossing Tee	Tennent Tee	97H/3	968	1458	1257	1638
Angle Crossing	Tennent Tee	97H/4	968	1458	1257	1638
Tennent	Tennent Tee	97H/5	968	1458	1257	1638
66kV						
Fyshwick 1	Queanbeyan 1	0844	583	865	750	970
Fyshwick 2	Queanbeyan 2	0845	583	865	750	970

Embedded Generation

Generators connected directly to Evoenergy's distribution network rather than through the transmission network are called Embedded Generators (EGs).

There are a number of different types of embedded generator connected to our network as follows:

- Solar Photovoltaic
- Gas, including bio-gas (from land fill sites)
- Battery Energy Storage Systems (BESS)
- Micro hydro

Evoenergy maintains records summarising activities relating to embedded generating units, including the treatment of connection applications and enquiries.

CONNECTION APPLICATIONS AND ENQUIRIES

The table below summarises data for connection enquiries and connection applications.

Installation Size	Number of Enquiries	Number of Applications	Average timeframe to process connection application (days)
≤ 5kVA single phase or ≤15kVA three phase – no battery Automated Micro	N/A*	3,794	0
< 30kW Complex Micro	N/A*	5,956 total 804 with batteries	5.5
> 30kW Low Voltage and High Voltage	83	76	12

*N/A – not applicable

SOLAR PHOTOVOLTAIC

Solar photovoltaic generation (PV) represents the majority of embedded generation connected to Evoenergy's network. The impact of such systems on network demand is limited by both the capacity of installed panels and their associated inverters. Typically panel capacities are greater than inverter capacities in installed systems, leaving inverter capacity as the main determinant of demand impact.

As of 30 June 2023, the total installed capacity of PV was 371 MW (396MW panel). 47,574 installation sites were recorded, with 97% of sites (75% of installed capacity) occurring in residential settings. This represents approximately 35% of NMIs[33], distributed all over the ACT. Several residential developments mandated the use of PV generation at their time of greenfield development, resulting in 100% PV penetration.

Capacities of these EGs vary. Domestic solar PV systems are typically 5-10 kW. The largest EG facility in the ACT is Royalla Solar Farm at Royalla which has a maximum output of 20 MW. Mugga Lane Solar Park at Mugga Lane in Hume has a maximum design output of 12.85 MW. Williamsdale Solar Farm at Williamsdale has a maximum design output of 10.6 MW. Mount Majura Solar Farm at Majura has a maximum design output of 3.6 MW.

33 Evoenergy considers that rooftop PV could be installed on separate houses as well as semi-detached houses. The 2021 Census reported 106,433 separate houses and 28,921 semi-detached, row or terrace house, townhouse etc. This is a total of 135,354 dwellings. Source: https://www.abs.gov.au/census/find-census-data/quickstats/2021/8

PV generation is unpredictable due to intermittent cloud cover. It is difficult to forecast availability and output accurately which makes it difficult to account for in network planning. However, research is currently being undertaken to correlate weather forecast information more closely with solar generation to provide a degree of forecasting capability in real time.

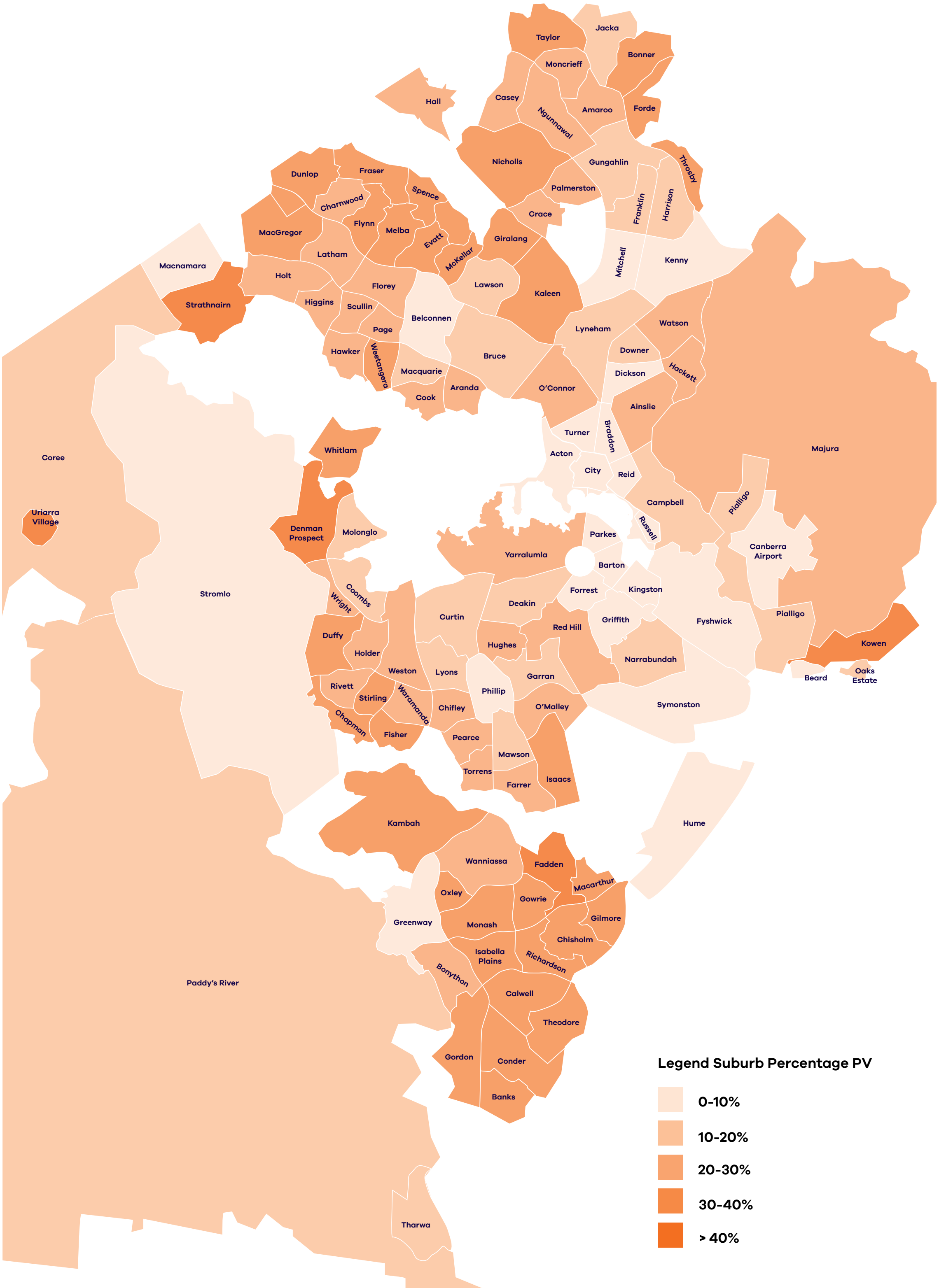
The developers of several new residential developments in the ACT are mandating or heavily incentivising rooftop solar PV generation to be installed on all detached dwellings. This low voltage inverter-based generation contributes to higher voltages being seen on some parts of the low voltage network. Evoenergy has reviewed its connection standards regarding the maximum export voltages allowable from such inverters.

At times of low load and high PV generation (typically middle of the day during summer months), power flows in the reverse direction from consumers to the network. Reverse power flows tend to raise voltage levels on the low voltage network. High levels of generation export also can exceed the ratings of Evoenergy's equipment especially power cables and distribution transformers. Evoenergy needs to manage reverse power flows and hosting capacity of the network to avoid these issues.

Section 4.2 provides further information on power quality issues associated with embedded generation.

More detail on geographic and network connectivity of PV systems is provided in **Figure 37** and **Table 47**

Figure 37. Distribution Of Domestic Rooftop Solar PV Installations Throughout The ACT.



Note: Calculated as percentage of customers (NMI) in suburb.

Table 47. PV generation installations by feeder as of 30 June 2023

Zone Substation / Feeder	No of Sites	Installed Panel Capacity (kW)	Installed Inverter Capacity (kW)
BELCONNEN	**3,803**	**27,687**	**25,168**
Aikman	6	197	179
Baldwin-Joy Cummins	444	2,595	2,406
Battye	13	93	83
Benjamin-Laurie	494	3,163	2,871
Cameron South	55	509	437
Chandler	1	199	166
Chuculba	322	2,168	1,892
Eardley	124	1,103	900
Emu Bank	3	114	231
Haydon	179	1,353	1,305
Maribyrnong	77	807	763
Mcguiness-Bellbird	347	2,467	2,243
Meacham-Bean	641	4,468	4,042
Shannon	383	2,538	2,214
Swinden-Lampard	136	1,817	1,702
William Slim	578	4,097	3,670
CITY EAST	**2,773**	**22,153**	**20,703**
Aero Park	8	1,344	1,443
Akuna	1	100	83
Allara	1	100	85
Binara	1	140	110
Braddon	4	266	253
Chisholm	145	888	874
Constitution	2	111	111
Cooyong	2	283	225
Cowper	183	1,394	1,283
Duffy	257	1,680	1,587
Ebden	449	2,639	2,455
Electricity House	3	193	130
Fairbairn	7	59	54
Ferdinand	240	1,675	1,518
Haig	42	788	833
Ijong	29	305	352
Lonsdale	3	113	90
Mackenzie	528	3,596	3,229
Masson	12	193	176
Northbourne	10	306	255
Petrie	2	41	30
Quick	21	221	176
Stott	497	3,052	2,824
Wakefield	160	1,414	1,320
Wolseley	166	1,252	1,205

CIVIC	**2,512**	**19,932**	**18,406**
ANU No 1,2,3,4,5	2	514	467
Belconnen Way North	271	2,076	1,820
Belconnen Way South	282	1,820	1,699
Black Mtn	1,104	8,204	7,541
CSIRO	2	214	210
Dryandra	342	2,334	2,229
Edinburgh	4	609	521
Girrahween	3	154	133
Hobart Long	1	72	55
Hobart Short	3	260	248
Jolimont	2	140	154
McCaughey	51	362	359
Miller	393	2,631	2,467
Nicholson	50	483	456
Wattle	2	59	48
EAST LAKE	**112**	**7,170**	**6,495**
Cessnock	1	10	8
Dairy North	46	4,237	3,532
Dairy South	5	294	606
Isa	37	1,697	1,543
Lyell	23	932	807
FYSHWICK	**130**	**4,940**	**4,618**
Abattoir	40	857	795
Airport	8	887	860
Barrier	15	891	817
Domayne	21	673	620
Gladstone	12	480	417
Tennent			
Whyalla-Pialligo	17	513	537
GILMORE	**2,536**	**32,989**	**31,605**
Alderson	23	1,570	1,501
Beggs	208	1,513	1,384
Edmond	340	2,280	2,085
Falkiner-Tralee	336	3,455	3,209
Findlayson	327	2,239	1,974
Isabella	1	13,000	13,320
Jackie Howe-Monaro	391	2,824	2,514
May Maxwell	289	1,745	1,585
Penton-Willoughby	334	2,461	2,264
Rossman	287	1,902	1,768
GOLD CREEK	**8,443**	**65,055**	**58,354**
Anthony Rolfe	381	3,295	2,956
Barrington	736	5,132	4,739
Birrigai	858	7,278	6,364
Ferguson	738	4,624	4,233
Gribble	33	1,504	1,198

Gungahlin	143	2,339	2,220
Hamer	770	6,456	5,665
Lander	649	4,286	3,789
Lexcen	413	2,807	2,646
Ling-Hughes	369	2,320	2,059
Magenta-Boulevard North	244	2,688	2,356
Nona	359	2,372	2,185
Riley	189	1,271	1,279
Saunders	929	7,225	6,357
Valley	76	574	520
Wanganeen-Bunburung	547	3,910	3,406
Wellington-Gurrang	393	2,709	2,523
West	616	4,264	3,859
LATHAM	**8,135**	**52,780**	**50,664**
Bowley	561	3,433	3,111
Conley	231	1,471	1,357
Copland	294	1,816	1,641
Elkington	396	2,514	2,265
Fielder	94	1,443	1,272
Florey	712	4,339	3,900
Homann	335	2,503	2,270
Latham	611	3,336	5,833
Lhotsky	906	5,444	5,012
Low Molonglo East	71	409	379
Low Molonglo West	468	3,066	2,749
Macrossan	365	2,138	1,980
Markell	449	3,081	2,831
Melba	316	2,248	2,001
O-Loghlen	370	2,253	2,081
Paterick	221	1,729	1,447
Powers	213	1,222	1,147
Seal	382	2,451	2,264
Tillyard	404	2,720	2,422
Verbrugghen	262	1,940	1,742
Weir	472	3,216	2,952
TELOPEA PARK	**1,846**	**18,167**	**16,946**
Blackall	5	695	613
Brisbane	1	60	55
CNBP1	2	179	175
Cunningham	462	3,088	2,957
Empire	243	1,823	1,731
Forster	116	1,135	1,065
Giles	41	414	390
Jardine	5	51	46
KF1	50	416	472
King Edward + Belmore	60	869	792
Kurrajong	3	211	163
Mildura	2	199	200

Monash	19	171	163
Mundaring-Russell No 3	1	33	33
NSW Cres	30	1,326	1,168
Ovens	27	308	273
Power House	137	1,241	1,125
Queen Victoria Terrace	4	358	235
Riverside	1	31	25
Strzelecki	165	1,145	1,029
Sturt	156	1,304	1,256
Telopea Park East	2	109	86
Throsby	312	2,832	2,749
TENNENT	**18**	**1,800**	**3,600**
Williamsdale	18	1,800	3,600
THEODORE	**3,979**	**46,220**	**46,267**
Banyule	403	2,427	2,224
Callister	622	3,893	3,560
Chippindall	487	3,309	2,966
Eaglemont	609	3,970	3,685
Fairley	399	2,465	2,273
Lawrence Wackett	433	2,977	2,719
Lethbridge	364	3,011	2,731
Morison	413	2,498	2,275
Royalla 1	1	20,000	22,170
Templestowe	248	1,670	1,665
WANNIASSA	**7,039**	**49,143**	**44,816**
Ashley	256	1,817	1,701
Athllon	387	2,434	2,242
Bissenberger-Hawkesbury	781	5,638	5,121
Brookman	307	2,328	2,160
Conolly	259	1,666	1,520
Erindale	2	107	89
Fincham	8	275	251
Gaunson	217	1,488	1,401
Gouger	200	1,497	1,354
Grimshaw	729	3,708	3,492
Hawker-Pridham	420	2,750	2,515
Hemmings	272	1,763	1,575
Lambrigg	195	1,672	1,495
Langdon	387	2,573	2,425
Longmore	442	2,872	2,601
Mannheim	268	1,851	1,598
Marconi	320	2,263	2,021
Matthews	390	2,558	2,342
Mugga	1	30	25
Muresk	398	2,730	2,582
Pitman-Rowland	14	1,400	1,216
Reid	380	2,628	2,306
Sainsbury	178	1,344	1,191

Sternberg	3	87	98
Symers	224	1,663	1,492
WODEN	**6,051**	**45,600**	**42,130**
Bunbury	459	3,028	2,892
Carruthers	300	2,277	2,090
Cooleman	180	1,118	1,065
Corinna	2	32	57
Cotter 11kV	580	4,533	4,341
Curtin North	315	2,577	2,399
Daplyn	372	2,423	2,189
Deakin No 1	191	1,729	1,482
Deakin No 2	108	870	825
Devonport	75	574	512
Easty	6	134	134
Follingsby	411	2,928	2,699
Hilder	529	3,757	3,318
King	36	855	783
Launceston	2	110	104
Lyons West	465	2,949	2,788
McInnes	279	1,890	1,656
Phillip North	12	664	671
Streeton	596	4,895	4,476
Theodore	273	2,180	2,110
Tidbinbilla 22kV	3	65	60
Weston East	350	2,326	2,115
Wilson	369	2,636	2,404
Yarralumla	138	1,048	957
Grand Total	**47,574**	**396,474***	**371,405***

* Please note minor discrepancy between this number and overall total due to feeders not being assigned for some systems. Data cleansing is underway

BATTERY ENERGY AND STORAGE SYSTEMS

As of 30 June 2023, approximately 5,300 domestic battery systems have been connected beyond-the-meter for customers connected to the Evoenergy network. Additionally, one privately owned and operated 2.66MW/5MWh battery storage system is connected directly to the Evoenergy distribution network in Holt. Connection of other large systems is currently underway.

