# Annual Planning Report 2019

**Version 1.0 | Effective Date: 21/12/19**

evoenergy

# Document management

## Version control

| Date | Version | Description | Author |
|---|---|---|---|
| 21/09/19 | 0.1 | Initial Draft | J.Worony |
| 04/12/19 | 1.0 | Final Draft | J.Worony |
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## Approval

| Date | Name | Position | Signature |
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This report is prepared by Evoenergy in its capacity as the Transmission Network Service Provider and 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 2020. 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.

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## Introducing Evoenergy

Evoenergy is licensed by the Independent Competition and Regulatory Commission (ICRC) to provide transmission, distribution and connection services in the ACT. Evoenergy is both a Distribution Network Service Provider and a Transmission 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, 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 in accordance with section 5.13.2 and schedule 5.8.

Our “poles and wires” network is supplied predominantly by power imported from interstate. There is an increasing amount of generation embedded within Evoenergy’s network. Evoenergy’s main focus is on the provision of safe, reliable and quality electricity supply in a prudent and efficient manner. We are an asset manager 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 capacity limitations, asset renewal, power quality and reliability in relation to transmission 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 ten year planning requirements for the transmission network and five year planning requirements for the distribution network.

This APR has been prepared to comply with the NER clause 5.12.2 Transmission Annual Planning Report (TAPR) and clause 5.13.2 and Schedule 5.8 Distribution Annual Planning Report (DAPR).

# Executive summary

**Transforming our business for the future**

The energy industry is changing at an increasingly rapid pace. The penetration of distributed energy resources, new technologies, customer expectations, economic regulation and Government policy means Evoenergy is in the midst of transforming its business to meet this need. We are taking significant steps to be a collaborative, innovative and flexible participant within the future electricity industry.

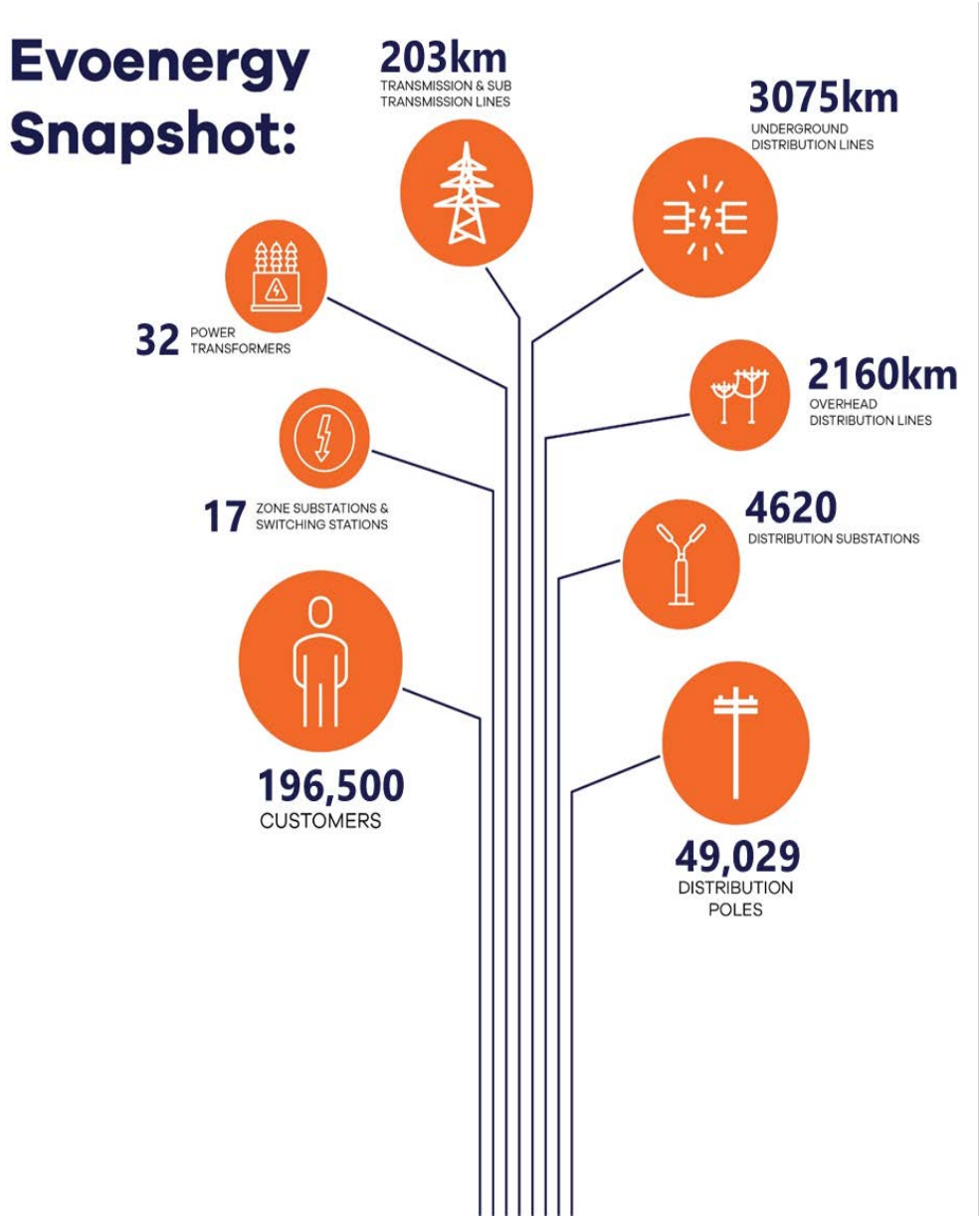
Evoenergy's strategy focuses on five key areas:

- Delivering outcomes for customers consistent with their expectations
- Working existing assets smarter and harder
- Innovative future energy solutions
- Sound financial performance
- Transformation towards the contemporary Distribution System Operator (DSO) role

Evoenergy is in the process of transforming from its traditional network service provider role to a DSO role as we balance the need for network support services and the speed at which energy consumers who are also now energy producers grow in the ACT.

Energy policy is also an important factor which will determine our future business environment. The ACT Government's 2020-25 sustainable energy policy is an important consideration for our operating environment. We support the ACT Government's legislated target of zero net emissions by 2045, and we are taking steps to innovate and modernise our energy networks to meet this target.

This includes working with stakeholders to meet the ACT Government's targets to maintain 100% renewable electricity from 2020 and to achieve net zero emissions by 2045. We are committed to exploring policies and initiatives to optimise investment in the electricity network and to achieve the optimum outcomes for ACT consumers. Evoenergy is keen to explore "in front of the meter" and "behind the meter" solutions, and network support options.




**Key planning focus areas**

Our network planning is aligned with Evoenergy's strategy and Energy Networks Association's (ENA) Electricity Network Transformation Roadmap.

## 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 the community, environment and our workforce.

We are focused on integrating safety outcomes into asset management and are developing Formal Safety Assessments that quantify mitigated risks against the five primary objectives of technical regulation: public safety, worker safety, loss of supply, environment and property. This will include key programs such as vegetation and bushfire management but also underpins Evoenergy's risk mitigation and investment in compliance with technical and economic regulatory requirements.

## Risk management

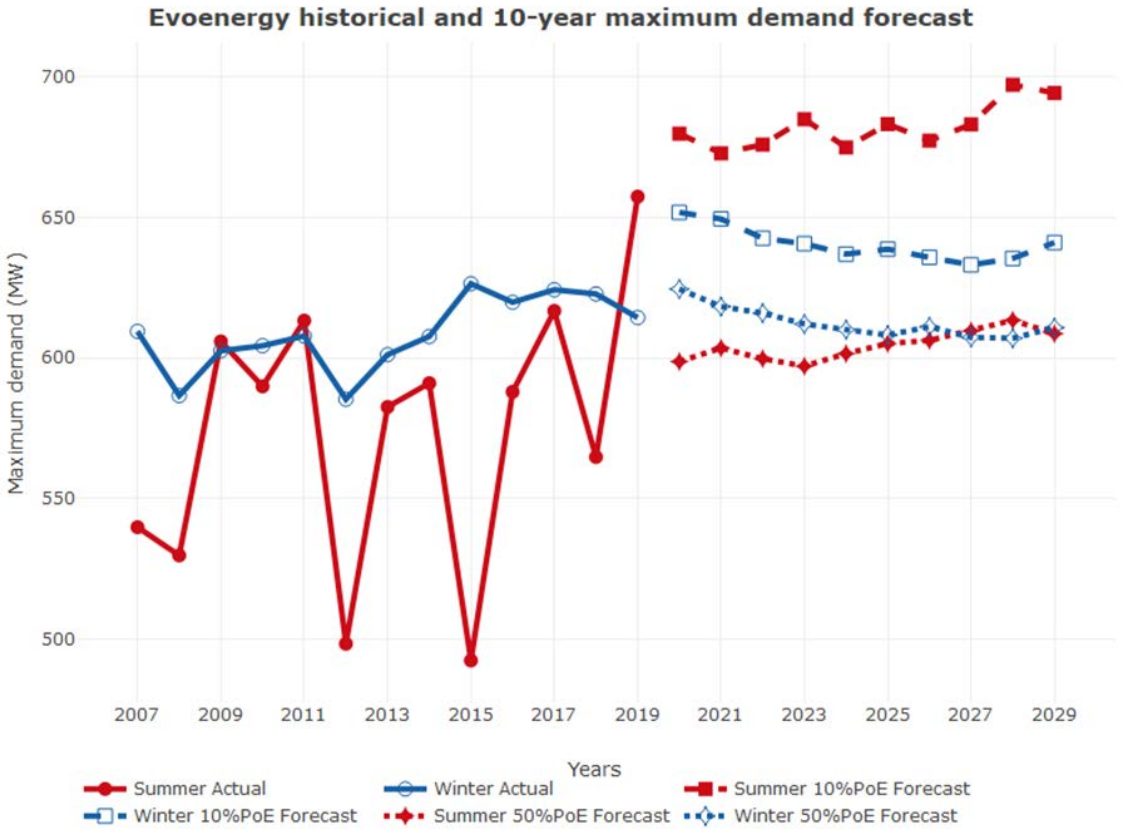
Risk management is an integral part of network planning and asset management investment decisions. Whenever practicable, we assess the value of risk (such as “safety”, “energy at risk” or “unserved energy”) and compare it with the life cycle cost of solution.