HYDRO-ELECTRIC AND GAS

There is an existing micro-hydro generator connected to the Evoenergy network, the Stromlo micro-hydro which has a peak output capacity of 630 kW. This is connected to Woden Zone Substation via a shared 11 kV feeder.

There is one bio-gas generator installed at Mugga Lane Waste Transfer Station (4 MW), connected to Gilmore Zone Substation via a shared 11 kV feeder. This site has indicated plans for further expansion.

Evoenergy is aware of other gas and diesel generators connected to major customer sites, primarily for backup rather than export purposes.

Appendix C: The Regulatory Framework And Operating Environment

Section 2.3 provides an overview of Evoenergy regulatory environment. This appendix includes additional commentary on Evoenergy as a regulated entity.

The National Energy Market (NEM) physical infrastructure comprises both government owned and private assets managed by participants. The NEM includes operation of physical infrastructure including national grid and the operation of energy market. The market uses sophisticated algorithms to dispatch generation according to demand, network capacity, network availability, energy price, and available generation capacity.

Evoenergy is a Registered Participant in the NEM. Evoenergy is registered as the Distribution Network Service Provider (DNSP). The networks are regulated entities. The regulated entities within the NEM are ring-fenced from the competitive market to ensure that the competition is not distorted either through cost transfer or some competitors gaining unfair advantage. Day to day operation of NEM is managed by the Australian Energy Market Operator (AEMO) with the oversight of wholesale generation, dispatch, and transmission of electricity in Queensland, New South Wales, South Australia, Victoria, the ACT and Tasmania. AEMO manages NEM in line with the *National Electricity Law (NEL)* and the *National Electricity Rules (NER).*

The *National Electricity Objective* (NEO), as stated in the NEL is to:

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

a. price, quality, safety, reliability and security of supply of electricity; and
b. the reliability, safety and security of the national electricity system; and
c. the achievement of targets set by a participating jurisdiction –
    i. for reducing Australia's greenhouse gas emissions; or
    ii. that are likely to contribute to reducing Australia's greenhouse gas emissions."

This NEO requires Registered NEM participants to balance the costs and risks associated with electricity supply.

The economic regulation within NEM is managed by the Australian Energy Regulator (AER) in accordance with the NER, and procedures and guidelines developed under NER. Every five years, after detailed review, the AER determines the revenue allowance which Evoenergy is allowed to earn in the following five years.

The Australian Energy Market Commission (AEMC) is the rule making body which administers the National Electricity Rules, consults on proposed changes with the NEM participants and publishes the changes. Some obligations relating to consumers are covered in the National Energy Retail Rules and National Energy Retail regulations under the National Energy Customer Framework (NECF).

Evoenergy is a holder of the distribution licence in the Australian Capital Territory which is granted by the Independent Competition and Regulatory Commission (ICRC). The ICRC monitors compliance with the licence conditions. The licence is granted under the Utilities Act (2000). More detailed requirements under the Act are covered in the industry codes, such as the Consumer Protection Code which includes Guaranteed Service Levels and the corresponding penalties which are applicable if Evoenergy performance falls below the stated levels.

The ACT Technical Regulator's role is to ensure safe and reliable energy services to the community. The Utilities Technical Regulation team (UTR) supports the Technical Regulator. The Director-General of the Environment, Planning and Sustainable Development Directorate (EPSDD) is the ACT's Technical Regulator. The Utilities (Technical Regulation) Act 2014 sets out technical requirements for utilities in the ACT. The specifics of many requirements are set out in technical codes made under the Act.

The paragraphs below provide a brief description of key regulatory artefacts relevant to network planning and asset management.

National Electricity Rules

The NER covers a broad range of economic, technical, and legal obligations which NEM participants must comply with. From the network planning perspective, NER **Chapter 5** and Chapter 5A describe the main requirements and operating criteria that must be applied by Network Service Providers to their networks. These criteria specify certain electrical performance standards that must be met such as voltage levels, voltage unbalance, voltage fluctuations, harmonics levels, protection operating times, power quality and power system stability.

Electricity Distribution Supply Standards Code

The *Electricity Distribution Supply Standards Code* sets out technical performance standards for Evoenergy's distribution network. Evoenergy is required to take all reasonable steps to ensure that its Electricity Network will have sufficient capacity to make an agreed level of supply available.

This code specifies reliability standards that Evoenergy must endeavour to meet when planning, operating, and maintaining the distribution network. It also specifies power quality parameters that must be met including limits on voltage flicker, voltage dips, switching transients, earth potential rise, voltage unbalance, harmonics, and direct current content.

Regulatory Investment Test

Clause 5.17 of the NER describes the Regulatory Investment Test for Distribution (RIT-D). This test must be carried out for any proposed investment where the augmentation or replacement cost of the most expensive credible option exceeds $6 million. The regulatory investment tests provide the opportunity for external parties to submit alternative proposals to the Network Service Provider, who is obliged to consider any credible proposal including non-network alternatives without bias.

Incentive Schemes

Service Target Performance Incentive Scheme

Evoenergy is subject to the AER's Service Target Performance Incentive Scheme (STPIS). Reliability refers to the extent that consumers have a continuous supply of electricity. The main objective of the STPIS is to provide TNSP's and DNSP's with an incentive to maintain or improve reliability levels and response to consumer outages. STPIS achieves this by rewarding network businesses that outperform their targets or by penalising network businesses that do not.

The AER applied the STPIS to Evoenergy for the 2019-24 regulatory control period. The

AER set the targets based on the Evoenergy's reliability performance for the previous 5 years. The value of annual incentive is capped at 5% or revenue. The estimated monetary value of reliability is a based on economic value of reliability to consumers as approved by the AER.

For full details of the STPIS refer to the AER Electricity Distribution Network Service Providers - Service Target Performance Incentive Scheme Guideline v2.0, November 2018 (STPIS Guidelines) and AER determination for Evoenergy for the 2019-24 period available from the AER website.

The Evoenergy STPIS scheme has two components:

1. Reliability of Supply (unplanned SAIDI and SAIFI)
2. Customer Service (telephone response time).

Both SAIDI and SAIFI are subdivided into Urban and Rural components. The definitions for the reliability of supply components are:

Unplanned SAIDI (System Average Interruption Duration Index)

The sum of the duration of each unplanned sustained consumer interruption (in consumer minutes) divided by the total number of distribution consumers (urban or rural). Unplanned SAIDI excludes momentary interruptions.

Unplanned SAIFI (System Average Interruption Frequency Index)

The total number of unplanned sustained consumer interruptions divided by the total number of distribution consumers (urban or rural). Unplanned SAIFI excludes momentary interruptions. Key points:

- The parameters are separately applied to the two feeder types that Evoenergy has – urban and short rural
- The performance targets are set at the start of each regulatory period and will remain the same for the full 5-year regulatory period.

For further detailed discussion on performance metrics relating to reliability refer to **Chapter 4**. In addition to reliability performance, the scheme also includes the customer service performance measure based on the customer contact centre telephone answering times.

Capital Expenditure Sharing Scheme

Evoenergy is subject to the AER's Capital Expenditure Sharing Scheme (CESS) administered by the Australian Energy Regulator.

The main objective of the CESS is to provide DNSPs with an incentive to undertake efficient capital expenditure (capex) during a regulatory control period. It achieves this by rewarding DNSPs that outperform their capex allowance by making efficiency gains and spending less than forecast or by penalising DNSPs that spend more than their capex allowance because of a lack of efficiency gains.

Consumers generally benefit from improved capital efficiency through lower regulated prices. Under the CESS, a service provider retains 30% of any underspend or overspend while consumers retain 70% of underspend or overspend. This means that for a one dollar saving in capex, the service provider retains 30 cents of the benefit while consumers keep 70 cents of the benefit. The management of capital expenditure by Evoenergy must be carefully managed because it is subject to factors which are outside our control. For example, the residential or commercial land development programs or customer-initiated works may fluctuate significantly according to market conditions. Higher level activity in those areas may translate to capital expenditure above the allocated regulatory allowance. For the overall capital expenditure to stay within the regulatory envelope, a reduction in other capital programs must offset higher customer-initiated capital programs.

For full details of the CESS refer to the AER Capital Expenditure Incentive Guideline for Electricity Network Service Providers, April 2023 (CESS Guidelines) available from the AER website.

Efficiency Benefit Sharing Scheme (EBSS)

The EBSS is designed to ensure electricity distributors are provided with a continuous incentive throughout the regulatory control period to achieve the lowest efficient levels of operating expenditure through the sharing of efficiency gains and losses with consumers. The EBSS gives a consistent incentive to deliver efficiency improvements throughout the regulatory period by allowing the distributor to retain a share of the efficiency gains over time. For the five-year regulatory period, efficiency gains or losses are shared approximately 30% to the distributor and the remaining 70% to consumers.

The EBSS scheme is relevant to the network investment decisions for several reasons. Different solutions to network limitations may be associated with different levels of operating expenditure. More importantly, many non-networks and demand side management solutions, especially involving other parties replace the capital investment in the network with operating investment. For example, if Evoenergy provides an incentive for another party to install a network battery, the incentive amount would count as operating expenditure. Similarly, if Evoenergy contracts consumers to reduce electrical demand in exchange for the monetary compensation, any incentive paid out would count towards our operating expenditure.

The additional details on EBSS are contained in the AER's Efficiency Sharing Scheme Guidelines, November 2013 (EBSS guideline) available from the AER website.

Demand Management Incentive Allowance Mechanism

Currently, Evoenergy is subject to two schemes which provide incentives in relation to the application of demand side management and non-network solutions. Evoenergy participates in both demand management schemes.

During the current 2019-24 regulatory period Evoenergy participates in the Demand Management Incentive Allowance Mechanism (DMIAM). The DMIAM has been introduced by AER under National Electricity Rules. The AER provides oversight of the allowance mechanism. The DMIAM provides funding to distributors to undertake demand management research and development projects that have the potential to reduce long-term network costs. The DMIAM provides Evoenergy with an allowance which is available for eligible projects. The allowance for the regulatory period is capped at a fixed percentage of the distributor's revenue allowance. For Evoenergy for the five-year regulatory period the allowance is estimated at around $1.5 million dollars. Evoenergy is supporting DMIAM and considers eligible projects as part of its network planning process. Further information on DMIAM is provided in the AER's Demand Management Incentive Mechanism Guideline, December 2017 available form AER's website.

Demand Management Incentive Scheme

In the current 2019-24 regulatory period Evoenergy also participates in the Demand Management Incentive Scheme (DMIS). This participation is consistent with AER's revenue determination for Evoenergy published for the current regulatory period in April 2019.

The DMIS provides Evoenergy with an incentive to undertake efficient expenditure on non-network options relating to demand management. Specifically, the DMIS provides networks with a cost-uplift of up to 50% for eligible efficient demand management projects, subject to net-benefit constraints stipulated in the AER guidelines for the scheme. The overall uplift which can be allowed to Evoenergy under the scheme is subject to an overall annual limit. The scheme recognises that some existing regulatory settings provide disincentives to non-network and demand side management solutions. DMIS is designed to provide a greater incentive for the distributors to implement demand management solutions. Evoenergy supports in principle application of DMIS to non-network projects. As part of its network planning process, Evoenergy considers projects eligible for the scheme.

A comprehensive description of the DMIS is provided in the AER's Demand Management incentive Allowance Guideline, December 2017 which is available from the AER website.

Appendix D: Asset Management System Certification

Certification of Asset Management System to ISO 55001:

ISO 55001 states the requirements for an integrated, effective management system for asset management, the intent being to maximize value for money from assets. Evoenergy has adopted ISO 55001 as the reference for measuring asset management continuous improvement and compliance.

Evoenergy holds a current certification under the standard.

Annual audits are undertaken on our Asset Management System in order to retain our certification to ISO 55001.

BUREAU VERITAS
Certification

Certification

Awarded to

ACTEWAGL DISTRIBUTION
T/A EVO ENERGY

CNR OAKDEN AND ANKETELL STREET, GREENWAY, ACT
AUSTRALIA

Bureau Veritas certify that the Management System of the above organisation has been audited and found to be in accordance with the requirements of the management system standards indicated below

STANDARD

ISO 55001:2014

SCOPE OF SUPPLY

PLANNING, DESIGN, DEVELOPMENT, INSTALLATION, OPERATION AND MAINTENANCE OF ELECTRICITY TRANSMISSION AND DISTRIBUTION ASSETS.

Original Approval Date: 11 January 2018

Subject to the continued satisfactory operation of the organisation's Management System, this certificate is valid until: 10 January 2027

To check the validity of this certificate please call tel. 1800 855 190

Further clarification regarding the scope of this certificate and the applicability of the Management System requirements may be obtained by consulting the organisation.

Certificate Number: AU005702-1

Andrew Mortimore
VP/CE CIF Pacific Region

Date: 6 December 2023

Managing office: Bureau Veritas Pty Ltd, Level 11, 500 Collins Street, Melbourne, Victoria, 3000, Australia

Issuing office: Bureau Veritas Pty Ltd, Level 11, 500 Collins Street, Melbourne, Victoria, 3000, Australia

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Appendix E: Demand Forecasts – Supplementary Information

This appendix provides supplementary information in relation to the demand forecasts discussed in Chapter 5.

The information provided includes:

- The key relevant definitions, formulas, assumptions, and a high-level explanation of the forecasting methodology
- Demand forecast tables for connection points of Evoenergy network to Transgrid network (bulk supply points)
- Zone substation demand forecast tables and charts.

Overview

Maximum demand forecasts provide long-term summer and winter maximum demand estimates conditional on observed annual historical data during those seasons. Similarly, minimum demand forecasts provide long-term daytime and night-time minimum demand estimates conditional on observed annual historical data during those time-of-day periods.

In alignment with previous years' reports and compliant with AEMO's revised connection point forecasting methodology, forecasts provide

- seasonal maximum demand (as apparent power in MVA) for the zone substations Belconnen, City East, Civic, East Lake, Fyshwick, Gilmore, Gold Creek, Latham, Telopea Park, Theodore, Wanniassa and Woden,
- seasonal maximum demand (as real power in MW) for the bulk supply points Canberra Bulk Supply Point, Queanbeyan Bulk Supply Point, Williamsdale Bulk Supply Point, Stockdill Bulk Supply Point and
- seasonal maximum and time-of-day minimum demand (as real power in MW) for the system.

The forecasting horizon is 10 years except for Fyshwick Zone Substation and Queanbeyan Bulk Supply Point for which the forecasting horizon is 1 year (due to the decommissioning of Fyshwick Zone Substation by 2024).

Also included are seasonal 10-year maximum demand forecasts for the new Stockdill Bulk Supply Point, which are based on seasonal Canberra Bulk Supply Point forecasts and a load flow analysis, as summarised in the "Bulk Supply Points Demand Forecasts" section below.