## System level demand

In 2019, forecast peak demand for network-delivered energy remains relatively flat, with around 2.5% increase in peak summer demand and a 2% decrease in peak winter demand forecast over the next ten years. 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 in 2019 of 657 MWs. This highlights the impact of changing weather conditions and the impact on cooling loads during the summer period. In contrast to the summer demand, the peak winter demand has been more stable but decreasing, reflecting the impact on heating loads during the winter period. The 2019 system peak winter demand was 614 MWs which is around 2% lower than the historic peak.

These trends are illustrated in the following historical and 10-year maximum demand forecast as of September 2019.

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

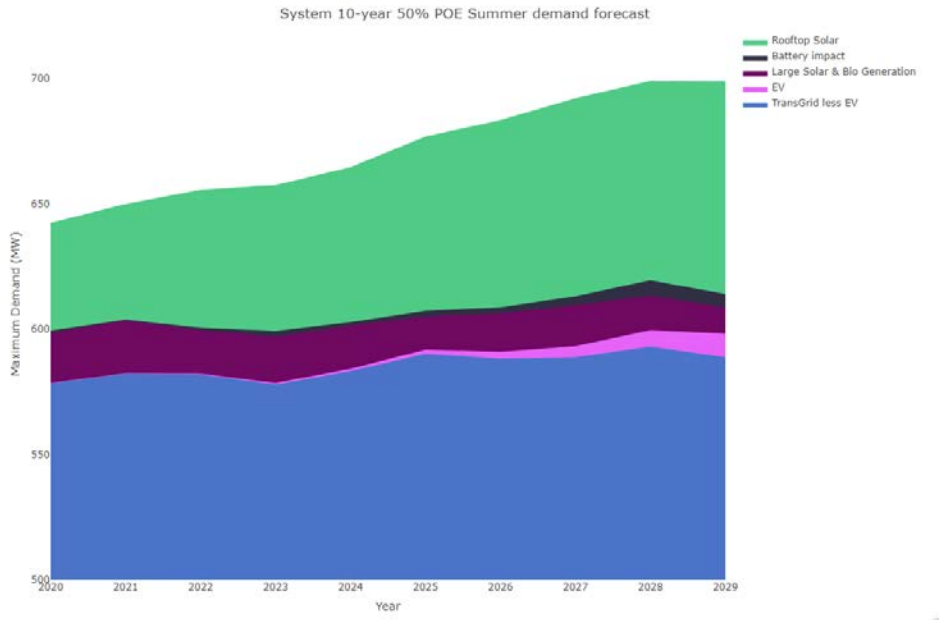



The importance of forecast peak demand is the impact of potential unserved energy (energy at risk) which determines when network capacity should be augmented to underpin the security and reliability of supply. Chapter 5 provides more information on demand forecast methodology and outcomes for the system and distribution substations.

## The shift in energy sources

We forecast that a decreasing proportion of supply (generation) from the interstate grid will be required to meet demand. The following graph based on AEMO data illustrates this trend over the next ten years. In winter, the level of imports from the TransGrid NSW network to satisfy maximum demand is projected to be flat due to increasing contributions from embedded generation sources. In summer, the forecast distributed generation contribution towards consumer peak demand is around 20%. Within a decade, at times of minimum network demand (not included in the graph), consumers are expected to draw 80% or more of their energy from renewable energy generation sources embedded in the ACT network. Under some scenarios, the ACT could even be exporting energy to the NSW grid. The trend confirms the long term structural changes in network consumption and the changing role of the licensed utilities such as Evoenergy.

**Figure 2.** Summer maximum demand components




## Localised constraints and existing assets conditions concerns

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 the areas which are experiencing or are forecast to experience high residential and commercial growth. Consequently, Evoenergy has identified a number of limitations within the distribution and transmission networks.

**Table 1.** Existing and emerging limitations of the transmission network and distribution network

| Location | Network Element | Constraint | RIT | MVA required | Consult | Decision | Required | Estimated cost |
|---|---|---|---|---|---|---|---|---|
| **Canberra CBD Central** | Feeder | Capacity | No | 2020 0.3 MVA<br>2024 8.5 MVA | Dec-19 | Mar-20 | Dec-20 | $1.3m |
| **Gungahlin Town Centre** | Feeder | Capacity | No | 2020 5.6 MVA<br>2024 20 MVA | Dec-19 | Mar-20 | Dec-20 | $3.8m |
| **Dickson - Dooring St** | Feeder | Capacity | No | 2020 0.7 MVA<br>2024 2.9 MVA | Dec-19 | Jun-20 | Dec-21 | $3.5m |
| **Molonglo Valley** | Zone Substation | Capacity | Yes | 2021 1.5 MVA<br>2024 13 MVA | Mar-20 | Jun-20 | Dec-21 | $32.1m |
| **Strathnairn** | Feeder | Capacity | No | 2022 1.0 MVA<br>2024 3.1 MVA | Jun-20 | Dec-20 | Jun-22 | $2.2m |
| **Belconnen Town Centre** | Feeder | Capacity | No | 2022 2.4 MVA<br>2024 7.1 MVA | Dec-20 | Jun-21 | Dec-22 | $1.8m |
| **Canberra CBD East** | Feeder | Capacity | No | 2022 0.9 MVA<br>2024 6.2 MVA | Dec-21 | Jun-22 | Dec-23 | $2.3m |
| **Fyshwick** | Zone Substation, Transmission and Feeders | Asset Condition | No | 2024 32 MVA Note 2 | Jun-21 | Dec-21 | Jun-24 | $5.6m |
| **North Canberra** | Transmission | Voltage | No | N/A | Jun-21 | Dec-21 | Jun-24 | Tbc |
| **Mitchell / Gold Creek** | Zone Substation | Capacity | Yes | Anticipated limitation in 2024-29 period subject to further investigations | | | | |
| **Strathnairn** | Zone Substation | Capacity | Yes | Anticipated limitation in 2024-29 period subject to further investigations | | | | |

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

Note 2: The exact capacity constrain level is to be confirmed after network studies and an assessment of the load transfer capacity to East Lake Zone Substation.

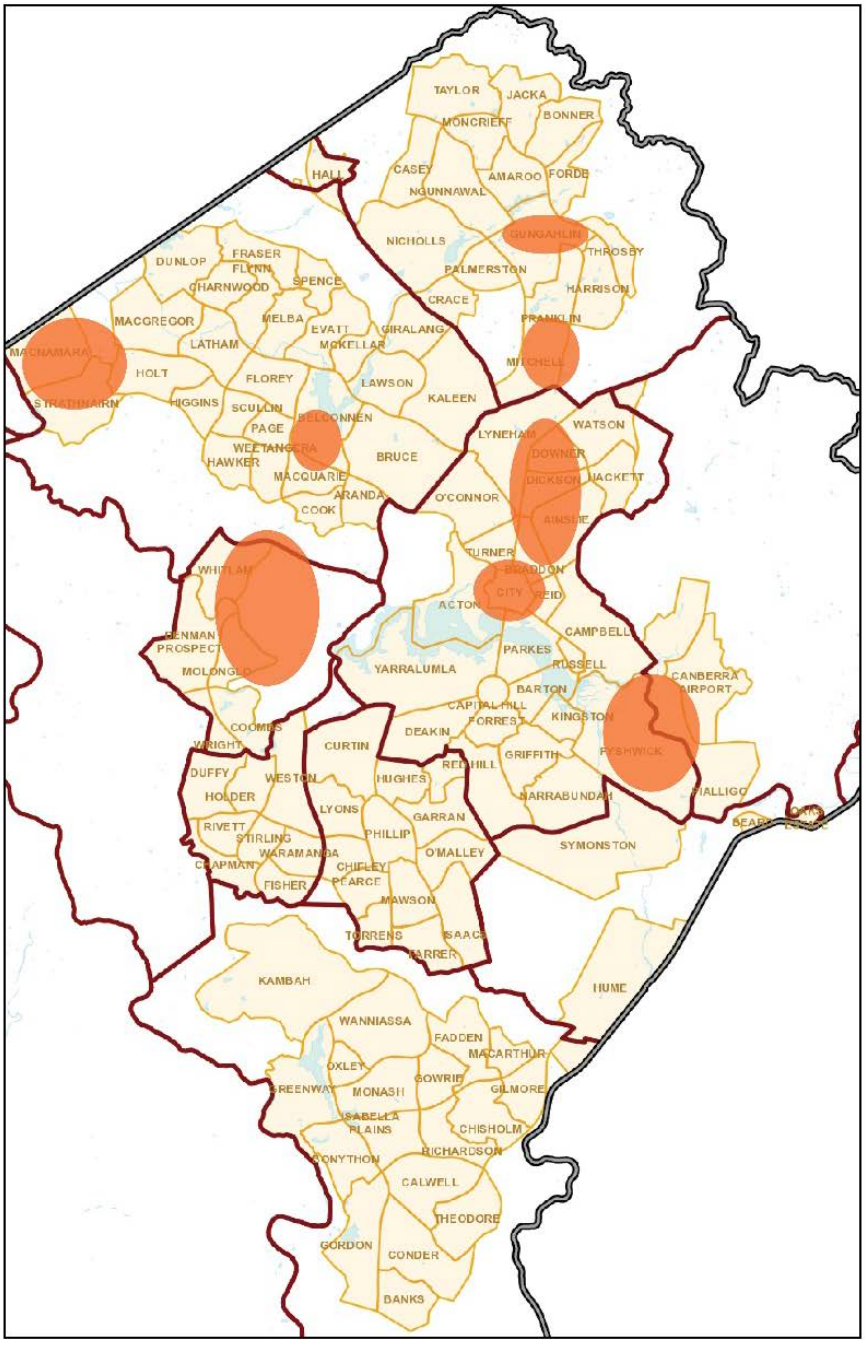
In addition to these localised capacity constraints, the make-up of electricity demand is changing in the ACT; specifically around customers driving localised growth in electricity demand, where electricity is sourced, and the impact that is having on network utilisation and performance.