Key Forecasting Terms As Applied By Evoenergy In This Report

Maximum Demand

Zone substations

For zone substations, maximum demand is defined as the maximum apparent power S (in MVA) recorded during a specific financial year and season.

$$\text{Maximum demand (in MVA)} = \max_t S_t, \text{ and}$$

$$t_{\text{Maximum demand}} = \arg\max_t S_t.$$

Annual & seasonal zone substation maximum demands are non-coincident maximum demands, i.e. maximum demands correspond to the absolute maximum values recorded at every individual asset, and timestamps of the individual assets' maximum demands do not coincide with the timestamp of the overall system maximum demand.

Bulk supply points

For bulk supply points (BSP), maximum demand is defined as the maximum real power P (in MW), recorded during a specific financial year and season.

$$\text{Maximum demand (in MW)} = \max_t P_t, \text{ and}$$

$$t_{\text{Maximum demand}} = \arg\max_t P_t$$

As with the zone substation maximum demands, annual & seasonal bulk supply point maximum demands are non-coincident maximum demands.

System maximum demand

The annual & seasonal system maximum demand is the overall maximum of the coincident sum of individual maximum demands (in MW) measured at every zone substation (ZSS). The time t covers all 15 minute intervals within a specific financial year and season.

$$\text{Maximum demand (in MW)} = \max_t \sum_{i \in \text{ZSS,Queanbeyan BSP}} \text{Maximum demand (in MW)}_{i,t}.$$

System minimum demand

The system minimum demand is defined as the minimum of the coincident sum of individual maximum demands (in MW) measured at every zone substation (ZSS). The time t covers all 15 minute intervals within a specific financial year and time of day.

$$\text{Minimum demand (in MW)} = \min_t \sum_{i \in \text{ZSS,Queanbeyan BSP}} \text{Maximum demand (in MW)}_{i,t}.$$

Financial year

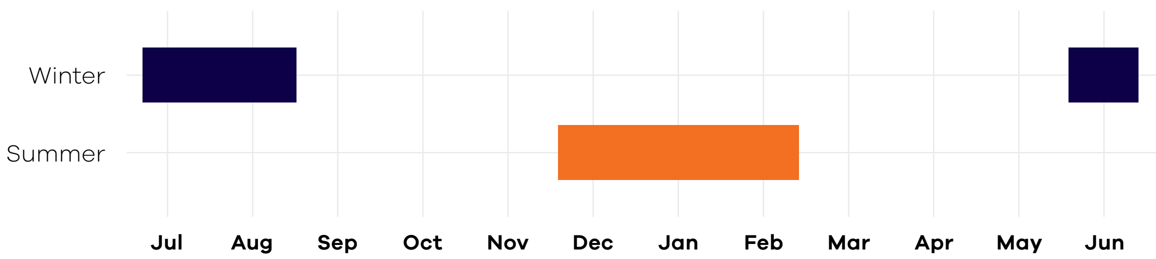
A financial year (FY) is defined as the period from (and excluding) 1 July, 00:00 AEST until (and including) 1 July, 00:00 AEST. Throughout this section, the terms "year" and "financial year" are used interchangeably, and always refer to a financial year as the unit of time.

Seasons

The summer and winter seasons are defined by the months:

- "Summer": December, January, February,
- "Winter": July, August, June.

Figure 38. Seasons Across One Financial Year



Note that "Winter" is a non-contiguous period.

Time-Of-Day Periods

The daytime and night-time periods are defined by hours:

- "daytime": 8:00 AM – 8:00 PM
- "night-time": 8:00 AM – 8:00 PM

Which is a definition used commonly within the industry.

Probability Of Exceedance

Compliant with the National Electricity Rules (NER) on load forecasting, forecasts show estimates for "least-likely" and "most-likely" scenarios. Specifically, the forecasting model provides estimates for the maximum and minimum demand data (both historical and forecasts) at different probability of exceedance (PoE) levels; maximum and minimum demands at the 10%, 50% and 90% PoE level correspond to values that are expected to be exceeded in 1, 5, and 9 out of 10 years, respectively.

Source Data

Maximum Demand Data

Historical data of seasonal maximum demands during previous financial years excluding the current financial year (FY23/24) for the zone substations (in MVA), bulk supply points (in MW) and the system (in MW) are taken from the Annual Planning Report 2022.

Data for the previous financial year (FY22/23) are extracted from measured energy values recorded by network metering installed at bulk supply points (operated by Transgrid) and zone substations (operated by Evoenergy).

Energies are then converted to powers as follows: Active (real) powers P and reactive powers Q are calculated from the corresponding real and reactive energy consumptions, by assuming uniform usage during the time interval

P [in MW] = 4×10^{-3} × active energy consumption [in kWh]

Q [in MVAR] =4×10^{-3} × reactive energy consumption [in kVARh].

The factor of 4 is due to the fact that there are four 15-minute intervals per hour, and consumptions are measured in kilo watt (volt ampere reactive) hours over a 15-minute interval.

For zone substation data, the apparent power S is then calculated from P and Q as

$$S = \sqrt{P^2 + Q^2}.$$

Minimum Demand Data

All historical data are extracted from measured energy values recorded by network metering installed at the bulk supply points (operated by Transgrid).

Real energy consumption values at the bulk supply points are converted to real power values, again assuming uniform usage during the 15-minute interval and as detailed in the previous subsection.

Block Loads

In addition, forecasts account for known commercial and residential block loads. The block load information was collated on the connection enquires, applications and government land release programs, as shown in **Table 48** and **Table 49**

Table 48. Summer Block Loads (MVA)

Zone	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Belconnen	0.2	0.4	0.5	0.3	0.4	0.5	0.7	0.7	0.7	0.6
City East	0.8	1.7	1.7	1.7	1.6	1.9	2.6	2.4	2.3	2.2
Civic	0.9	1.0	1.7	1.5	1.3	1.5	1.6	1.6	1.6	1.4
East Lake	34.5	2.4	1.5	0.5	0.3	0.3	0.2	0.2	0.2	0.2
Fyshwick	0.5	-	-	-	-	-	-	-	-	-
Gilmore	0.7	1.3	1.8	1.8	1.8	1.1	1.2	0.9	0.9	0.4
Gold Creek	1.5	4.9	1.0	1.1	0.6	0.8	1.3	1.2	1.2	1.2
Latham	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.4	0.4	0.4
System	11.2	7.2	13.3	6.9	8.9	10.1	10.2	9.1	7.2	6.5
Telopea Park	0.1	0.2	0.4	0.4	0.6	0.7	0.9	0.8	0.8	0.7

Theodore	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1
Wanniassa	0.6	1.1	1.4	1.3	0.4	0.9	1.0	0.9	1.0	0.6
Woden	2.6	1.2	2.0	0.9	1.2	1.4	1.7	1.5	1.4	1.3

Table 49. Winter Block Loads (MVA)

Zone	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Belconnen	0.2	0.4	0.5	0.3	0.4	0.5	0.7	0.7	0.7	0.6
City East	0.8	1.6	1.6	1.7	1.6	1.9	2.6	2.4	2.3	2.2
Civic	0.8	1.0	1.6	1.4	1.2	1.4	1.6	1.5	1.6	1.4
East Lake	34.5	2.4	1.5	0.5	0.3	0.3	0.2	0.2	0.2	0.2
Fyshwick	0.5	-	-	-	-	-	-	-	-	-
Gilmore	0.7	1.6	2.2	2.3	2.3	1.1	1.2	0.9	0.9	0.4
Gold Creek	1.9	4.9	1.0	1.1	0.6	0.8	1.4	1.4	1.3	1.3
Latham	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.4	0.4	0.4
System	10.8	6.9	13.0	6.9	9.1	10.4	10.6	9.3	7.8	7.0
Telopea Park	0.1	0.2	0.4	0.4	0.6	0.7	0.9	0.8	0.8	0.7
Theodore	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1
Wanniassa	0.8	1.4	1.7	1.6	0.4	1.0	1.1	0.9	1.2	0.7
Woden	3.0	1.5	2.0	0.9	1.2	1.4	1.7	1.5	1.4	1.3

Forecasting Model

A fully Bayesian model for seasonal maximum and time-of-day minimum demand data was developed, motivated by the need for coherence, plausibility and parsimony of model assumptions and predictors affecting long term demand forecasts. The predictive performance of the model was assessed by comparing maximum demand forecasts with those from last year's annual planning report using the same historical data.

The new long-term demand forecasting model implements a joint model for temperature T and maximum/minimum demand MD as a function of time (corresponding to a specific financial year and season/time-of-day) t. Specifically, the maximum/minimum demand of measurement i is

$$\begin{aligned} \mathrm{MD}_i &\sim N(\mu_{\mathrm{MD},i}, \sigma_{\mathrm{MD}}), \\ \mu_{\mathrm{MD},i} &= \mu_{\mathrm{baseline},i} + \mu_{\mathrm{temp},i} + \mu_{\mathrm{growth},i}, \end{aligned}$$

where

$$\begin{aligned} \mu_{\mathrm{baseline},i} &= \beta_{00,\mathrm{MD}} + \sum_{k=1}^{N_{\mathrm{ch}}} I(t_i, t_{\mathrm{ch},k})\beta_{0k,\mathrm{MD}}, \\ \mu_{\mathrm{temp},i} &= \beta_{1,\mathrm{MD}}(T_i - \min(T_i)), \\ \mu_{\mathrm{growth},i} &= \beta_{2,\mathrm{MD}} t_i, \end{aligned}$$

and the likelihood of T Is modelled using a Gumbel distribution

$$\begin{aligned} T_i &\sim \mathrm{Gumbel}(\mu_{T,i}, \sigma_T), \\ \mu_{T,i} &= \beta_{0,T} + \beta_{1,T} t_i. \end{aligned}$$

The following (weakly) informative priors are used for maximum demand modelling:

$$\begin{aligned} \beta_{0,T} &\sim \mathrm{N}(\min(T), \sqrt{\mathrm{abs}(\min(T))}), \\ \beta_{1,T} &\sim \mathrm{N}(0.01, 0.001), \\ \sigma_T &\sim \text{Half-Cauchy}(0, 2.5), \\ \beta_{00,\mathrm{MD}} &\sim \mathrm{N}(\mathrm{mean}(\mathrm{MD}), 10\sqrt{\mathrm{mean}(\mathrm{MD})}), \\ \beta_{0k,\mathrm{MD}} &\sim \mathrm{N}(0, 10), \\ \beta_{1,\mathrm{MD}} &\sim \begin{cases} \mathrm{N}(0,10) & \text{for maximum demand modelling}, \\ \mathrm{N}(0,0.1) & \text{for minimum demand modelling}, \end{cases} \\ \beta_{2,\mathrm{MD}} &\sim \mathrm{N}(0, 3), \\ \sigma_{\mathrm{MD}} &\sim \text{Half-Cauchy}(0, 2.5). \end{aligned}$$

Key features of the model can be summarised as follows:

- Maximum demand is decomposed into a baseline, temperature and (organic) growth component. All three components have either a direct (baseline, growth) or indirect time dependence (temperature).
- The baseline component allows for historic block loads by fitting a piecewise constant to the observed data using the indicator function

- $$I(t_i, t_{\mathrm{ch},k}) = \begin{cases} 1 & \text{if } t_i \geq t_{\mathrm{ch},k}, \\ 0 & \text{else}, \end{cases}$$
- where $t_{\mathrm{ch},k}$ is the time of the k th change point (block load).
- For maximum demand modelling, the temperature component uses recorded annual extremal temperatures (maximum temperatures for the summer MD model, minimum temperatures for the winter MD model) for the years with recorded historical MD data. Simultaneously, the model estimates the parameters of the underlying Gumbel temperature distribution using *all* available temperature data. Annual extremal temperature data are available from 1996 onwards, and are averaged across two weather stations in the ACT (Canberra Airport and Isabella Plains (Tuggeranong)). Characterising both models jointly ensures that uncertainties in the parameter estimates from both the MD and T models are properly included in the long-term MD forecasts. For minimum demand modelling, a narrow and strongly informative prior centred around zero is chosen for $\beta_{1,\mathrm{MD}}$, whose regularisation properties characterise the lack of any strong temperature dependence in minimum demand data.
- In alignment with model parsimony, organic growth is modelled using a simple linear time dependence; it was confirmed that a higher-order polynomial fit to the historical MD data does not provide better forecasts. The organic growth component can be interpreted as the compound effect that captures economic growth as well as the MD offset due to increased PV generation.
- As with all Bayesian models, using sensible prior distributions on all parameters is critical to obtaining meaningful posterior densities. Specifically, a narrow and informative prior was chosen for $\beta_{1,T}$ to include a small and realistic time-dependent global warming effect. The mean time-dependent effect of 0.01 °C per year is in agreement with the observed changes in the global Australian climate system of about 1 °C since 1910 [Australian Government Department of Agriculture, Water and the Environment, Climate change]. All other weakly informative priors are chosen in agreement with common prior choice recommendations [Gelman, Prior Choice Recommendations].

Forecasts are then obtained following a three-step process:

1. First, forecasts of temperature values T_{pred} for future years t_{pred} are obtained based on the fitted Gumbel model with posterior densities for the location μT and scale parameters σT
2. Posterior predictive densities of T_{pred} as well as posterior densities of all MD model parameters are then used to obtain MD predictions as posterior predictive densities $\mathrm{MD}_{\mathrm{pred}}$ for all future years.
3. Posterior predictive densities of maximum demand estimates are then adjusted for future block loads using afore-mentioned indicator function [Equation] which shifts the posterior predictive density by the future block load BLq at time tq. Final MD estimates at the 100α% level is then obtained from the 100(1–α)% quantiles of the posterior predictive MD density at every year. Posterior predictive densities of minimum demand densities are not adjusted for future block loads, as the effect of block loads on minimum demand is difficult to assess; consequently, minimum demand estimates provide a lower bound on the forecast minimum demand trends.

All models are fitted to maximum and minimum demand data using the Bayesian inference framework and probabilistic programming language Stan [Stan Development Team, 2020, Stan Modelling Language Users Guide and Reference Manual] through the R interface RSTAN [Stan Development Team, 2020, RStan: the R interface to Stan, R package].

Feeder Forecast

Evoenergy does not routinely prepare feeder forecasts and feeder forecasts are not included in this report. The distribution system capacity limitations are usually identified by Evoenergy for a supply area and often include several interconnected feeders. The area forecasts are based on the inherent load trends specific to that area and known block loads. The project justification reports include forecast for respective areas and projected feeder loadings which are available for any network studies or consultation on non-network solutions.

Bulk Supply Points Demand Forecasts

Tables below show the results for the summer and winter demand forecast for bulk supply point at Canberra Substation, Stockdill Substation, Williamsdale Substation, and Queanbeyan Substation. These are connection points between the Evoenergy network and Transgrid network operated by Transgrid.

Canberra Bulk Supply Point Demand Forecast

Table 50. Summer (Su) And Winter (Wi) Maximum Demand Forecast Table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2024	224	273	335	382	473	567
2025	227	277	340	384	477	571
2026	233	285	348	390	484	577
2027	258	310	374	410	505	602
2028	261	316	380	416	511	609
2029	265	322	388	420	517	617
2030	270	328	397	425	523	625
2031	273	334	404	428	528	629
2032	274	338	411	430	532	635
2033	275	341	416	434	536	642

Stockdill Bulk Supply Point Demand Forecast

Stockdill substation was energised in December 2020. Because of this there is limited historical data at the site which has been used for forecasting.

Table 51. Summer (Su) And Winter (Wi) Maximum Demand Forecast Table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2024	94	101	109	125	139	153
2025	94	101	109	125	139	153
2026	94	101	110	124	140	153
2027	94	101	110	124	140	154
2028	94	102	110	125	140	154
2029	94	102	110	125	140	155
2030	94	102	110	124	140	155
2031	94	102	111	124	140	155
2032	94	102	111	124	140	155
2033	93	102	111	124	140	155

Queanbeyan Bulk Supply Point Demand Forecast

Please note once Fyshwick Zone Substation is decommissioned Evoenergy will contribute no load to Queanbeyan BSP hence there is no forecast for these years.

Table 52. Summer (Su) And Winter (Wi) Maximum Demand Forecast Table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2024	24	30	35	20	27	34
2025	-	-	-	-	-	-
2026	-	-	-	-	-	-
2027	-	-	-	-	-	-
2028	-	-	-	-	-	-
2029	-	-	-	-	-	-
2030	-	-	-	-	-	-
2031	-	-	-	-	-	-
2032	-	-	-	-	-	-
2033	-	-	-	-	-	-

Williamsdale Bulk Supply Point Demand Forecast

Table 53. Summer (Su) and Winter (Wi) maximum demand forecast table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2024	141	188	235	167	225	278
2025	143	191	239	170	229	284
2026	147	196	244	175	234	289
2027	160	210	258	188	248	304
2028	163	213	262	191	253	309
2029	165	216	267	195	258	315
2030	169	221	272	199	263	321
2031	172	224	276	203	269	326
2032	175	228	281	205	273	331
2033	176	230	283	208	276	338

Zone Substations Limitation Tables

Table 54 and **Table 55** show the summer and winter demand (MVA) forecast for each zone substation compared against their two hour emergency and continuous ratings. POE10, POE50 and POE90 are included in the tables. A zone substation may operate between its continuous and two hour emergency ratings provided that sufficient transfer capacity exists between substations (and through the distribution network) to reduce the load to below the continuous rating in the event of a credible contingency event such as a power transformer failure. The identified limitations where demand exceeds two hour emergency ratings over the 10-year period are highlighted in **red font**.

Table 54. Zone Substation - Summer Forecast Demand (MVA) Summary

ZSS	Continuous Rating	Emergency 2-hr Rating	POE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Belconnen	55	74	90	45	45	45	45	45	45	45	45	45	45
			50	53	53	53	53	53	53	53	53	53	54
			10	62	62	62	62	62	62	63	63	63	64
City East	95	95	90	56	57	57	57	58	59	60	61	62	63
			50	65	65	66	67	67	68	69	71	72	73
			10	75	76	77	77	78	79	81	82	83	84
Civic	110	114	90	46	47	48	48	49	50	51	52	53	54
			50	52	52	53	54	55	56	57	58	59	60
			10	59	60	61	62	63	64	65	66	67	68
East Lake	50	60	90	46	48	49	50	50	50	50	50	50	50
			50	50	53	54	54	55	55	55	55	55	55
			10	56	58	59	60	60	60	60	**61**	**61**	**61**
Fyshwick	28	28	90	24	-	-	-	-	-	-	-	-	-
			50	**30**	-	-	-	-	-	-	-	-	-
			10	**35**	-	-	-	-	-	-	-	-	-
Gilmore	45	62	90	30	32	35	38	41	43	45	47	48	50
			50	35	37	40	42	45	47	49	51	53	55
			10	40	42	45	48	50	53	55	57	59	60

Table 54. Zone Substation - Summer Forecast Demand (MVA) Summary

ZSS	Continuous Rating	Emergency 2-hr Rating	POE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Gold Creek	57	74	90	65	72	**76**	**80**	**83**	**86**	**90**	**93**	**97**	**101**
			50	**77**	**84**	**88**	**92**	**95**	**98**	**103**	**106**	**110**	**114**
			10	**93**	**100**	**104**	**108**	**111**	**115**	**119**	**123**	**126**	**131**
Latham	95	95	90	46	46	46	47	47	48	48	48	49	49
			50	53	53	53	54	54	54	55	56	56	57
			10	62	62	62	63	63	64	64	65	66	66
Telopea Park	100	114	90	64	63	63	62	61	61	61	60	60	59
			50	77	76	75	75	75	74	74	74	74	74
			10	92	91	91	91	91	91	91	91	92	92
Theodore	45	62	90	22	22	22	22	22	23	23	23	23	23
			50	26	26	26	26	26	26	26	27	27	27
			10	30	30	30	30	30	30	31	31	31	31
Wanniassa	95	95	90	49	50	50	51	50	50	50	50	50	50
			50	59	60	60	60	60	60	61	61	61	61
			10	71	72	72	73	73	73	73	73	74	74
Woden	95	95	90	60	60	61	62	62	62	63	64	64	64
			50	70	71	72	72	72	73	73	74	75	75
			10	84	84	86	86	86	87	88	88	89	89

Notes:

Woden substation load includes the load of the future Molonglo Zone Substation

Tennent Zone Substation has not been included in this table as forecast is required due to the nature of the load (please refer to the table below)

Table 55. Zone Substation - Winter Forecast Demand (MVA) Summary And Capacity Constraints

ZSS	Continuous Rating	Emergency 2-hr Rating	POE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Belconnen	55	76	90	55	56	56	56	57	57	58	59	60	60
			50	58	59	59	60	60	61	62	62	63	64
			10	62	62	63	63	64	64	65	66	67	68
City East	110	114	90	66	67	69	71	72	74	76	79	81	83
			50	71	72	74	75	77	79	82	84	86	88
			10	76	77	79	81	82	84	87	89	92	94
Civic	110	143	90	49	50	51	53	54	55	57	58	59	61
			50	52	53	55	56	57	59	60	61	63	64
			10	56	57	58	59	61	62	64	65	67	68
East Lake	55	60	90	48	50	51	52	52	52	52	52	52	52
			50	51	53	54	55	55	55	55	56	56	56
			10	54	56	58	58	58	59	59	59	59	60
Fyshwick	28	28	90	20	-	-	-	-	-	-	-	-	-
			50	28	-	-	-	-	-	-	-	-	-
			10	**35**	-	-	-	-	-	-	-	-	-
Gilmore	45	69	90	37	39	42	45	49	51	53	55	57	58
			50	38	41	44	47	51	53	55	57	59	60
			10	40	42	46	49	52	54	57	59	61	62

Table 55. Zone Substation - Winter Forecast Demand (MVA) Summary And Capacity Constraints

ZSS	Continuous Rating	Emergency 2-hr Rating	POE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Gold Creek	57	84	90	**88**	**96**	**100**	**105**	**108**	**112**	**117**	**122**	**126**	**131**
			50	**92**	**100**	**105**	**109**	**113**	**117**	**122**	**127**	**131**	**136**
			10	**96**	**105**	**109**	**114**	**118**	**122**	**127**	**131**	**136**	**141**
Latham	100	114	90	65	65	65	65	65	66	66	67	67	67
			50	70	70	70	71	71	71	72	72	73	73
			10	75	75	76	76	76	77	78	78	79	79
Telopea Park	100	114	90	76	76	76	76	77	77	78	78	79	79
			50	81	82	82	82	82	83	84	84	85	85
			10	87	87	88	88	89	89	90	91	91	92
Theodore	45	69	90	27	27	27	27	27	27	27	27	27	27
			50	28	29	29	29	29	29	29	29	29	29
			10	30	30	30	30	31	31	31	31	31	31
Wanniassa	100	114	90	69	70	71	72	72	72	73	73	74	74
			50	76	77	78	79	79	80	80	81	81	81
			10	83	84	85	86	86	87	88	88	89	90
Woden	100	114	90	81	82	85	86	87	89	91	93	94	96
			50	86	88	91	92	93	95	97	99	101	103
			10	91	93	96	97	99	101	103	105	107	109

Notes:

Woden substation load includes the load of the future Molonglo Zone Substation

Tennent Zone Substation has not been included in this table as forecast is required due to the nature of the load (please refer to the table below)