Electricity connections grew by 3,780 in 2019, with load growth driven by:

- Urban infill development – supported by the ACT Government land release 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 by the data centres
- Greenfield residential developments primarily in Gungahlin, Molonglo Valley, Ginninderry - with an increasing proportion of medium density developments

Figure 3 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.

**Figure 3.** Overview - network limitations heat map




Evoenergy continues to focus on the management of existing assets taking into account asset performance and risks relating to asset conditions, age and criticality. Our annual planning review process identified a need for two major asset retirements over the current regulatory period (2019 – 2024). Table 2 summarises the major asset renewal requirements 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[1] | Consult | Decision | Date Required | Estimated cost |
|---|---|---|---|---|---|---|---|
| **Latham Zone Substation** | Substation Switchboard | Asset condition & performance | No | Dec 2022 | June 2023 | Jun 2024 | $3.1m |
| **Wanniassa** | Distribution Line Underground Cable | Asset condition & performance | No | Dec 2022 | June 2023 | Jun 2024 | $4.3m |

## Maintaining reliability

Evoenergy's reliability performance continues to be one of the best in Australia. We are subject to the Australian Energy Regulator's (AER) reliability performance targets for unplanned outages and jurisdictional ACT reliability targets for planned and unplanned outages. Our aim is to maintain reliability performance in line with our regulatory targets and incentive schemes. Our reliability strategy is published on the Evoenergy website. The focus of our reliability strategy is to target underperforming areas including worst-served customers and worst-performing distribution lines.

## Power quality - voltage regulation

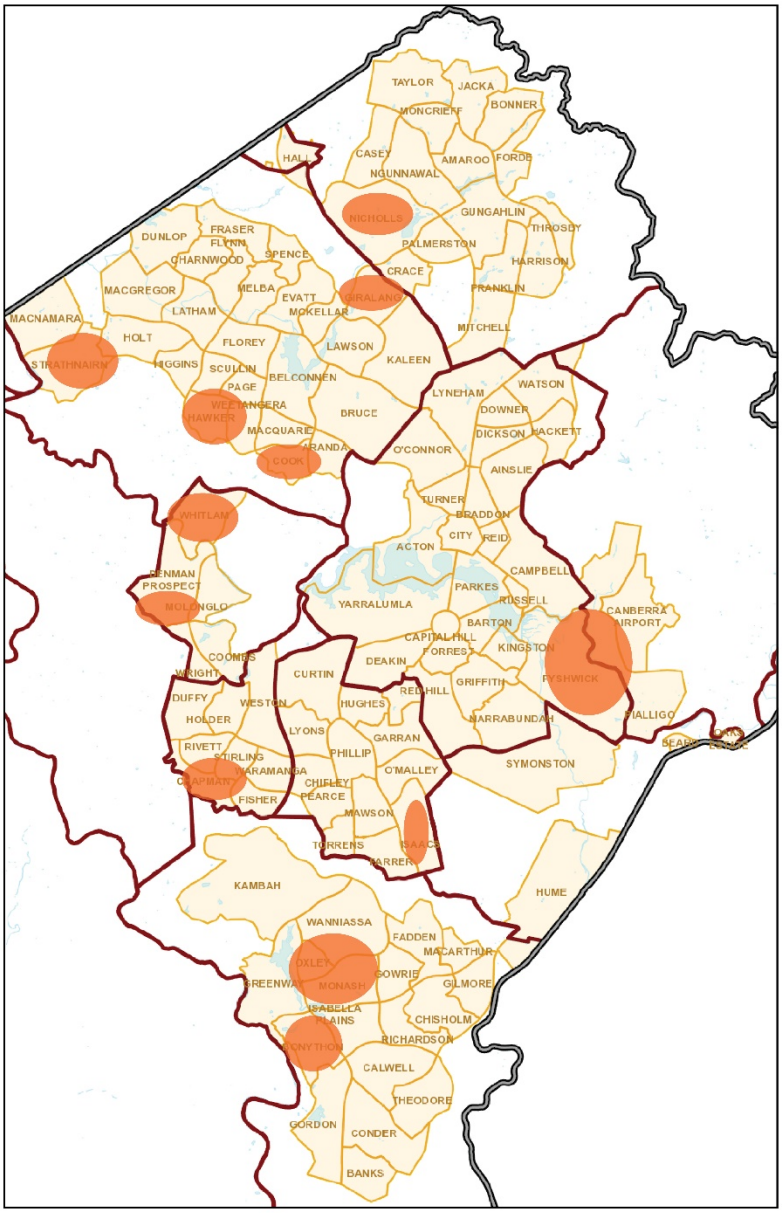
One of the most important planning considerations affecting forecast demand is the gradual shift from electricity generated and transmitted outside the ACT to embedded generation within the ACT, and unprecedented growth in "in front of the meter" and "behind the meter" generation. 43 MWs of large scale solar generation is currently embedded in the ACT network, with another further 30 MWs of new solar generation under consideration. There is continued strong growth in rooftop photovoltaic generation with approximately 20% of all single residential dwellings in the ACT now with photovoltaic installations. In 2018, rooftop photovoltaic generation increased by over 20MW which was the highest annual increase on record, with generation reaching almost 110 MWs.

This presents a key challenge for Evoenergy as this increase in embedded generation creates two way energy flows and over-voltages in the network. The voltage regulation issue usually occurs in the locations where the penetration of photovoltaics is high, causing power quality issues, which can be detrimental to electrical appliances.

Figure 4 provides and overview of locations within ACT where the penetration of photovoltaics for single residential dwellings exceeds 25%.

[1] Under NER projects above $6 million require regulatory investment test.

**Figure 4.** Overview - rooftop photovoltaic generation heat map >25%




### Working with stakeholders on solutions

Our key focus is to improve our planning and development of solutions in collaboration with our stakeholders to achieve better medium term and long term outcomes at lower cost. This is particularly important as Evoenergy focuses on demand side and non-network solutions. Evoenergy considers that this engagement is essential to achieving long term outcomes which are in the best interest of consumers and our business.

With the ACT Government's 100% renewable electricity and net zero emission targets, this presents a key opportunity for Evoenergy and its stakeholders to trial new service delivery models. We endeavour to work on solutions that utilise distributed energy and promote the network's role in optimising performance around emerging distributed energy markets to meet long term demand.

A key issue is providing enough time and also more than one channel for stakeholders to understand and respond with non-network solutions, without placing minimum service levels at risk. Where appropriate, it also allows Evoenergy to be more adaptive, innovative and flexible, and allows us to trial new network solutions. We are keen to partner with the community on transforming the network's role as contestable markets evolve around distributed energy resources.

These non-network options include:

- Residential greenfield growth – work with interested parties on a deployment of energy packages, innovative pilots and business models with distributed and centralised storage options for optimal customer and Evoenergy benefits
- Residential infill growth – Evoenergy seeks feedback on how it can support innovation in distributed energy for apartments, high rise and existing homes
- Exploring innovative solutions in commercial areas of Fyshwick, Hume, Mitchell including network support options (e.g. network batteries)

Evoenergy is introducing a more transparent and structured engagement model in relation to the non-network, demand management and network options as described in Chapter 1.

## Overview - Network planning and asset management pressure points

Table 3 provides an overview of the factors impacting our asset management and the network elements and performance affected.

**Table 3.** Overview - Network Planning and Asset Management pressure points

| Factors | Capacity/ Security | | | | | Reliability | | | | | Power quality | | | | | Safety and environment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Transmission lines | Zone susbtataions | HV distribution network | Distribution susbstaions | LV Distribution Lines | Transmission lines | Zone susbtataions | HV distribution network | Distribution susbstaions | LV Distribution Lines | Transmission lines | Zone susbtataions | HV distribution network | Distribution susbstaions | LV Distribution Lines | Transmission lines | Zone susbtataions | HV distribution network | Distribution susbstaions | LV Distribution Lines |
| **System demand trend and generic load growth** | | | | | | | | | | | | | | | | | | | | |
| **Localised load growth - residential/ commercial developments** | | | | | | | | | | | | | | | | | | | | |
| **Embedded generation (micro and small)** | | | | | | | | | | | | | | | | | | | | |
| **Embedded generation (large scale)** | | | | | | | | | | | | | | | | | | | | |
| **Asset condition/age** | | | | | | | | | | | | | | | | | | | | |
| **Compliance including technical standards and vegetation management** | | | | | | | | | | | | | | | | | | | | |

The above table summarises Evoenergy's current position against the key factors driving its performance and investment over the planning horizon. The colours in this table highlight the following:

- Orange colour indicates the first tier key priority areas for asset management, network planning, demand management and anticipated investment.
- Yellow colour indicates the second tier components which will require increased attention from network planners and asset managers.
- Grey colour indicates components for which Evoenergy anticipates a business-as-usual treatment.