Zone Substation Demand Forecast Charts

Figure 39. Belconnen Substation 10-year summer and winter demand forecast chart

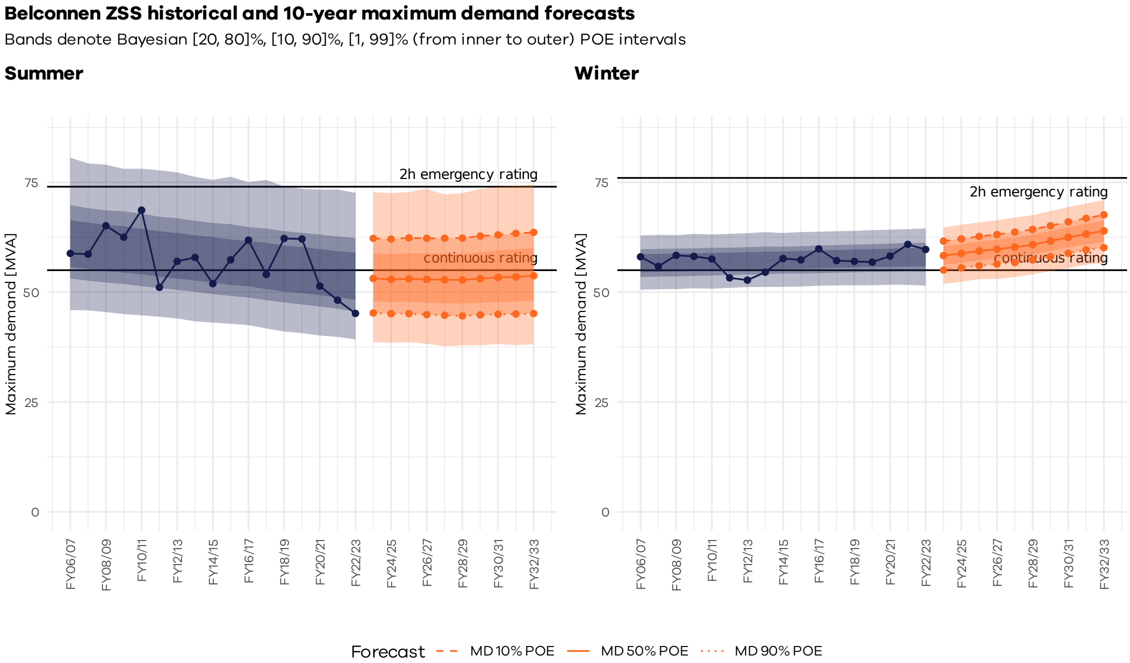


Figure 40. City East Substation 10-year summer and winter demand forecast chart

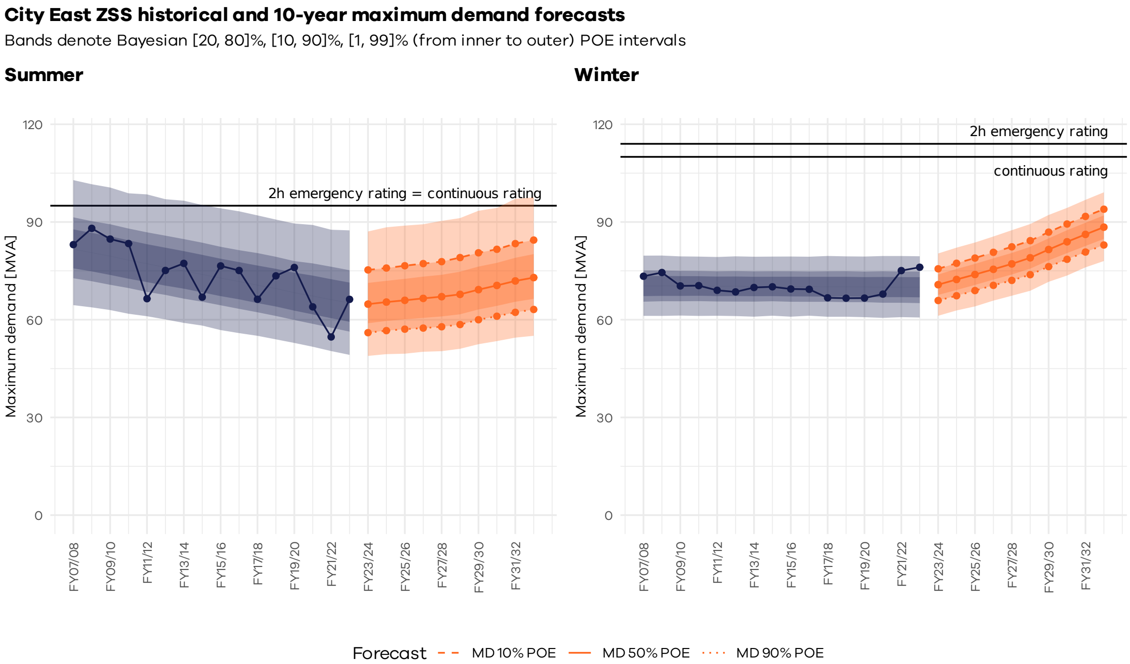


Figure 41. Civic Substation 10-year summer and winter demand forecast chart

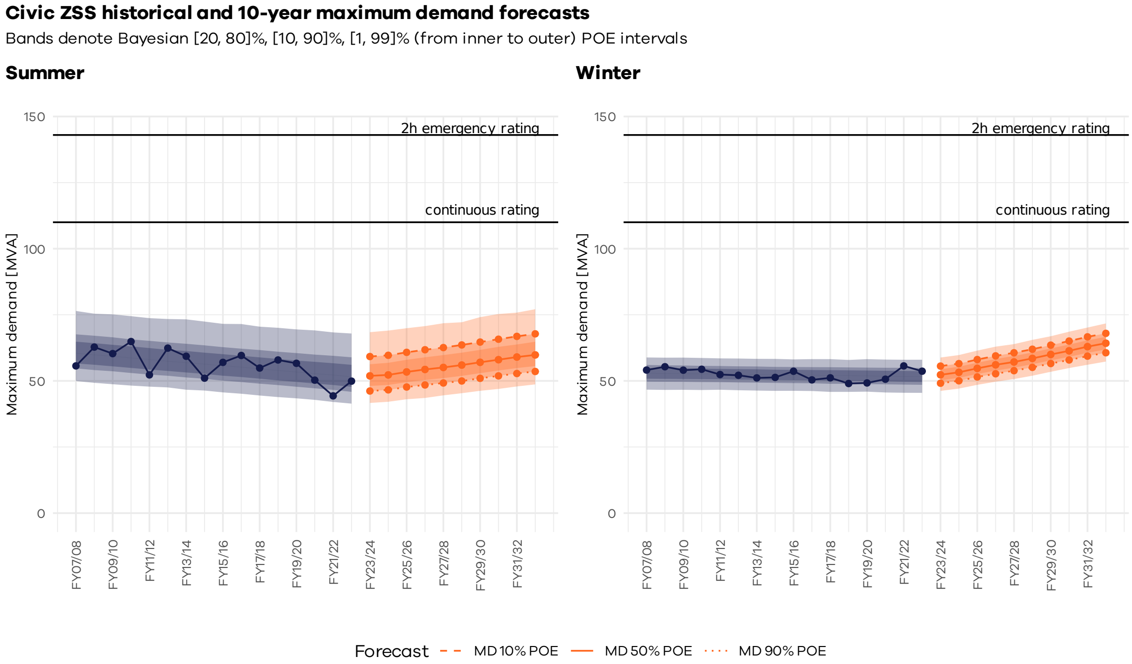


Figure 42. East Lake Substation 10-year summer and winter demand forecast chart

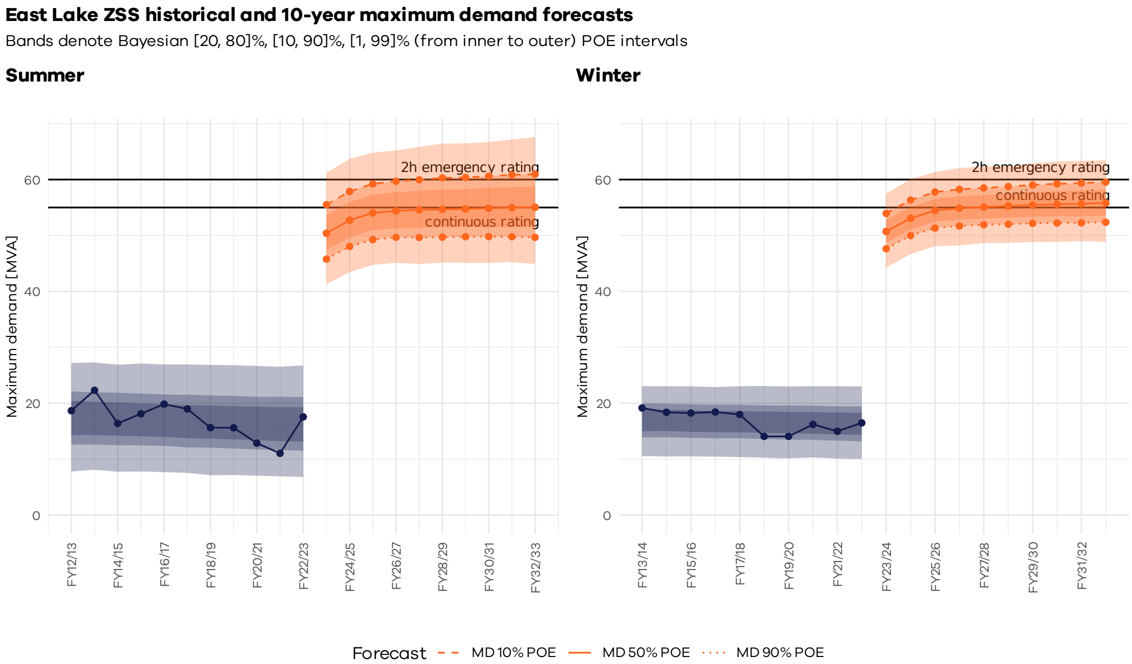


Figure 43. Fyshwick Substation 10-year summer and winter demand forecast chart

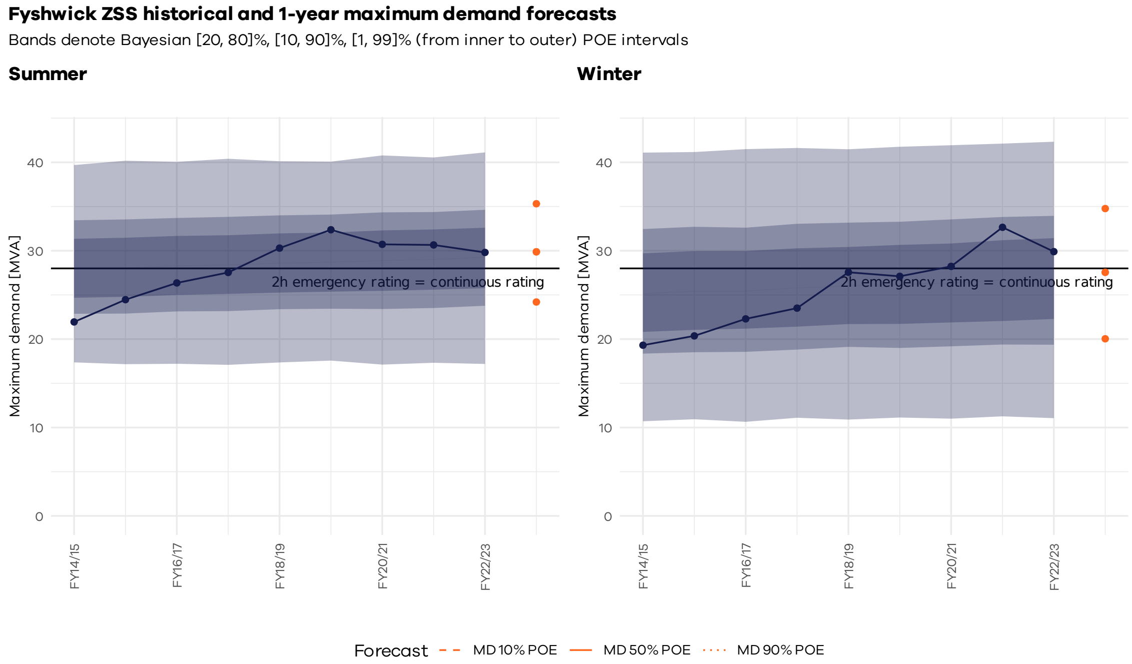


Figure 44. Gilmore Substation 10-year summer and winter demand forecast chart

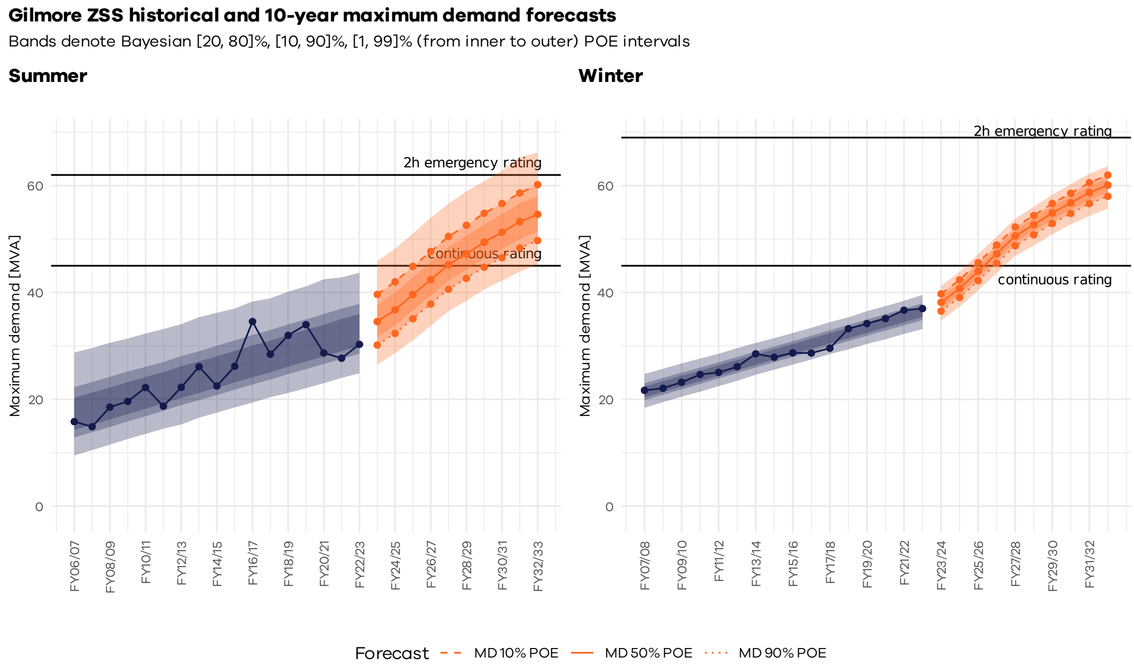


Figure 45. Gold Creek Substation 10-year summer and winter demand forecast chart

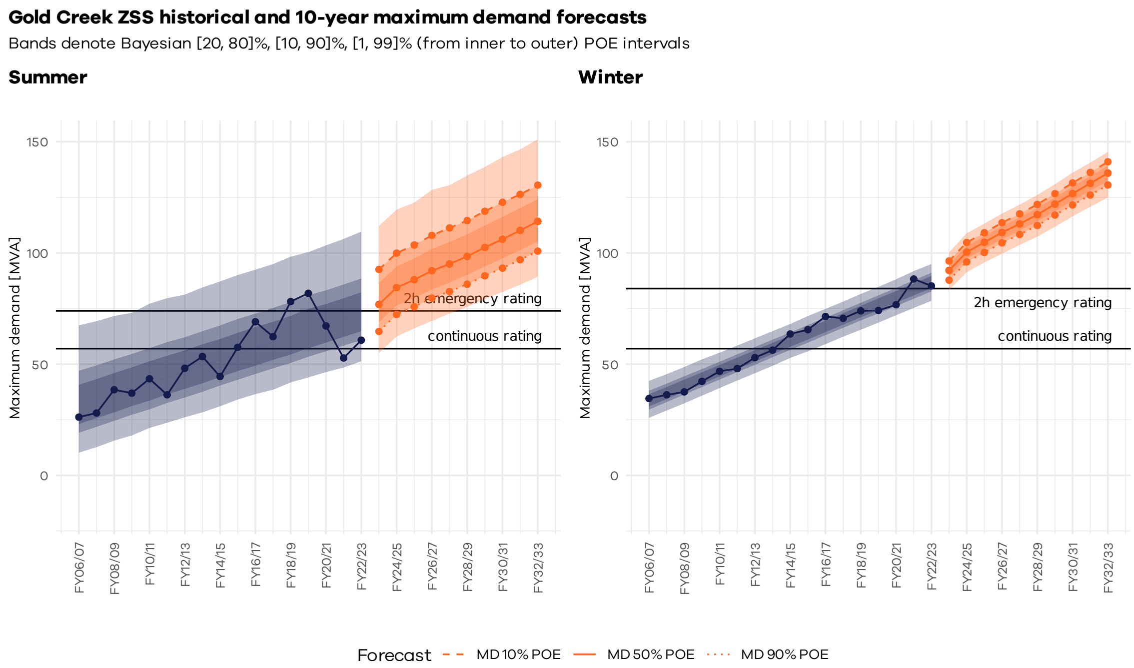


Figure 46. Latham Substation 10-year summer and winter demand forecast chart

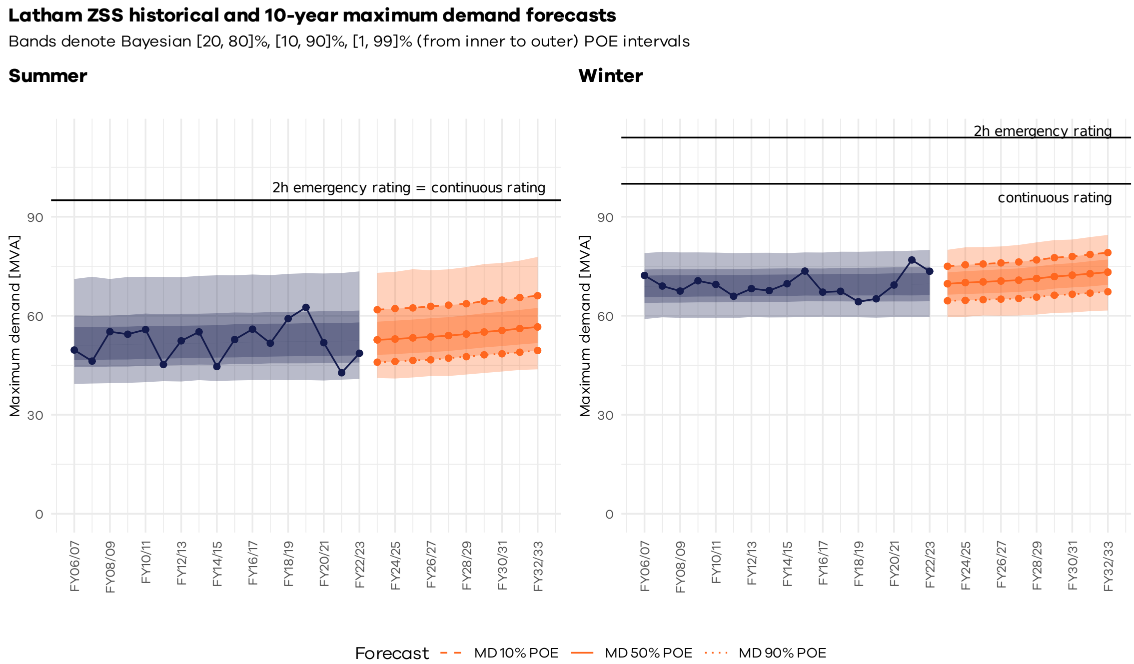


Figure 47. Telopea Park Substation 10-year summer and winter demand forecast chart

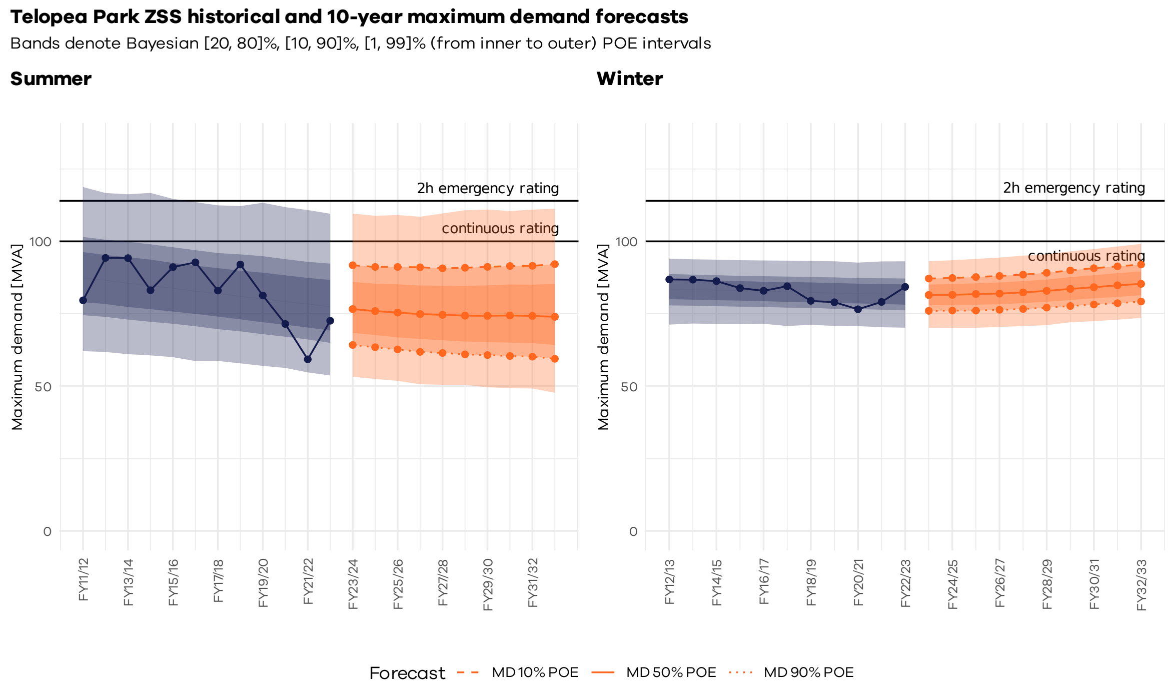


Table 56. Tennent Substation Historical Generation & Consumption Peaks

Year	Season	Generation Peak (MVA)	Consumption Peak (MVA)
2019	Summer	10.	2.5
2019	Winter	7.2	0.2
2020	Summer	9.9	0.1
2020	Winter	8.7	1.7
2021	Summer	10.1	1.6
2021	Winter	6.6	0.1
2022	Summer	10	0.1
2022	Winter	8.8	0.1
2023	Summer	10.1	0.1
2023	Winter	7.6	0.4

Tennent is a zone substation purpose built to connect to the large-scale Royalla solar farms. The generation peak is higher than the load peak. It is geographically removed from Canberra and there is no growth in either consumption or generation. For this reason, a forecast has been deemed unnecessary.