# 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 the current Evoenergy's 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: | Discuses 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 is operating in a rapidly evolving energy environment. We experience changes in technology, consumption patterns, customer preferences, energy policies and regulatory settings. This transformation is presenting both challenges and opportunities to Evoenergy, consumers and other stakeholders.

Close engagement with our stakeholders[2] is an integral part of our approach and being innovative, flexible and adaptable business. We consult with stakeholders in relation to a range of matters relating to our business. For example Evoenergy consults on preparation of regulatory submissions to the Australian Energy Regulator, resolving network constraints, tariff policy options and project development. Parties and groups impacted by projects are consulted in relation to environmental, social, economic, and governance concerns. Stakeholders contributing to regulatory submissions are consulted on policy options.

Evoenergy firmly believes in a regular, structured communication and updates to stakeholders including providing feedback on stakeholder input or concerns. The consultation on general matters is often conducted according to the Stakeholder Engagement Strategy. For specific consultation matters additional plans or programs may be developed.

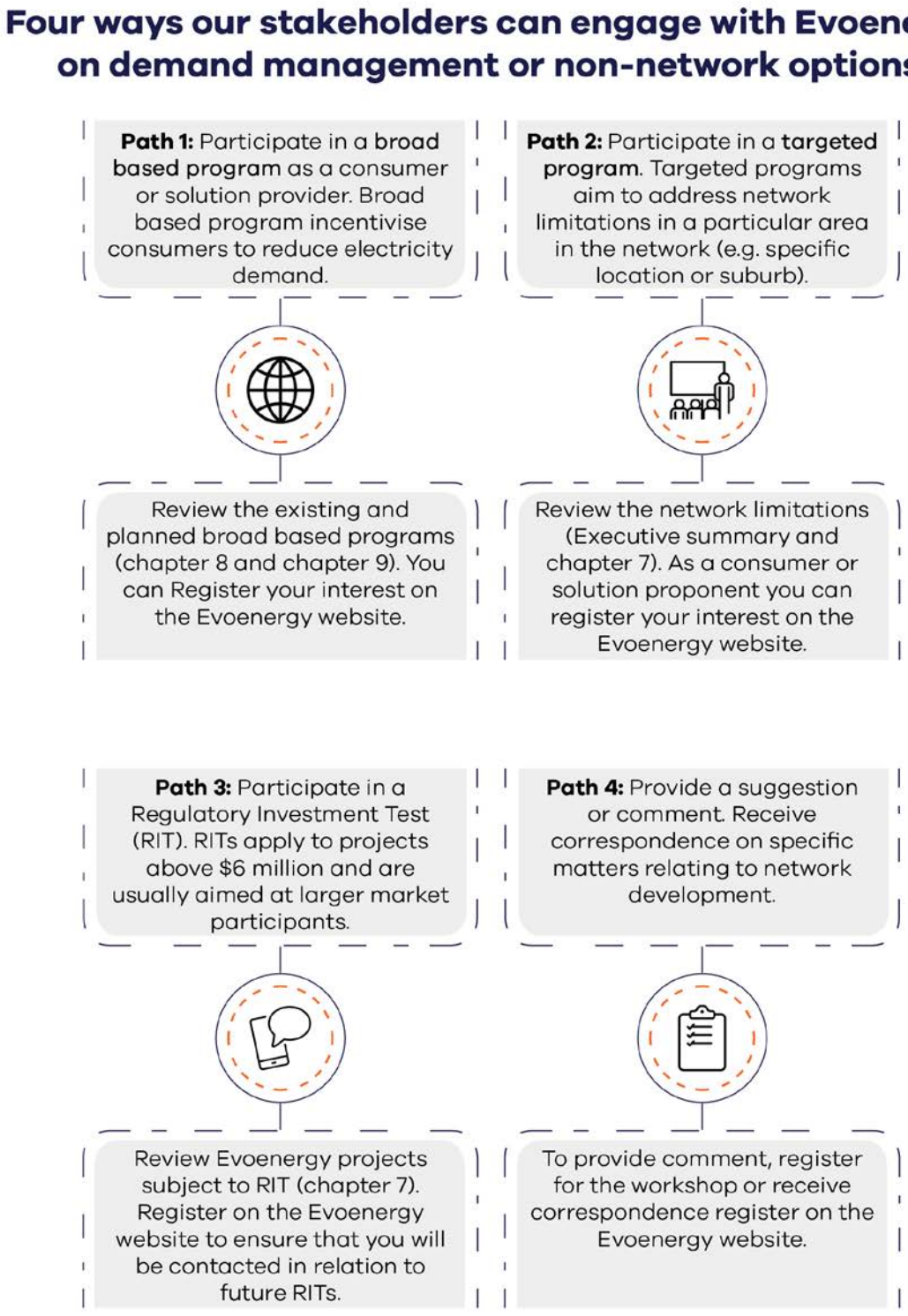
The 2019 Stakeholder Engagement Strategy is available on our website at the same time this Annual Planning Report is published. Key concepts in this strategy include:

- Continuing to grow our customer focus;
- Making engagement business as usual; and
- Aligning our work with the interests of our stakeholders.

This chapter focuses on the engagement with consumers and interested parties when Evoenergy investigates network limitations and optimum network solutions. Evoenergy is keen to work more closely with all interested parties to arrive at optimum solutions including demand management and non-network alternatives.

[2] One forum for engagement is the Energy Consumer Reference Council (ECRC) which includes broad representation of our customers and ACT community. ECRC is being consulted on a range of matters including regulatory submissions, network development and network tariffs.

**Figure 5.** Four paths of engagement




## 1.1 Engagement in broad-based demand management programs

As part of our Peak Demand Reduction Strategy, we are developing several demand management programs designed to address broader groups of consumers and stakeholders. A number of current demand management initiatives are in the early stages of development and maturity and further information is available on the Evoenergy website. Evoenergy will progress these initiatives further over short to medium term. Several programs are expected to commence

in the 2019-24 period. 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 consumers and other stakeholders who can assist in peak demand reduction. For example interrupting air-conditioning load or refrigeration for short periods of time can take place without a major inconvenience to consumers. Another example of broad based programs are cost reflective or innovative tariffs which incentivise consumers to reduce demand. The programs may include proof of concept pilots and trials before the programs can be implemented.

Customer benefits

There are a number of possible benefits available to participants. The specific benefits may depend on the design of the particular program. Consumers can benefit from a reduction in electricity bill through when using “time of use” or “demand tariffs”. There are various types of monetary incentives which can be considered and tested including cash buy-backs, one off incentives, availability payments or payments on event ( e.g. when a network outage event occurs).

How to participate

If you would like to participate in a broad based program including a pilot or a trial you can register via the website either as 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.

You are not obligated to participate if you register, but your contribution is valuable to Evoenergy. In the future, we may ask you if you are interested in participating in one of the programs or pilot projects. We may publish a Request for Proposal (RFP) to submit proposed solutions and invite you to respond. As part of the engagement we will explain the network issue, possible solutions and incentives which would be available to you. If you are a business operating in the demand management space we may invite you to discuss your demand side management proposal or provide additional information.

## 1.2 Engagement in targeted demand management initiatives

As part of the network planning process, Evoenergy identifies existing and emerging electricity network limitations. Table 1 identifies limitations in relation to the distribution and transmission networks. The table identifies locations of constraint, the level of constrain 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 demand management solutions

Targeted programs focus on a reduction of demand in specific areas or pockets of the network where limitations were identified. Vast proportion of limitations identified by Evoenergy in the 2019 planning review relate to the distribution line (feeder) capacity constraints.

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.

Customer benefits

There are a number of possible non-network solutions ranging from demand reduction to contracted embedded generation. Full range of available options and corresponding incentives is discussed in the Evoenergy Peak Demand Reduction Strategy. The incentives can range from reductions in electricity bills to substantial contributions towards capital costs of solutions.

If a customer 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 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[3]. You can also provide a suggestion or request information or updates on any program.

Evoenergy investigates intended 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 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 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 RFP no later than 21 months before the limitation must be addressed and allow 3 to 6 months for selection of preferred solutions. For transmission system limitations we will generally endeavour to publish RFP no later than 36 months before the network limitation must be addressed. Figure 1 provides a process overview including Evoenergy stakeholder engagement through demand management strategy.