Figure 48. Theodore Substation 10-year summer and winter demand forecast chart

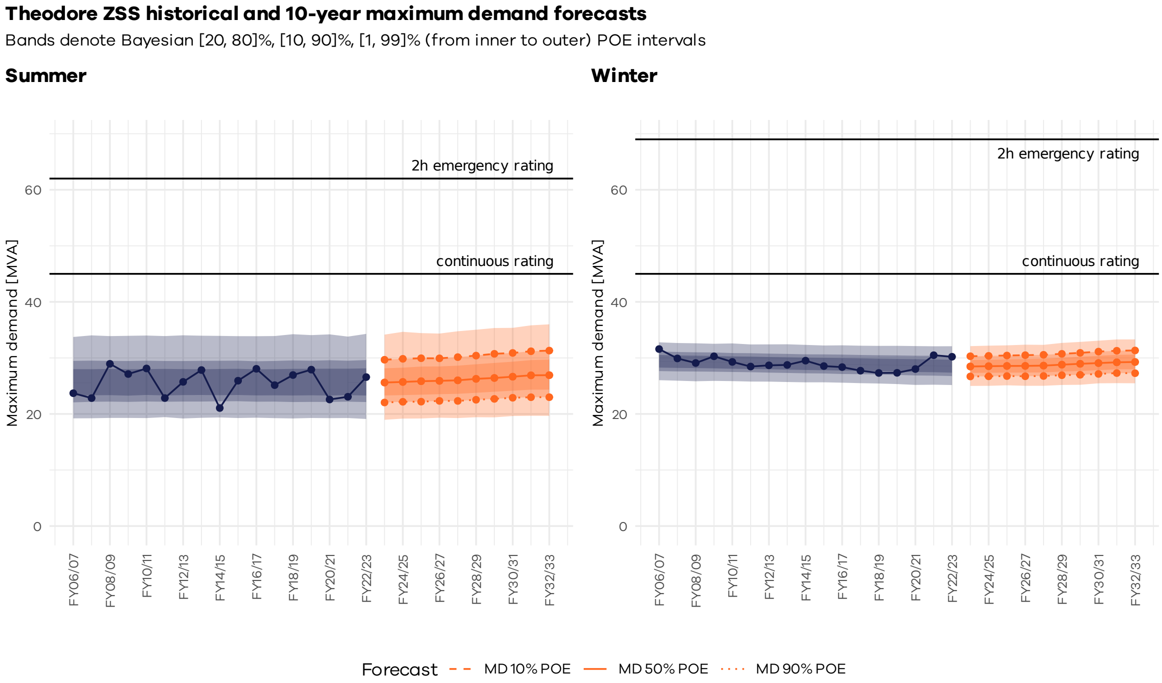


Figure 49. Wanniassa Substation 10-year summer and winter demand forecast chart

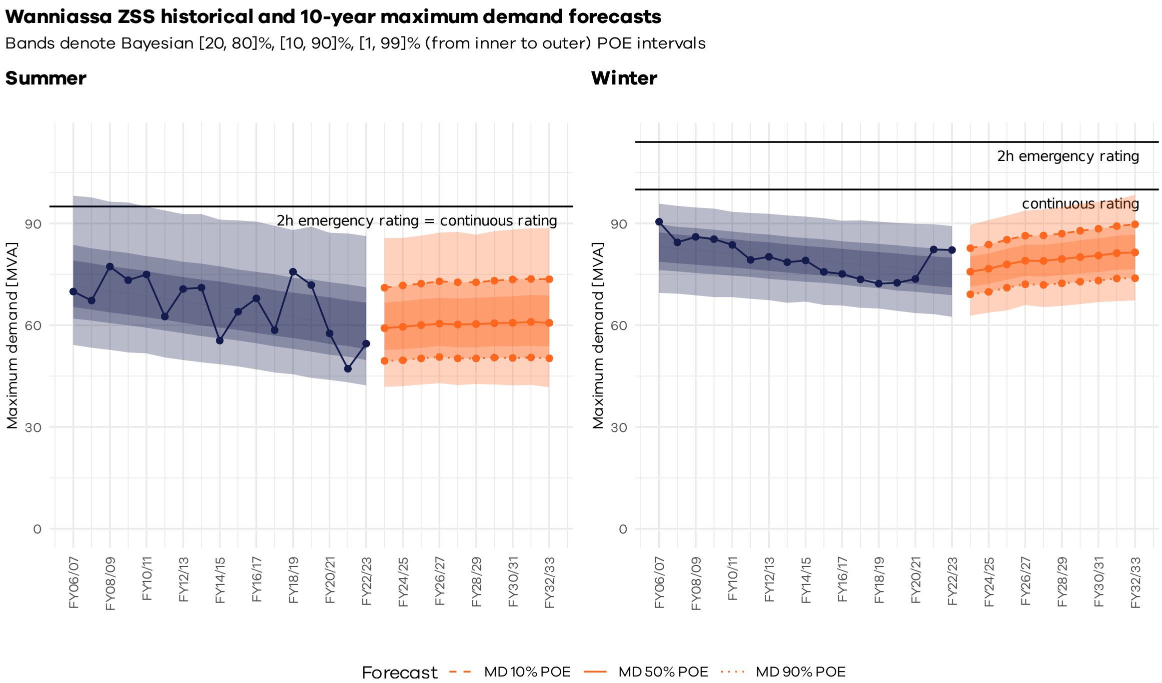
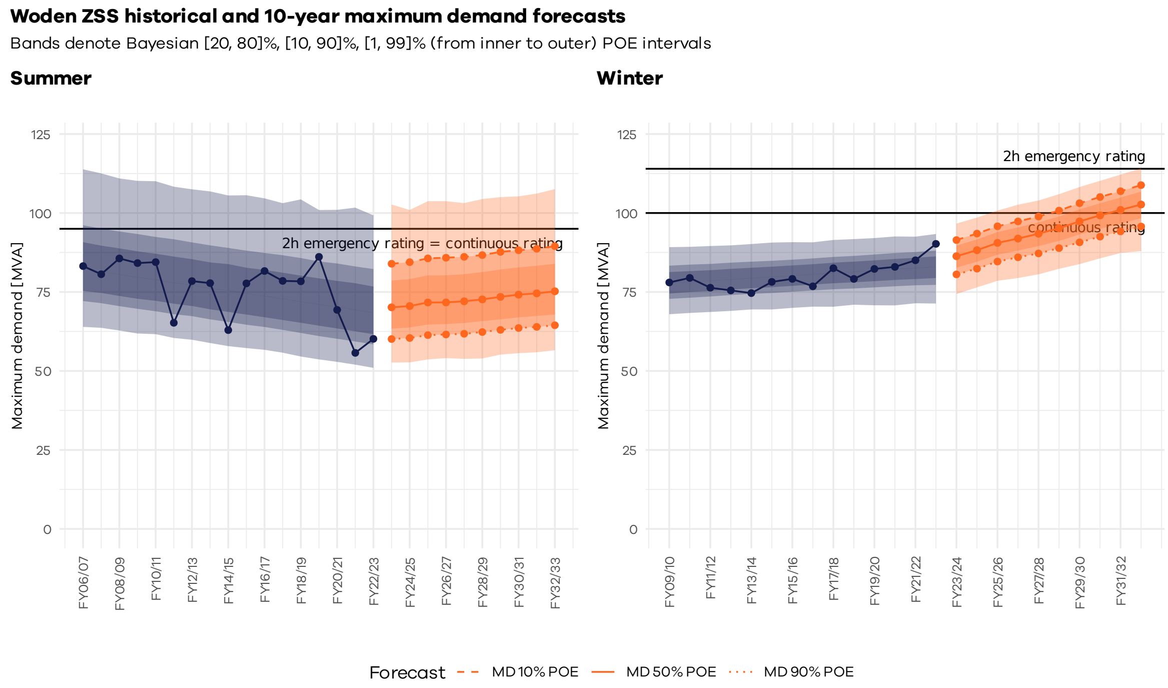


Figure 50. Woden Substation 10-year summer and winter demand forecast chart



Zone Substation Export Forecasts

The table below shows the adjusted net export (MVA) forecast for the zone substation and comparison with the two hour and continuous emergency rating of the substations. Only POE50 is included in the tables. There are no Zone Substation constraints from exports forecast for the next ten year period.

Table 57. Zone Substation - Adjusted Net Exports (MVA) summary

ZSS	Continuous Ratings*	Emergency 2-hr Ratings *	POE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Belconnen	55	74	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
City East	95	95	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Civic	110	114	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
East Lake	50	60	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fyshwick	28	28	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gilmore	45	62	50	1.0	1.0	1.0	2.0	2.0	3.0	3.0	3.0	4.0	4.0
Gold Creek	57	74	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latham	95	95	50	0.0	0.0	0.0	1.0	2.0	3.0	4.0	5.0	7.0	8.0
Telopea Park	100	114	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Theodore	45	62	50	25.0	27.0	29.0	31.0	33.0	35.0	37.0	39.0	41.0	43.0
Wanniassa	95	95	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Woden	95	95	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*Continuous rating for summer as minimum demand will likely be in warmer weather

Appendix F: Network Reliability Standards And Performance

Key Definitions

- **SAIDI:** System Average Interruption Duration Index. The ratio of total consumer minutes interrupted to total consumers served. This is a performance measure of network reliability, indicating the total minutes, on average, that consumers are without electricity during the relevant period.
- **SAIFI:** System Average Interruption Frequency Index. The ratio of total consumer interruptions to total consumers served. This is a performance measure of network reliability, indicating the average number of occasions each consumer is interrupted during the relevant period.
- **CAIDI:** Customer Average Interruption Duration Index. The ratio of total consumer time interrupted to total consumer interruptions. Measured in minutes and indicates the average duration an affected consumer is without power. CAIDI = SAIDI/ SAIFI.

Network reliability standards (set by the Australian Energy Regulator and jurisdictional technical regulator), the performance and the key reliability measures are outlined in the following sections:

Australian Energy Regulator Reliability Targets

The purpose of the Service Target Performance Incentive Scheme (STPIS) is to provide an incentive to maintain existing supply reliability to consumers, and to implement improvements to match consumers' value of supply reliability. The scheme includes financial incentives or penalties based on improvement or deterioration in network performance compared to past benchmarks. The scheme currently applies to unplanned supply interruptions.

The determination by AER for Evoenergy in April 2019 applied the STPIS scheme to the 2019-24 regulatory control period. In each year, the incentives and penalties are capped at 5% of the annual Evoenergy allowance.

STPIS targets are set by the AER for the five-year regulatory control period. The targets set by AER for 2019-24 are in **Table 58** The targets apply to unplanned supply interruptions only.

Table 58. STPIS Reliability Performance Targets for Unplanned Outages:

Year	2019-24 Target	Units
Unplanned SAIDI[34]		
Urban	32.524	Minutes
Short Rural	35.056	Minutes
Whole Network (weighted average)	33.366	Minutes
Unplanned SAIFI[35]		
Urban	0.565	Number
Short Rural	0.591	Number
Whole Network (weighted average)	0.574	Number

Jurisdictional Regulator Reliability Targets

The ACT Utilities (Technical Regulation) Act requires Evoenergy to comply with the relevant technical codes. The reliability targets specified in the Electricity Distribution Supply Standards Code are shown in **Table 59**. The ACT targets apply to planned and unplanned supply interruptions.

Table 59. Electricity Distribution Supply Standards Code Annual Reliability Targets

Parameter	Target	Units
Average outage duration (SAIDI)	91.0	Minutes
Average outage frequency (SAIFI)	1.2	Number
Average outage time (CAIDI)	74.6	Minutes

34 SAIDI-System Average Interruption Duration Index – refers to the combined length of supply interruptions (minutes) which average customer experiences during the year

35 SAIFI-System Average Interruption Duration Index – refers to the number of sustained (not momentary) supply interruptions which average customer experiences during the year.

Performance Against The Reliability Targets

Table 60 provides the historical reliability performance statistics for Evoenergy's network. The table includes SAIDI and SAIFI figures for the rural network, urban network, and the whole of the network from the year 2015 onwards. The planned and unplanned outages are set out against jurisdictional and STPIS reliability targets.

Table 60. Performance Vs Targets – Planned And Unplanned Interruptions

		2017-19				2019-24		
	Target	2017-18	2018-19	Target	2019-20	2020-21	2021-22	2022-23
SAIDI								
Whole Network Overall	**91 (ICRC)**	99.97	92.53	**91 (ICRC)**	81.7	82.04	164.69	90.11
Whole Network Planned	-	57.18	41.54	-	33.32	39.87	35.63	49.54
Whole Network Unplanned	-	31.44	34.94	-	35.31	37.79	54.57	40.75
Urban Unplanned	**30.32 (ICRC)**	29.76	33.19	**32.524 (ICRC)**	29.32	31.78	47.33	29.42
Short Rural Unplanned	**46.86 (ICRC)**	34.19	36.58	**35.056 (ICRC)**	46.63	57.35	51.49	60.42
SAIFI								
Whole Network Overall	**1.2 (ICRC)**	0.79	0.95	**1.2 (ICRC)**	0.71	0.75	1.2	0.62
Whole Network Planned	-	0.21	0.19	-	0.17	0.2	0.21	0.26
Whole Network Unplanned	46.86	0.49	0.63	0.62	0.49	0.52	0.83	0.62
Urban Unplanned	**0.585 (AER)**	0.45	0.6	**0.565 (AER)**	0.44	0.46	0.82	0.46
Short Rural Unplanned	**0.895 (AER)**	0.56	0.6	**0.591 (AER)**	0.59	0.72	0.85	0.88
CAIDI								
Whole Network Overall	**74.6 (ICRC)**	126.54	97.4	**74.6 (ICRC)**	115.07	109.39	136.89	102.67
Whole Network Planned	-	272.29	218.63	-	196	199.35	171.36	192.57
Whole Network Unplanned	-	64.16	55.46	-	72.06	72.67	65.91	65.28
Urban Unplanned	-	66.13	55.32	-	66.64	69.09	57.72	63.96
Short Rural Unplanned	-	61.05	60.97	-	79.03	79.65	60.58	68.66

Reliability Strategy And Plan

Overall Evoenergy aims to maintain existing levels of reliability for consumers, ensure we comply with our license conditions, and elevate value delivered to consumers. Evoenergy will make improvements over the short, medium, and long term against the following guiding policies:

Invest in people and process

Network reliability performance depends on capable people given appropriate tools and training, delivering to well-designed process. Events that stress-test the system and anomalous performance outcomes can reveal gaps in existing people and process management. We can reflect on these experiences to drive changes that improve the system and make it more robust to future events.

Plan for a more responsive network

One of the most direct ways to improve network reliability performance is to enhance the typical speed at which supply is restored when outages occur. We can achieve this by creating a more flexible network that lends itself to rapid deployment of resources to areas of need and can be easily reconfigured to avoid dependencies on faulted assets.

Embed risk-based asset management

A mature understanding of risks and the asset management choices we can make to control them is critical to efficient and effective management of network reliability. We will benefit from improving our understanding of the condition and lifecycle stages of our assets, with implications for inspection, maintenance, and resource prioritisation.

Incorporate best-practice vegetation management

Vegetation is a large contributor to unplanned outages on overhead networks. Outages can occur when trees come in contact with overhead wires or when trees fall on overhead networks, often during storms. Recent revisions to Australian Standards for vegetation management present an opportunity to review our own practices, and re-establish what best practice vegetation management looks like for Evoenergy.