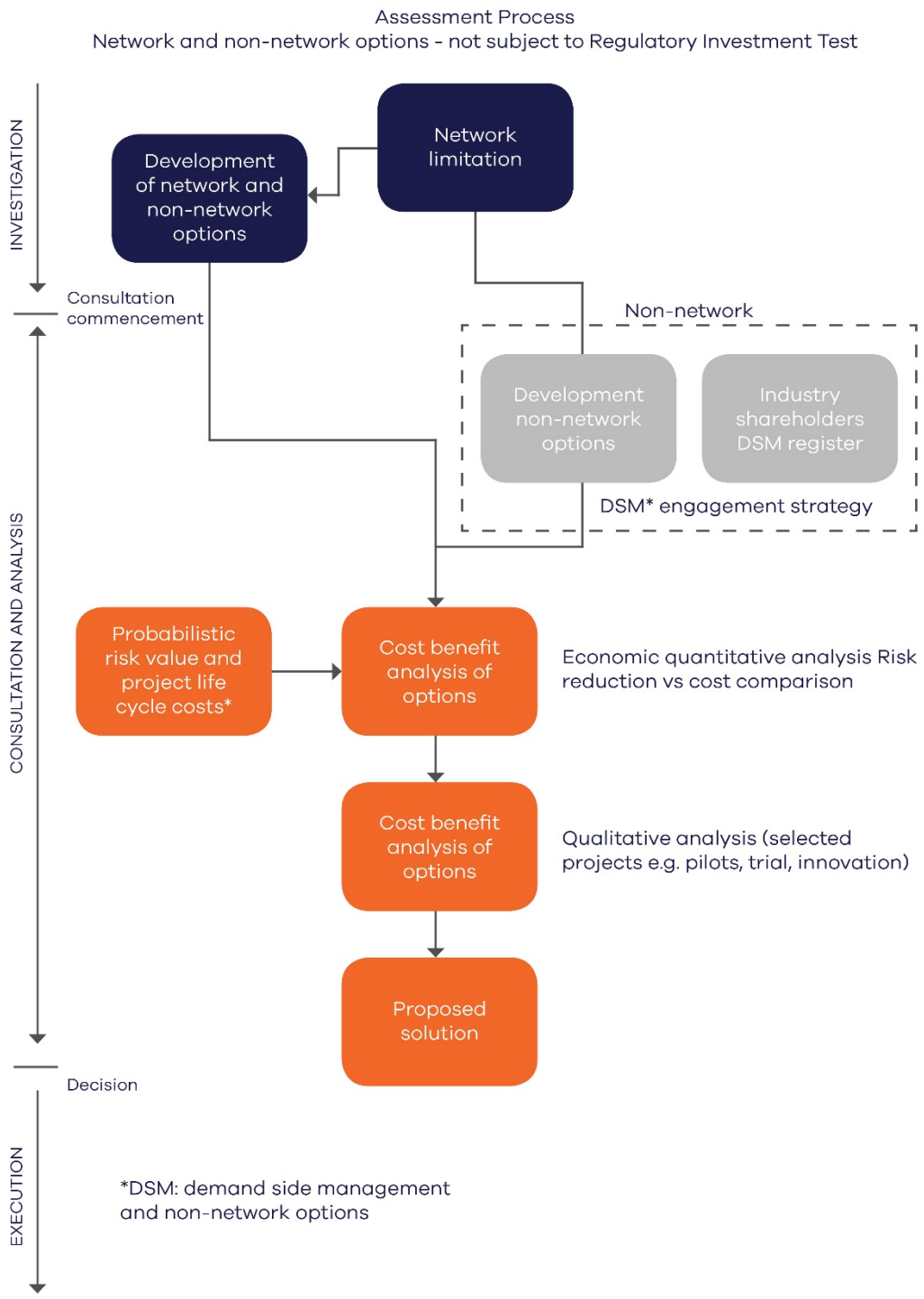
Our RFP will explain the network limitation, the timeline for resolution and possible solutions. The RFP will indicate what investment, capital contribution or incentive we are prepared to provide to external praties to resolve the issue.

Distribution and transition above $6 million are subject to mandatory Regulatory Investments Test[4] (RIT) process. As described in the next section for RIT projects we will follow AER's guidelines for regulatory investment tests for distribution or transmission.

[3] Strict privacy provisions apply: no marketing, no spam email, no sharing of information with the third parties. Privacy policy available on the Evoenergy website,

[4] Projects above $6 million are subject to Regulatory Investment Tests.

**Figure 6.** Process overview – projects not subject to regulatory investment test



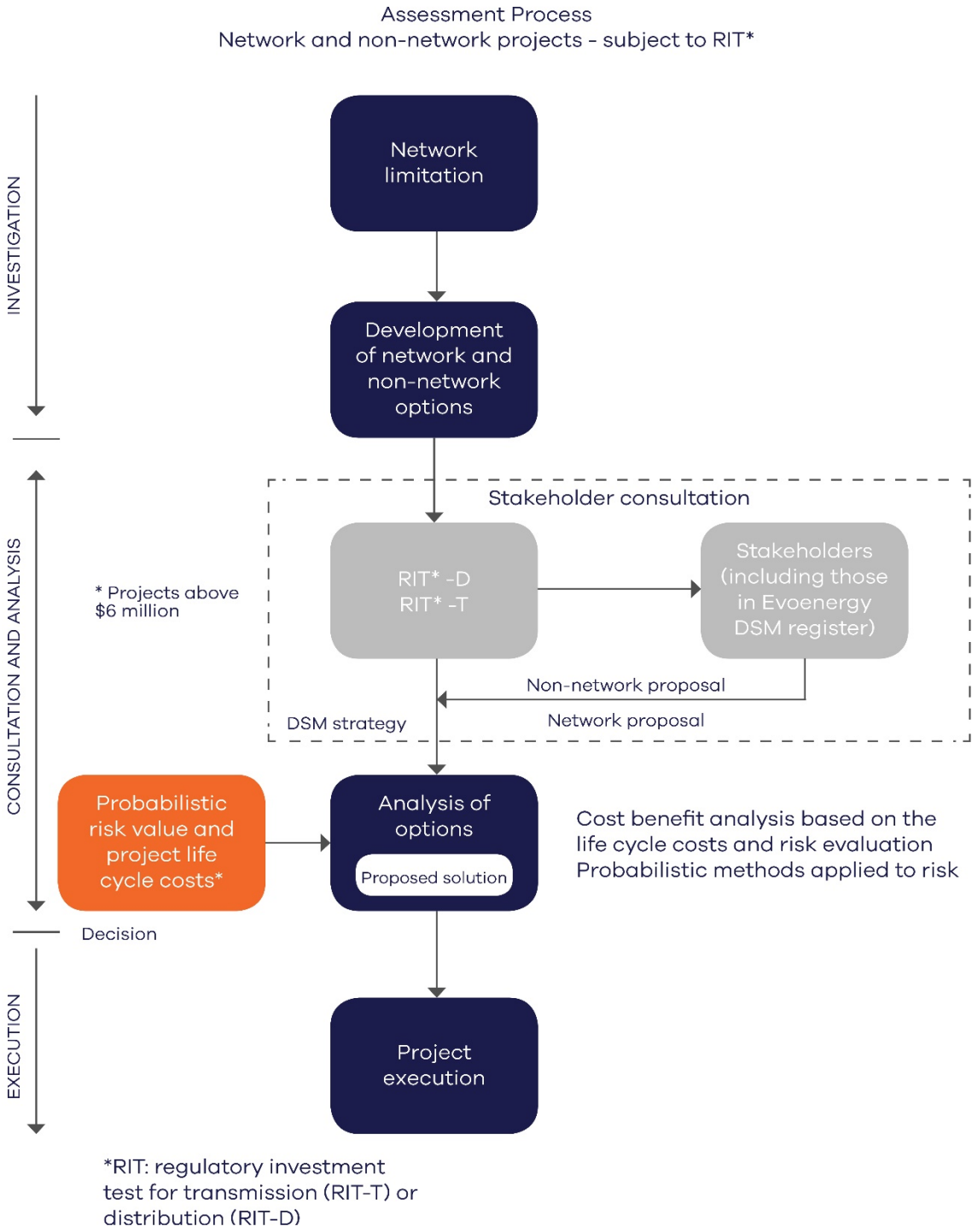
## 1.3 Engagement in a regulatory investment test

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 optimised solution includes a mix of non-network and network elements, RIT rules oblige Evoenergy to implement such a solution.

RIT Transmission (RIT-T) is conducted for transmission projects according to the process set out in AER's Application Guidelines. RIT for distribution projects (RIT-D) is conducted according to the process set out in AER's Application Guidelines for Regulatory investment test for distribution. For eligible projects, Evoenergy initiates RIT-D and RIT-T 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. For transmission projects, Evoenergy usually commences RIT-T process no later than 36 months prior to intended completion.

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

**Figure 7.** 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 minutes from the Energy Consumer Reference Council (ECRC) are published on the Evoenergy website. ECRC is a forum of Evoenergy's stakeholders. It representatives of consumers, business 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 on the Evoenergy website.

# Chapter 2 About Evoenergy

This chapter provides the following information:

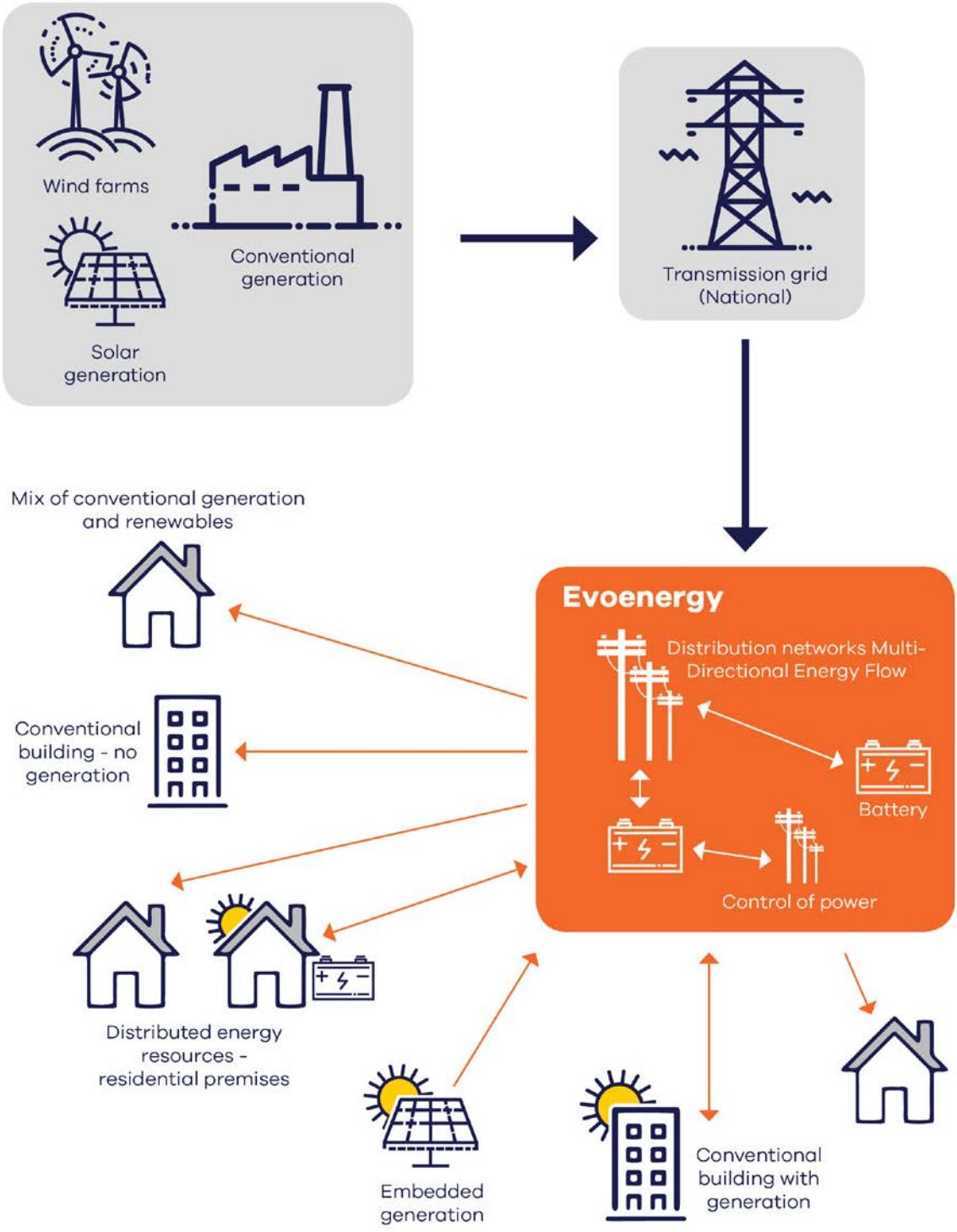
- Introduces Evoenergy as a licensed transmission network and distribution network provider.
- Provides an overview of the electricity network and the physical environment.
- Provides an overview of the regulatory environment.
- Discusses the main factors and trends which are currently impacting Evoenergy's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

## 2.1 Introduction

Evoenergy is a utility licensed in the ACT to provide electricity transmission, 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 Transmission Network Service Provider (TNSP) and 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 transmission 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 and distributed energy resources.

**Figure 8.** Evoenergy within the industry supply chain




The following section provides an overview of Evoenergy's network and physical environment.

## 2.2 Evoenergy's physical environment

Evoenergy provides electricity and gas services over an area of 2,358 square kilometres to 196, 500 electricity customers as of 30 June 2019, within the ACT. It also supplies electricity to around 90 customers in New South Wales.

Evoenergy owns and operates the electricity network which includes 196 km of transmission lines, sixteen 132 kV/11 kV zone substations and switching stations, around 4600 distributions

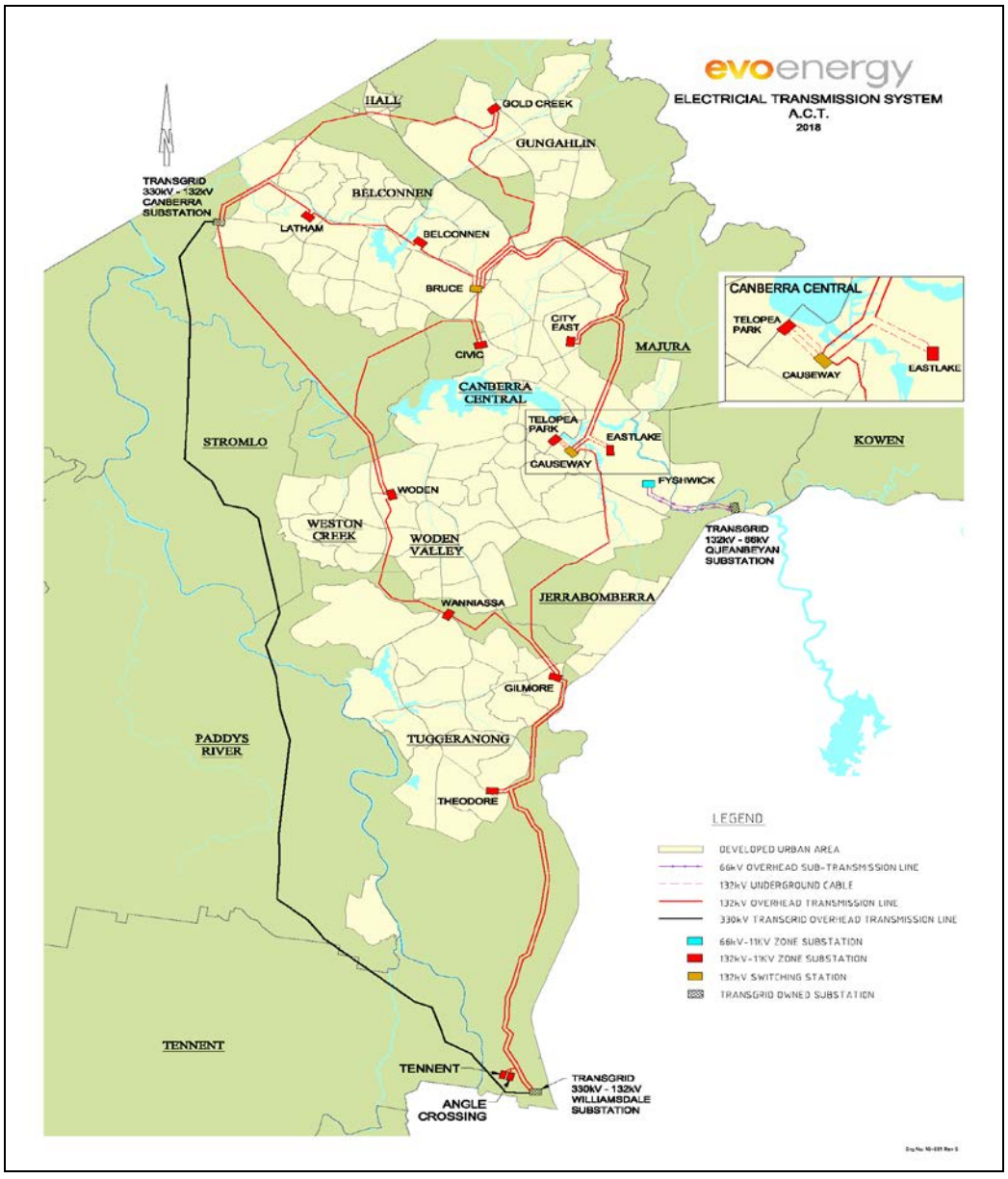
substations and over 5200 km of distribution lines. More detailed statistical information on the network asset numbers is provided in Table 17.

Figure 9 and Figure 10 below show the overview of the main components of the existing Evoenergy's transmission network including bulk supply points, zone substations and interconnecting lines.

Figure 9 is geographic representation of transmission lines and zone substations within the ACT.. Evoenergy's network includes transmission 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 transmission lines and overhead distribution lines are located in bushfire prone areas. 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.

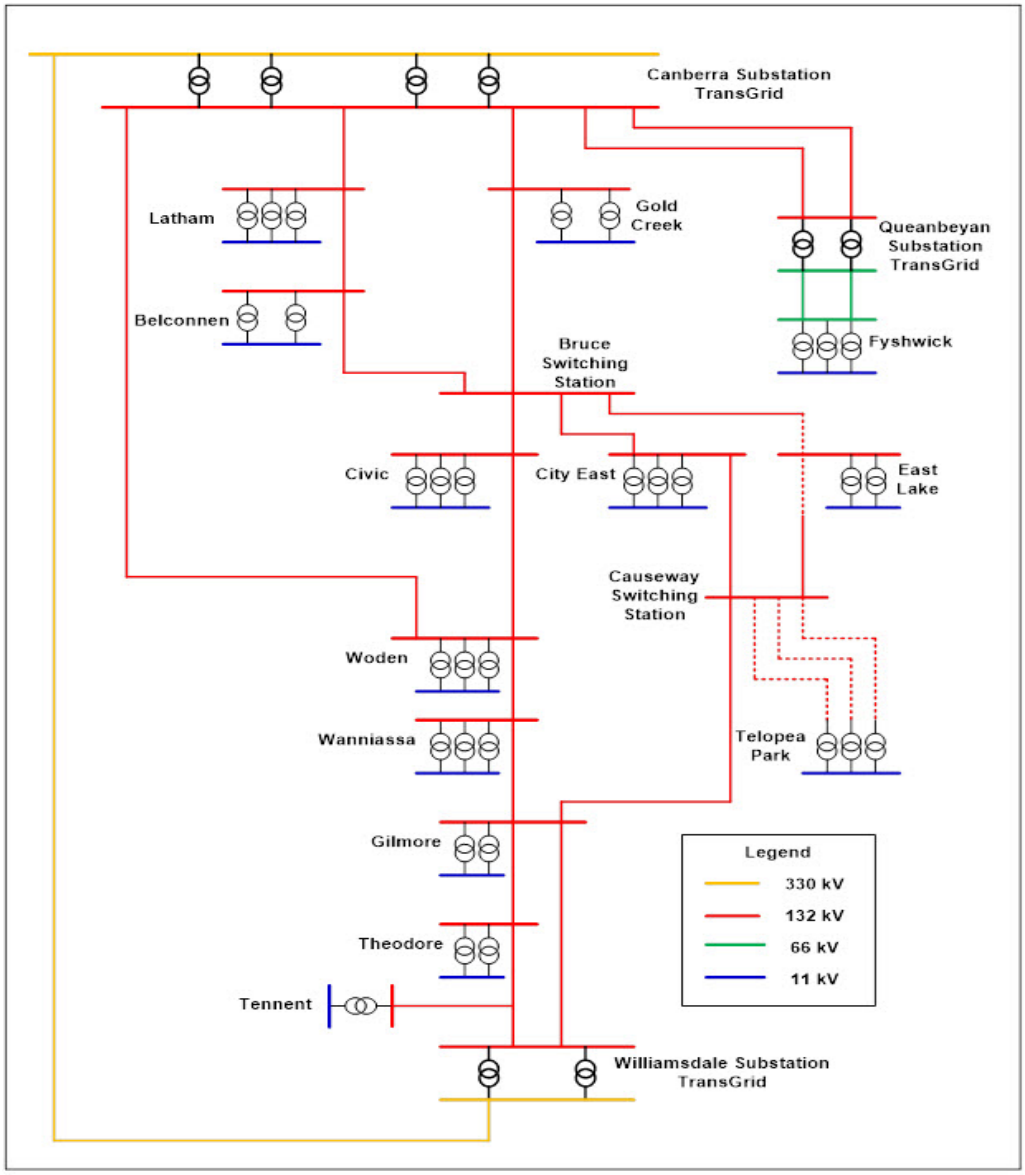
Appendix B –provides additional details on the network's physical assets including a number of transmission and distribution assets, lengths of lines and cables, the rating of the main transmission components and zone substations.