Create a better outage experience

Customer engagement undertaken in preparation for the 2024-2029 regulatory submission has revealed that customers are interested in Evoenergy doing more to improve their experience and level of support when an outage occurs. Whilst these considerations may not contribute directly to our outage duration and frequency statistics, they are clearly an important contributor to the impact that outages have on our customers.

Appendix G: Power Quality Standards And Performance

This appendix provides additional information in relation to power quality in addition to the information provided in Chapter 4.

The appendix includes the following commentary:

- An overview of the main standards, guidelines and other technical requirements relating to power quality
- Description of key power quality parameters and requirements
- Summary of power quality issues related to embedded generation.

Power quality standard and references

Schedule 5.1 of the *NER lists the Network System Standards* that are to be achieved by Network Service Providers (NSPs). Evoenergy's approach to network planning complies with these reliability and performance requirements when considering network developments and aims to meet the NER requirements, relevant standards codes, and guidelines. These include:

- *NER Schedule 5.1a – System Standards.*
- *NER Schedule 5.1 – Network Performance Requirements to be provided or co-ordinated by Network Service Providers.*
- *NER Schedule 5.3 – Conditions for Connection of Customers.*
- *AS 2344 – Limits of electromagnetic interference from overhead a.c. power lines and high voltage equipment installations in the frequency range 0.15 MHz to 3000 MHz.*
- *AS/NZS 3000 – Australian/New Zealand Wiring Rules.*
- *AS/NZS 7000 – Overhead Line Design.AS/NZS 61000 – Electromagnetic Compatibility (various sub-standards).*
- *AS/NZS 60038 – Standard Voltages.*
- *HB 264:2003 – Power quality handbook.*
- *AS/NZS 4777 Grid connection of energy systems via inverters.*
- Evoenergy Service & Installation Rules for Connection to the Electricity Distribution Network.
- Evoenergy Requirements for Connection of Embedded Generators up to 5 MW to the Evoenergy Distribution Network.

Power Quality Parameters

Steady State Voltage

Voltage levels at consumers' premises must be supplied and maintained within regulation limits to ensure correct operation of appliances and safety to equipment and personnel. Exceeding the upper voltage limit may result in insulation breakdown and subsequent equipment damage, whilst operating below the lower limit impacts on power quality and could cause fuses to blow due to higher current.

Steady state phase-neutral low voltage at the consumer's point of supply is maintained at 230 V +10%/-6% in accordance with Australian Standards AS/NZS 60038 and AS 61000.3.100. Steady state voltage at the consumer's point of supply is measured to ensure the V1% and V99% (phase-to-neutral and phase-to-phase) remain within limits.

Table 61. Voltage Tolerance Limits:

Voltage Boundary	AS 600038	As 61000.3.100
Nominal Voltage	230 Volts	230 Volts
Upper Limit	+10%	+10%
Lower Limit	-6%	-6%
$V_{99\%}$ / V_{MAX}	253 Volts	253 Volts
$V_{1\%}$ / V_{MAX}	216 Volts	216 Volts
Utilisation Limit (+10% / -11%)	440 Volts (Phase-to-Phase Maximum) 253 Volts (Phase-to-Neutral Maximum)	-
	356 Volts (Phase-to-Phase Minimum) 205 Volts (Phase-to-Neutral Minimum)	

Rapid Fluctuations In Voltage (Flicker)

Voltage fluctuations are defined as repetitive or random variations in the magnitude of the supply voltage. The magnitudes of these variations do not usually exceed 10% of the nominal supply voltage. However small magnitude changes occurring at certain frequencies can give rise to an effect known as flicker. Voltage fluctuations may cause spurious tripping of relays, interference with communications equipment, and may trip electronic equipment.

Flicker is usually consumer-generated due to the following:

1. Frequent starting of induction motors – mainly the direct online starting of induction motors.
2. Electric welders.
3. Arc furnaces.

Evoenergy responds to a consumer report of flicker by installing a mobile power quality analyser. Evoenergy either advises the consumer if the flicker is due to its operations or rectifies if caused by Evoenergy's equipment.

Maximum permissible voltage flicker levels are specified in TR IEC 61000.3.7.

Table 62. Voltage fluctuation:

Compatibility levels for flicker in LV systems	
P_{st}	1.0
P_{lt}	0.8

Compatibility levels are not defined for MV, HV and EHV systems in the Australian Standards.

P_{st} refers to "short term severity level" and is determined for a 10-minute period.

P_{lt} refers to "long time severity level" and is calculated for a two-hour period. It is derived from the values of P_{st} for 12 consectutive10-minute periods.

Table 63. Voltage flicker levels for different voltage levels

Planning levels for flicker in MV, HV & EHV systems		
	MV	HV/EHV
P_{st}	0.9	0.8
P_{lt}	0.7	0.6

Voltage Dips

Voltage dips are typically caused by events such as lightning or faults on adjacent feeders, or are generated by equipment located within consumers' premises (e.g. induction motor starting).

Dips caused by faults on adjacent feeders can propagate throughout the network, affecting consumers' supply voltage on all feeders at the zone substation. Although only consumers on the faulted feeder experience an interruption, many experience the reflected voltage sags generated by the fault.

Evoenergy monitors voltage dips as part of its proactive power quality monitoring program. Evoenergy uses its SCADA system and protection records to analyse events and uses its mobile power quality analysers to assist in the analysis and rectification of voltage dips. Evoenergy shall use the implementation of numerical protection devices and the ADMS to further reduce the overall number of voltage dips on the network. Evoenergy proposes to review fault switching and investigate the use of auto-reclosers, sectionalises and fault passage indication devices to reduce fault switching.

Table 64. Voltage Dip Voltage Tolerances[36]

Dips Down to % Nominal Voltage	Max No. of Dips Per Year (per point of supply) Urban	Max No. of Dips Per Year (per point of supply) Rural
< 30	2	6
30 – 50	20	40
50 – 70	20	40
70 – 80	25	50
80 – 90	200	300

Voltage Transients

Switching transients are primarily associated with the operation of circuit breakers and are typically the consequence of the switched current being extinguished prior to the natural current zero value of the sinusoidal current waveform. This characteristic is termed as current chopping.

The chopping of the current results in transient voltages being generated which enter and travel through the interconnected network. Switching transients can also be generated by the switching of lumped capacitances (e.g. capacitor banks).

Switching transients are typically high frequency, short duration voltage conditions (mainly overvoltage conditions) which can result in damage to sensitive equipment.

Evoenergy shall manage switching transient voltages through switchgear procurement standards (i.e. utilising switching equipment that has small chopping current characteristics) and asset specific maintenance regimes, and routine maintenance programs designed to avoid excessive switch contact arcing.

The Electricity Distribution Technical Standards Code requires Evoenergy to take all reasonable steps to ensure that switching transients on its electricity network are limited to less than two times normal supply volts.

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Voltage Difference Neutral To Earth

Voltage differences between neutral and earth can present the risk of damage to electrical equipment at consumers' premises as well as a risk of electric shock and fire. Typically, voltage differences can be caused by such things as:

- Inadequate earthing (high earth resistance or open circuit earth) at substations.
- Inadequate bonding of earth and neutral in Multiple Earth Neutral (MEN) systems.

Evoenergy adheres to the relevant distribution substation earthing requirements and advises consumers of correct earthing practices. Evoenergy includes neutral to earth monitoring as part of its power quality monitoring program to assist with classifying neutral to earth voltage non-compliance.

The Electricity Distribution Technical Standards Code prescribes voltage difference between neutral and earth is < 10 V steady state (5-minute average) at the point of supply.

Table 65. Voltage Difference Between Neutral To Earth Limits[37]

Voltage Difference Between Neutral to Earth
< 10 Volts (5 minute average at the point of supply)

Voltage Unbalance

Voltage unbalance typically results from:

- Unbalanced phase impedances.
- Unbalanced phase loadings.
- Interaction between phases (induced voltages) on overhead lines.

Unbalanced voltages can result in high neutral currents which introduce the potential for high neutral to earth voltage difference, and the generation of negative sequence voltages that can damage three-phase induction motors.

Evoenergy manages voltage unbalance within the required limits through appropriate design practices and transformer procurement specifications. Evoenergy uses its mobile power quality analysers and quality of supply survey procedures to identify and rectify voltage unbalance. This is supported using ADMS calculations to ensure compliance.

The Electricity Supply Distribution Code requires Evoenergy to take all reasonable steps to ensure that the voltage of electricity distributed through its electricity network does not exceed:

- a 6% difference between the highest and lowest phase to neutral or phase to phase steady state voltage (five minutes average) for the low voltage network; and
- a 3% difference between the highest and lowest phase to phase steady state voltage (five minutes average) for the high voltage network.

Direct Current Component

Direct current component in the neutral conductor has the effect of offsetting the sinusoidal waveform and can be caused by equipment that has different operating characteristics in each half of the voltage cycle. A high DC component can cause damage to electronic devices and impact on the correct operation of protective devices. It can also lead to an increase in losses and result in heating within electrical and electronic equipment. Limiting the direct currents in the neutral to acceptable limits is important because such current can cause corrosion of the network and a customer's earthing system, leading to potentially unsafe operating condition.

The Electricity Supply Distribution Code requires Evoenergy to take all reasonable steps to ensure that electricity distributed through its electricity network does not exceed a direct current voltage component of the neutral conductor with respect to earth of more than plus or minus 10 volts at the point of supply.

Harmonics

Harmonics are usually consumer generated. Non-linear loads such as industrial equipment

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(e.g., arc welders), variable speed drives, uninterruptible power supplies, some types of lighting, and office equipment, are all sources of harmonic currents. Harmonic currents flowing in transformers cause an increase in the copper (resistive) losses and iron (magnetising) losses. Harmonic distortion can cause the supply voltage waveform to depart from sinusoidal in a repetitive manner. This can affect the operation of computer equipment, create noise on radio and television receivers, and cause vibration in induction motors.

Evoenergy responds to consumer requests to measure and analyse harmonic levels. Evoenergy uses its mobile power quality analysers and undertakes harmonic monitoring as part of its power quality surveys.

Consumers must ensure that harmonic distortion caused by their equipment does not exceed the limits prescribed in AS/NZS 61000

Table 66. Compatibility levels for Individual harmonic voltages in low voltage networks

Odd harmonics, non-multiple of 3		Odd harmonics, multiple of 3		Even harmonics	
Harmonic order (h)	Harmonic voltage (%)	Harmonic order (h)	Harmonic voltage (%)	Harmonic order (h)	Harmonic voltage (%)
5	6	3	5	2	2
7	5	9	1.5	4	1
11	3.2	15	0.4	6	0.5
13	3	21	0.3	8	0.5
$17 \leq h \leq 49$	2.27x(17/h)-0.27	$21 \leq h \leq 45$	0.2	$10 \leq h \leq 50$	2.27x(17/h)-0.27

The corresponding compatibility level for the total harmonic distortion is: THD = 8% (LV) and 3% (HV).

Electromagnetic Fields (EMF)

Electromagnetic fields are a key design consideration for bare electrical conductors such as overhead lines and bus-work, particularly those which operate at high voltage. For conductors with an earth shield, such as underground high voltage cables, the fields are encapsulated within the cable and do not present external hazards.

Electromagnetic fields incorporate both electric fields resulting from the voltage on conductors and the magnetic fields generated by the current flowing in the conductors. Both phenomena result in a "grading" of the respective fields from the conductor to the nearest earth location. In terms of voltage there will be a voltage "gradient" between the conductor and earth. In terms of current there will be a grading of the magnetic field (flux density) from the conductor to the earth.

Depending on the strength of these fields minute currents can be induced in the bodies of animals and humans. Research is inconclusive at present but there are concerns as to the health implications of exposure to electromagnetic fields. As such there are strict guidelines for the management of electromagnetic fields incorporated into the design of overhead lines and high current equipment.

The Energy Networks Australia (ENA) Association has published an EMF Management Handbook (January 2016) which describes EMF in detail and methods to mitigate magnetic fields. Evoenergy follows these guidelines where practicable and complies with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Guidelines in the design of its network with respect to electromagnetic fields.

Inductive interference

Inductive interference refers to the ability of the magnetic fields generated by current flowing in typically overhead line conductors, to cause interference with other electromagnetic radiation such as radio, television, and communication signals.

Evoenergy shall continue to undertake routine maintenance programs to ensure all equipment is in good working condition, in particular all HV and LV overhead lines, to ensure that inductive interference is within the limits specified in Australian Standard AS 2344.

Power Factor

Power factor relates to the relationship between real and reactive power. In an alternating current (AC) system the in-phase portions of voltage and current waveforms produce "active" or real power which is the capacity of the electricity system to perform work. The out of phase portions of voltage and current waveforms produce "reactive" power. The combination of active and reactive power is termed apparent power. A low or poor power factor will result in inefficiency due to high apparent power loading with a low real power delivery.

Evoenergy monitors power factor as part of its programmed proactive and reactive monitoring of the network. Evoenergy uses the ADMS to identify areas of the network that may be experiencing power factor issues. Metering data is also used to identify installations with power factor outside acceptable limits.

Consumers can gain significant benefits by improving the power factor at their premises. These benefits include reduced electricity costs, increased plant load capacity and utilisation, and better voltage regulation. Improvement of power factor is usually achieved by the installation of capacitors.

Evoenergy requires that the power factor at the point of common coupling between Evoenergy's network and the consumer's installation shall be between 0.9 lagging and unity. Leading power factor is unacceptable. Details can be found in Evoenergy's Service & Installation Rules for Connection to the Electricity Distribution Network which can be found on our external website.

Appendix H: Network Technical Parameters And Systems

This appendix provides and additional information on the network technical parameters and systems.

Key Network Systems

SCADA Systems

Evoenergy's Supervisory Control and Data Acquisition (SCADA) systems provide essential real-time monitoring and control of Evoenergy's electrical network assets. Data from the field is captured within Remote Terminal Units (RTUs) which then communicate and provide monitoring and control capability to Evoenergy using our centralised Advanced Distribution Management System (ADMS). This data is available to Evoenergy's 24/7 control room for real-time network management and response and is also stored as historical for later analysis and investigation by engineering teams. A summary of the kinds of data and control provided by Evoenergy's SCADA system, and the applications for this data, includes:

- Remote control of circuit breakers and switches in the electrical network. This assists with reducing outage restoration times and mitigating the risks of arc flash by avoiding manual switching operations.
- Protection operation and fault passage indication. This again assists with reducing outage restoration times by providing information to the control room on the location of the faulted assets.
- Network load and voltage measurements. This assists Evoenergy with ensuring the network is run within real time load and voltage constraints. It also provides key historical information to network planning and power quality engineering teams to better target network augmentation and power quality remediation programs.
- Asset failure reporting for onsite investigation and remediation before further failures occur.
- Asset health and condition monitoring to better understand the health of the assets and make informed decisions around optimised maintenance and replacement programs.
- Monitoring and control of large-scale embedded generation systems to ensure the embedded generation does not cause any negative impacts on the wider electrical network.

Evoenergy currently has SCADA capability at all Zone substations and in recent years has also been significantly increasing SCADA capability within the distribution network. Newer devices and communications technologies available on the market have made SCADA installation in distribution substation easier and more cost effective. This has become important, particularly in recent times, with significant increases in the connection of rooftop solar, residential batteries and EVs to Evoenergy's network. Having access to SCADA data on a low voltage network level helps Evoenergy better assess the impact of these technologies and plan accordingly to ensure the ongoing security and reliability of electricity supply to Evoenergy's customers.