**Figure 9.** Evoenergy's transmission network – geographic representation



The diagram below depicts existing Evoenergy's transmission network and TransGrids 330 kV lines connecting Evoenergy's network through three bulk supply points (Canberra Substation, Queanbeyan Substation and Williamsdale 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 transmission lines. The bulk supply substations and 330 kV lines are operated by TransGrid.

**Figure 10.** Evoenergy's existing transmission network - schematic representation



## 2.3 Regulatory environment

Evoenergy is a utility regulated by commonwealth and jurisdictional legislative and regulatory instruments which cover economic and technical regulation.

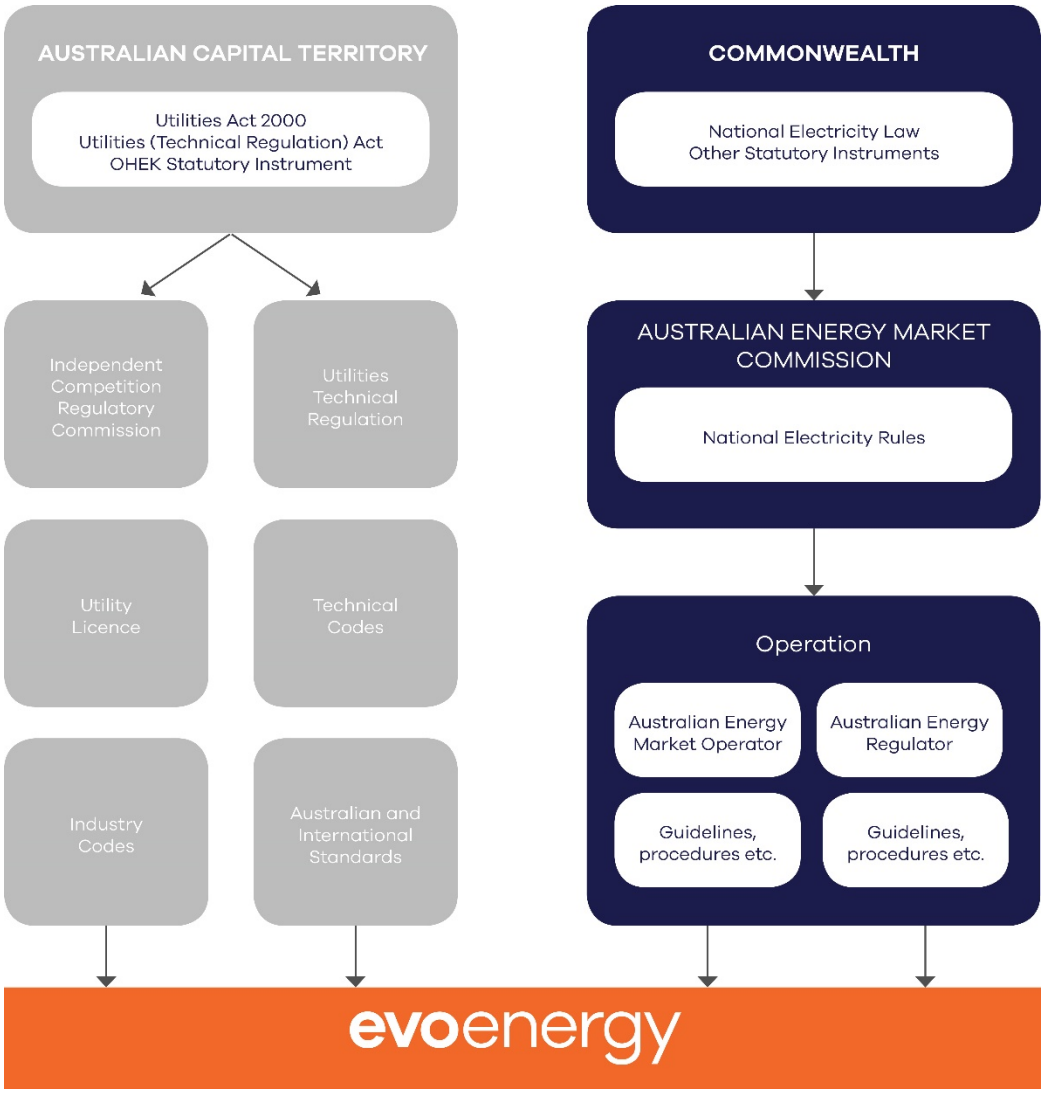
The way we plan our network is consistent with a range of obligations and regulatory instruments which support the National Electricity Objective (NEO):

"To promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to price, quality, safety and reliability and security of supply of electricity"

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, 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 11 provides an overview of main elements of Evoenergy's regulatory environment as a licenced and registered utility. The regulated Evoenergy's "poles and wires" business is ring-fenced form other entities and activities which operate in competitive markets. 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 11.** 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 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 (NEW) 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

Network planning process requires us to consider a range of internal and external factors impacting the electricity network. External factors are driven by consumer preferences, consumption trends, demand, development trends and technology impacting security of supply, reliability, power quality and safety.

Evoenergy is cognisant of the following current external factors impacting electricity network planning and asset management:

- Continuing high level of growth in distributed energy resources in particular residential photovoltaic installations, medium size commercial installations which create voltage regulation issues in some pockets within the network.
- Relatively flat winter demand, small growth in summer demand at the network level and higher demand growth pockets in several locations in the ACT.
- Relatively high rates of commercial developments, medium density residential greenfield and medium and high density residential brownfield developments causing localised network capacity constraints.
- The existing trends and the long term policy settings including ACT Government energy policies such perpetual 100% renewable energy target and 2045 zero emissions target reinforcing need for changes to the way we operate the network.
- 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 ACT Government energy polices and provides a long term context for the existing trends impacting Evoenergy's network.

### Government policies and long term context

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

43 MWs of large scale solar generation is currently embedded in the ACT network. There is around 30 MWs of new solar generation under consideration. The strong growth in rooftop photovoltaic generation continued last year. Around 20% of single residential dwellings in the Australian Capital Territory have photovoltaic installations. The installed capacity of residential installations has increased by 24% in the last year alone. At the same time the average size of residential photovoltaic installation has increased from 2.5 KVA in 2010 to around 6 KVA for the new installations in 2019. That growth had increasing impact on the network, particularly in relation to voltage regulation in areas where the penetration of photovoltaic is high. Figure 4 in the executive summary shows geographic areas of high PV penetration.

ACT Government energy policies point to the continuation of this trend. The government policy includes the 100% renewable energy target which is expected to be reached in 2020 and which has been extended in perpetuity into the future. Thus, the future increases in the energy

consumption will have to be matched by the volume of renewable generation. Despite a number of energy efficiency measures, the rapid uptake of the distributed generation in the Australian Capital Territory is expected to continue. Consequently, Evoenergy predicts an increase in quality of supply challenges which will have to be addressed through suitable network planning and network support measures.

The ACT Government energy policy includes a long term zero emission targets 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 which now is the main contributor towards greenhouse gas emissions at around 60%. 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.

Furthermore, the government discussion paper notes that the zero emission target would require "a transition away from using natural gas". Under most scenarios, that transition would likely result in an increased electrical energy consumption.

Evoenergy is cognisant of many future scenarios which will require changes to the network solutions and network investments if the zero emissions transportation and natural gas substitution translate to the increased electricity consumption.

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 controlling future uncertainty through adaptability and innovation.

### Planning towards future network

Evoenergy responds to the changing energy industry landscape. Our customers 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 DSO. Evoenergy's strategic planning focus is to develop and operate the transmission and distribution networks to effectively and efficiently cater for emerging technologies such as micro grids, embedded generation, smart networks, smart metering, electric vehicles, battery storage, hydrogen electrolysis, hydronic and vacuum waste services, dynamic ratings for transmission lines and power transformers; and identify any opportunities for stakeholder input.

Figure 12 provides and overview of the changing business environment influenced by our key stakeholders.

ACT Government 100% renewable energy target and the zero emissions target set for 2045 are key drivers of transformation. Rooftop solar PV are being encouraged by developers of large residential estates, and it is likely that battery energy storage and home energy management systems will be 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 customers 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.

These factors will influence future transmission and distribution infrastructure development and operation.

**Figure 12.** Towards the future network


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. The long-term strategy plan provides strategic direction for the efficient utilisation of existing assets.