Evoenegy has a SCADA asset replacement program targeted at older, less reliable devices with poor asset condition scores or utilising obsolete technologies. When SCADA assets are replaced, they are upgraded to the latest generation technologies, providing additional monitoring and control capabilities. Cyber security is also critical for Evoenergy SCADA systems and is a significant consideration in any targeted replacement or upgrade programs. For communications between Evoenergy's SCADA RTUs and central ADMS system, Evoenergy currently uses either direct optical fibre connection or 4G communications depending on availability and best cost benefit option for individual sites.

Protection Systems

Evoenergy uses protection systems throughout the network including at zone substations, switching stations and distribution substations. Protection relays are devices that monitor system conditions and detect abnormal conditions (such as those resulting from a fault on the system). The relays then quickly activate devices such as circuit breakers to isolate faulty electrical equipment and ensure the safety of our staff, the public and property.

Evoenergy has identified the need to replace several under-performing protection relays that have reached the end of their economic life. Old electro-mechanical and static/electronic protection devices are being progressively replaced with modern numerical relays.

All new or replacement protection systems will include the following:

- All protection devices will be multifunctional numerical control devices (IEDs) compliant with *IEC 61850 and DNP3 standards*.
- IEDs shall use *DNP3 or IEC 61850* protocol for SCADA communications to RTUs.
- Protection and automation functions will be implemented in IEDs.
- Duplicate protection devices shall be installed in 132 kV zone substation applications as required by the NER.
- Main and backup protection devices shall be installed in 11 kV zone substation applications.

Network Voltage Regulation

The Evoenergy network is supplied from Transgrid's bulk supply substations at Canberra, Stockdill, Williamsdale, and Queanbeyan. Voltage levels on the 132 kV bus at Canberra, Stockdill and Williamsdale substations is controlled by Transgrid via its 330/132 kV interconnecting transformers' on-load tap changers (OLTCs) and 132 kV capacitor banks. Similarly, the 66 kV bus voltage at Queanbeyan bulk supply substation is controlled by Transgrid.

The 11 kV bus voltage at each Evoenergy zone substation is maintained by the voltage-regulating relay which controls the tap position of the 132/11 kV transformers. To maintain the voltage within limits along the 11 kV feeders, the bus voltage is varied according to network conditions (loading, incoming voltage, feeder voltage drops, embedded generation etc.).

Evoenergy has installed TNSP metering on the 11 kV group circuit breakers at all 132/11 kV zone substations. In addition to providing metering functions to AEMO, these meters provide accurate voltage measurements and other power quality information to the ADMS in real time.

Evoenergy monitors steady state voltage levels and responds to consumer complaints where required. Evoenergy is considering the application of smart metering technology to further ensure compliance of steady state voltage levels.

Network Fault Level And Protection

Fault level is defined in terms of fault current (kA). The fault current is the maximum current that would flow at that point in the network should a short circuit fault occur. Major equipment elements such as circuit breakers, switchgear, cables, and busbars are specified to withstand the maximum possible fault level. This equipment is designed to withstand the thermal and mechanical stresses experienced due to the high currents in short circuit conditions.

Fault level is also an indication of a power system's strength. Higher fault current levels are typically found in a strong power system, while lower fault current levels indicate a weaker power system. A strong power system exhibits better voltage control in response to a system disturbance, whereas a weak power system is more susceptible to voltage instability or collapse. For example, connection points with higher fault levels experience less voltage flicker during load switching compared with those that have lower fault levels. System strength is a measure of the ability of a power system to remain stable under normal conditions and to return to a steady state condition following a system disturbance.

High voltage overhead lines that are insufficiently fault rated may cause the conductors to clash, sag below minimum ground clearance, or even break when subjected to a fault current. Such situations can occur when network augmentations such as the construction of a new zone substation increase the fault levels in the distribution network.

Conversely increasing amounts of power electronic converter generation (e.g., PV generation) connected to the network, replacing synchronous generation, serves to reduce fault levels and consequently reduce system strength.

Evoenergy specifies new 11 kV equipment to be capable of withstanding 25 kA three-phase short circuit fault current. Maximum 11 kV fault level on the network has been calculated at approximately 12.5 kA. Evoenergy's 11 kV network is non-effectively earthed via the neutral earthing transformers at zone substations. This keeps the fault level less than 3 kA and increases the longevity of 11 kV equipment.

Evoenergy specifies new 132 kV equipment to be capable of withstanding 31.5 kA three-phase short circuit fault current. Maximum 132 kV fault level on the network has been calculated at approximately 24.0 kA.

The high voltage system supplied by the 132 kV subtransmission network is not effectively earthed employing a neutral earthing transformer to limit 11 kV earth fault current to 3 kA. The wide use of earthing transformers to limit feeder earth (zero sequence) fault levels at zone substations is a unique characteristic of Evoenergy's network. Note that 3 kA is not used for earthing design as there is always some circuit impedance and/or fault impedance.

Electricity network earthing and protection systems are designed, installed, operated, and maintained with care to avoid injury to persons or damage to property or the environment.

Automatic Under-Frequency Load Shedding

Power system frequency control is achieved by the instantaneous balancing of electricity supply and demand. If electricity supply exceeds demand at an instant in time, power system frequency will increase. Conversely, if electricity demand exceeds supply at an instant in time, power system frequency will decrease. The amount and rate of change of frequency compared with the mismatch in supply-demand depends on the physical characteristics of electrical equipment and control systems.

To operate a power system, the system frequency must be maintained within a close margin around the nominal level of 50 Hz, and additionally, the Rate of Change of Frequency (RoCoF) must remain within specified limits. Failure to do so risks disconnection of consumers or even potential equipment damage.

The National Electricity Rules S5.1.10 requires network operators to have a proportion of their load available for shedding by under-frequency relays. This is required to arrest the collapse of the national grid in the event of a major contingency that results in a sudden large deficiency of generation, such as could occur due to tripping of several generating units or tripping of transmission interconnectors. NSPs in consultation with AEMO must ensure that enough load (minimum 60% of expected demand) is under the control of automatic under-frequency load shedding (UFLS) relays that operate in the event of a major contingency to ensure the network system frequency remains within the prescribed limits. NSPs must therefore provide, install, operate, and maintain facilities for automatic load shedding and conduct periodic testing of the facilities without requiring load to be disconnected.

Evoenergy applies under-frequency protection at the 11 kV level within its zone substations.

Earthing And Earth Potential Rise

The role of the network earthing is to ensure that the voltage does not raise above the acceptable limits under defined network fault conditions. The earthing also provides a path to earth for fault currents directly impacting the fault current levels and an operation of the electrical protection system.

Earth potential rise refers to the localised increase in the voltage of an object that should remain at earth potential and is typically caused by a fault current passing through an earth connection that is inadequate for the magnitude of the fault current. This can be due to:

1. Inadequate sizing of the earth conductor relative to the maximum fault current.
2. High impedance between the earth conductor and the mass of earth (true earth).

Under such conditions the passage of the fault current through the inadequate earth connection will result in a voltage increase on the earth connection for the duration of the fault. This condition can present risk of electric shock to a person who may be standing on "true earth" but is in contact with the inadequately earthed device. It can also result in damage to sensitive equipment.

Evoenergy complies with earth potential rise requirements by basing its network designs on reference publications[38]. Evoenergy's system is designed to ensure that step and touch voltages arising from earth potential rise are within the allowable limits of Australian Standard *AS/NZS 7000*. Evoenergy has developed a set of guides and standards relating to earthing design, construction, testing, and repair.

Transmission Service Network Provider (TNSP) Metering

Evoenergy has installed TNSP metering at all its zone substations. TNSP metering is a necessary part of the electricity market settlement process as defined in the National Electricity Rules (NER) chapter 7 and administered by the Australian Energy Market Operator (AEMO).

The TNSP metering interfaces with secondary systems equipment at Evoenergy's zone substations. These interfaces are at defined connection points between the 132 kV subtransmission network and the 11 kV distribution network. The TNSP metering has been installed in new dedicated metering panels and complies with AEMO requirements and Australian Standard *AS/NZS 1284.13:2002* (Electricity metering in-service compliance testing).

Consumer metering - competition in metering

Evoenergy manages a fleet of approximately 136,000 revenue meters installed at consumer premises. The main purpose of conventional meters is to measure a consumption of electricity. The meters are being managed in accordance with Evoenergy's metering asset management plan. The Power of Choice legalisation came into effect 1 December 2017 shifting the responsibility for new meter installations from Evoenergy to Electrical Retailers, who in turn engage Metering Co-ordinators to complete the work. The rules also require all new and replacement meters to be Type 1-4 meters (advanced meters). The functionality of advanced meters goes well beyond the measuring of energy consumption. The latest generation of meters include functionality which can provide additional information to consumers on their energy consumption, assist with network operation and provide additional data in relation to power quality.

Evoenergy is continuing to explore opportunities to work with retailers and metering providers to utilise advanced meters functionality in relation to cost reflective tariffs, outage management, network planning, power quality monitoring and demand management.

Key network technical parameters

Electromagnetic Fields (EMF)

Electromagnetic fields are a key design consideration for bare electrical conductors such as overhead lines and bus-work, particularly those which operate at high voltage. For conductors with an earth shield, such as underground cables, the fields are encapsulated within the cable and do not present external hazards.

Electromagnetic fields incorporate both electric fields resulting from the voltage on conductors and the magnetic fields generated by the current flowing in the conductors. Both phenomena result in a "grading" of the respective fields from the conductor to the nearest earth location. In terms of voltage there will be a voltage "gradient" between the

38 ENA EG-O Power System Earthing Guide | ENA EG-1 Substation Earthing Guide | AS 3835 – EPR – Protection of Telecommunication Network | AS/NZS 4853 – Electrical Hazards on Metallic Pipelines

conductor and earth. In terms of current there will be a grading of the magnetic field (flux density) from the conductor to the earth.

Depending on the strength of these fields minute currents can be induced in the bodies of animals and humans. Research is inconclusive at present but there are concerns as to the health implications of exposure to electromagnetic fields. As such there are strict guidelines for the management of electromagnetic fields incorporated into the design of overhead lines and high current equipment.

The Energy Networks Australia (ENA) Association has published an EMF Management Handbook (January 2016)[39] which describes EMFs in detail and methods to mitigate magnetic fields. Evoenergy follows these guidelines where practicable and complies with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Guidelines in the design of its network with respect to electromagnetic fields.

Inductive Interference

Inductive interference refers to the ability of the magnetic fields generated by current flowing in typically overhead line conductors, to cause interference with other electromagnetic radiation such as radio, television, and communication signals.

Evoenergy shall continue to undertake routine maintenance programs to ensure all equipment is in good working condition, in particular all HV and LV overhead lines, to ensure that inductive interference is within the limits specified in Australian Standard AS 2344:2016 Tables 1 and 2 (limits of radiated radio disturbance from overhead AC power lines and high voltage equipment).

Direct Current (DC) Component

A high DC component of the neutral voltage can cause damage to electronic devices and impact on the correct operation of protective devices. It can also lead to an increase in losses and result in heating within electrical and electronic equipment.

Evoenergy ensures that consumer's inverters connected to the network adhere to the relevant standards and regulatory requirements.

Evoenergy publishes on its website the "Requirements for Connection of Embedded Generators up to 5 MW to the Evoenergy Distribution Network "document. This includes the requirement that inverters must comply with the requirements of the Clean Energy Council (CEC) and *Australian Standard AS/NZS 4777* (Grid connection of energy systems via inverters).

Power Factor

Power factor relates to the relationship between real and reactive power. In an alternating current (AC) system the in-phase portions of voltage and current waveforms produce "active" or real power which is the capacity of the electricity system to perform work. The out of phase portions of voltage and current waveforms produce "reactive" power. The combination of active and reactive power is termed apparent power. A low or poor power factor will result in inefficiency due to high apparent power loading with a low real power delivery.

Evoenergy monitors power factor as part of its programmed proactive and reactive monitoring of the network. Evoenergy uses the ADMS to identify areas of the network that may be experiencing power factor issues. Metering data is also used to identify installations with power factor outside acceptable limits.

Consumers can gain significant benefits by improving the power factor at their premises. These benefits include reduced electricity costs, increased plant load capacity and utilisation, and better voltage regulation. Improvement of power factor is usually achieved by the installation of capacitors.

Evoenergy requires that the power factor at the point of common coupling between Evoenergy's network and the consumer's installation to be between 0.9 lagging and unity, with no allowance for leading power factor. Details can be found in Evoenergy's Service & Installation Rules for Connection to the Electricity Distribution Network which can be found on our external website.

System Losses

As electrical energy flows through the subtransmission and distribution networks, a portion is lost due to the electrical resistance and heating of network elements such as

39 http://www.ena.asn.au/sites/default/files/emf_handbook_2016

conductors, switchgear, and transformers. Across the Evoenergy network these losses may be up to 3%–5% of the total energy transported. Energy losses on the network must be factored in at all stages of electricity production and transportation. This is to ensure adequate supply is available to meet prevailing demand and maintain the power system in balance after energy losses. In practical terms, more electricity must be generated to allow for this loss during production and transportation.

Management of losses assists with achieving better business and environmental outcomes. Evoenergy periodically reviews open points on the network to enable the network to be reconfigured to reduce losses. This includes load balancing between zone substation transformers.

Electrical losses in the network are proportional to the square of the current (I^2). Power factor is an important part of distribution network, and is expressed as either a decimal value, for example 0.9, or as a percentage: 90%. Having a higher power factor results in a lower current, for the same amount of useful energy, and therefore reduces network losses. Evoenergy's service and installation rules require that the power factor is not lower than 0.9. However, there a few challenges with monitoring and enforcement of this requirement. Maximum demand and capacity tariffs, may be effective in reducing peak load on the network, will also result in reduced currents and therefore reduced network losses.

System losses are considered in the assessment of transformer tenders, through the asset life-cycle cost assessment. The methodology takes into account the estimated losses over the life of the transformer ensuring better energy efficiency and environmental outcomes.

Evoenergy considers network losses in the major investment decisions. Whenever appropriate, distribution losses are included in system planning. If a significant network augmentation option being considered offers a benefit of substantially reduced losses – that benefit is considered in cost benefit analysis of this option vs other alternatives. However, value of losses is usually not sufficient to justify investments. Depending on the specific solutions, the level of losses may however influence a selection of preferred option.

Evoenergy standardises cables and conductors approved for the application in the network. The standard cables allow Evoenergy to gain efficiency in procurement, design, construction, and maintenance. While different sized cables result in different electrical losses, cables are usually sized according to capacity requirements. In most cases the differences in value of electrical losses are not sufficient to justify a particular cable selection.

Distribution Loss Factors

Distribution Loss Factors (DLFs) represent the average energy loss between the distribution network connection point and the transmission network connection point to which it is assigned. Loss factors are calculated and fixed annually to facilitate efficient scheduling and settlement processes in the NEM.

Under the NER *Clause 3.6.3*, Evoenergy is required to calculate and publish annually the distribution loss factors on its network. Publishing of the loss factors improves transparency of the network loss performance to retailers and consumers. Evoenergy calculates distribution loss factors for both site-specific consumers (embedded generators with output greater than 10 MW and load consumers with maximum demand greater than 10 MW or 40 GWh consumption) and average DLFs for non-site-specific consumers. High voltage distribution feeders and subtransmission lines are analysed using data from Evoenergy's Advanced Distribution Management System (ADMS).

The DLF (Distribution Loss Factor) calculation methodology can be found on Evoenergy's website[40], and Evoenergy's published DLFs can be found on AEMO's website[41].

40 https://www.evoenergy.com.au/-/media/evoenergy/about-us/evoenergy-loss-factor-methodology.pdf
41 https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/loss_factors_and_regional_boundaries/2023-24/distribution-loss-factors-for-the-2023-24-financial-year.pdf?la=en

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