The following sections discuss how specific observed trends impact security or 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 is considered during the planning process. The demand forecast is prepared for the systems, zone substation 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. The distributed energy resources located behind the meter reduce the transportation of energy through the network. The energy consumption and demand can be also influenced by the electricity tariffs levels and structures. More importantly the demand is sensitive to weather conditions, in particular the maximum and minimum temperatures.

Evoenergy observations and findings:

The projected demand at the system level is relatively flat (Chapter 5 refers). No new major security concern have been identified at the system level to be addressed by Evoenergy. The previously identified constraints are being addressed by a joint planning with TransGrid through a construction of Stockdill bulk supply substation and interconnecting lines due to be commissioned in 2020 (Chapter 7 refers). However, Evoenergy is currently investigating and raising with TransGrid voltage regulation constraints at zone substations at the time of low network load which coincided with high PV generation.

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

## Factor impacting reliability

The reliability of the supply is measured though a number and duration of electricity supply interruptions experienced by network customers (Chapter 4 refers). The reliability of supply is impacted by a condition of network assets and factors outside Evoenergy control such as weather or accidental damage. Not all assets equally impact supply reliability. The probability of failure and consequences of failure are different for different assets depending on the location and function in the network. Health of some network components is critical to the electricity supply. Evoenergy optimises its maintenance activities according to age, health and criticality of the assets.

The 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:

Evoenergy's reliability for unplanned outages is one of the best in Australia[5]. Evoenergy's current strategic intent is to maintain reliability performance within the existing regulatory targets. Work program is oriented towards maintenance of reliability levels and targeting improvements in specific areas of concerns including worst performing feeders and worst served customers. More details on network reliability performance refer to Chapter 4.

[5] AEMC Annual Market Performance Report 2018

Evoenergy is cognisant of some assets posing increasing reliability risk (e.g. underground distribution cables or distribution switchboards). The management of the existing assets including maintenance and renewal seeks to prioritise and address these risks. The management of existing assets is discussed in Chapter 6.

## Factors impacting power quality and other technical parameters

Power quality relates to the standard voltage and current experienced by customers 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 factors. Departures form the standard may have adverse impact on customer equipment. Customer equipment may also contribute to the poor power and impact other consumers connected to the network. The 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:

Currently for Evoenergy, main power quality initiatives focus on the impact of the photovoltaic distributed generation. As demonstrated by voltage regulation constraints in some parts of the network, Evoenergy is reaching hosting capacity limits which needs to be assessed on individual basis.

In network locations with high concertation of photovoltaic generation, Evoenergy experiences increased incidence of voltage regulation constraints. At times of high energy production and a low consumption, the reverse power flow increases voltage levels beyond the normal operating limits. The high volts may cause automatic disconnection from the network of PV installations. The limitations impact the low voltage distribution network and, at times, distribution substations. The voltage regulation issues which will have to be managed are set to increase in line with the growing penetration of distributed generation.

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

Table 4 provides an indicative overview of the current factors impacting our asset management and the corresponding pressure points at various levels.

**Table 4.** How various factors currently impact Network Planning and Asset Management

| Factors | Capacity/security | | | | | Reliability | | | | | Power quality | | | | | Safety and environment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Transmission lines | Zone susbtataions | HV distribution network | Distribution susbstaions | LV Distribution Lines | Transmission lines | Zone susbtataions | HV distribution network | Distribution susbstaions | LV Distribution Lines | Transmission lines | Zone susbtataions | HV distribution network | Distribution susbstaions | LV Distribution Lines | Transmission lines | Zone susbtataions | HV distribution network | Distribution susbstaions | LV Distribution Lines |
| **System demand trend and generic load growth** | | | | | | | | | | | | | | | | | | | | |
| **Localised load growth - residential/commercial developments including in-fill** | | | | | | | | | | | | | | | | | | | | |
| **Embedded generation (micro and small)** | | | | | | | | | | | | | | | | | | | | |
| **Embedded generation (large scale)** | | | | | | | | | | | | | | | | | | | | |
| **Asset condition/age** | | | | | | | | | | | | | | | | | | | | |
| **Compliance including technical standards and vegetation management** | | | | | | | | | | | | | | | | | | | | |

The above table summarises Evoenergy's current position against the key factors driving its performance and investment over the planning horizon. The colours in this table highlight the following:

- Orange colour indicates the first tier key priority areas for asset management, network planning, demand management and anticipated investment
- Yellow colour indicates the second tier components which will require increased attention from network planners and asset managers.
- Grey colour indicates components for which Evoenergy anticipates a business-as-usual treatment

# 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 quality electricity supply.

Optimising the value of investments is at the core of Evoenergy network planning and asset management philosophy. Evoenergy asset management decisions recognise the transformation of electricity network and roles of network provider due to changes in consumer preferences and technologies. The approach is designed to support prudent and efficient investment and promote innovation.

The key characteristics of Evoenergy 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 for Asset Management*.

Appendix D – provides further description and details of Evoenergy's approach to the management of the existing assets and planning of the network.

**Certification of Asset Management System to ISO 55001**

*ISO 55001* states the specification for an integrated, effective management system for asset management which maximizes value derived from the use of assets. Evoenergy has adopted *ISO 55001* as the reference for measuring asset management continuous improvement and compliance.

JAS-ANZ accredited auditor assessed that Evoenergy attained the certification against the requirements of *ISO 50001 Asset Management standard*. Evoenergy intends to maintain that certification.

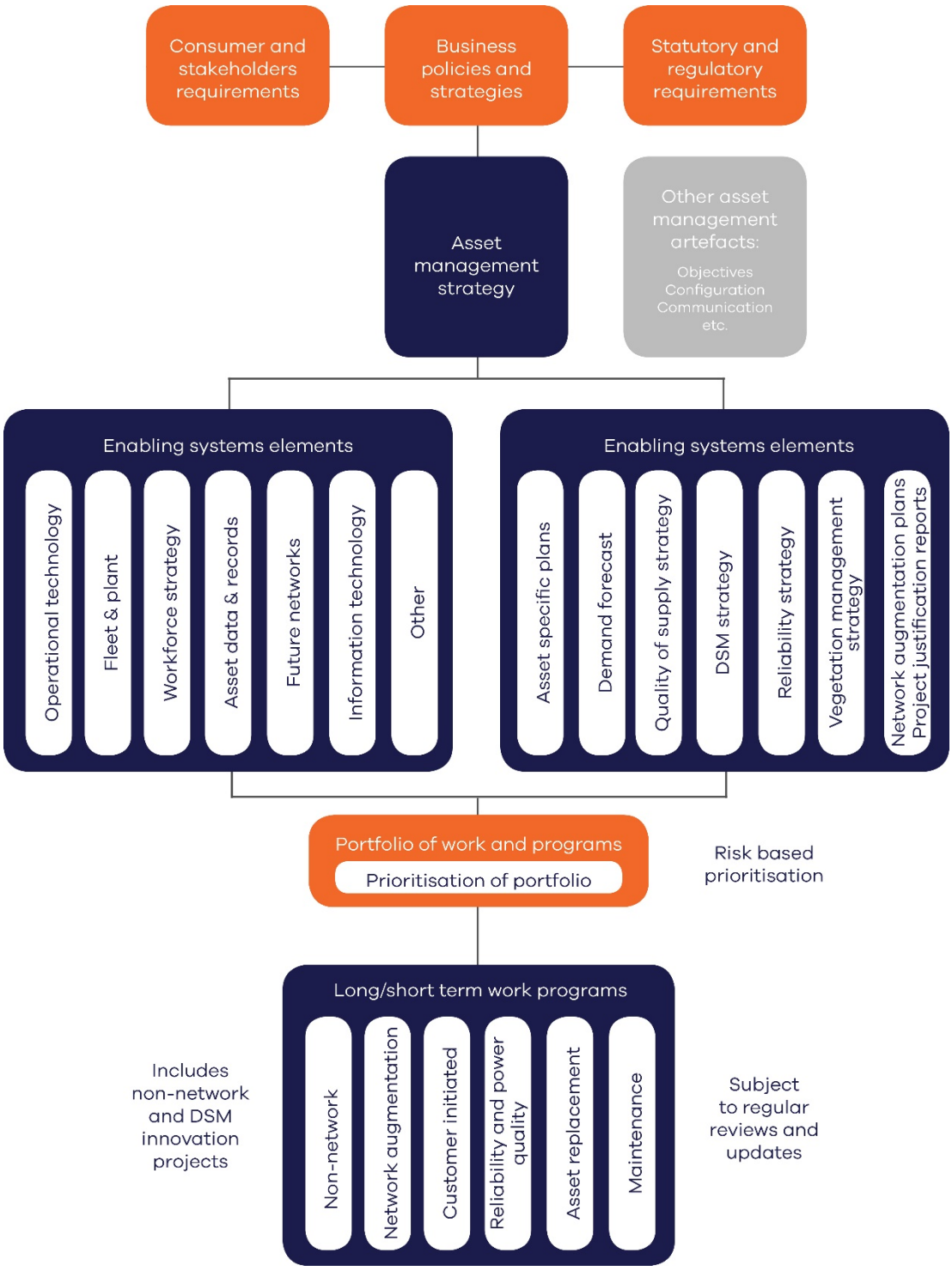
## 3.1 Asset management approach and components

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 performance, safety, load growth, security, 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 Risk 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 13 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 asset management processes are discussed further in Appendix D – The network planning outcomes are discussed in Chapter 6 for the existing assets and in Chapter 7 for planning of the network.

**Figure 13.** 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 considers the network performance and capacity against future network needs based on the projected demand forecast for the main network components such as transmission lines, zone substations and distribution lines.

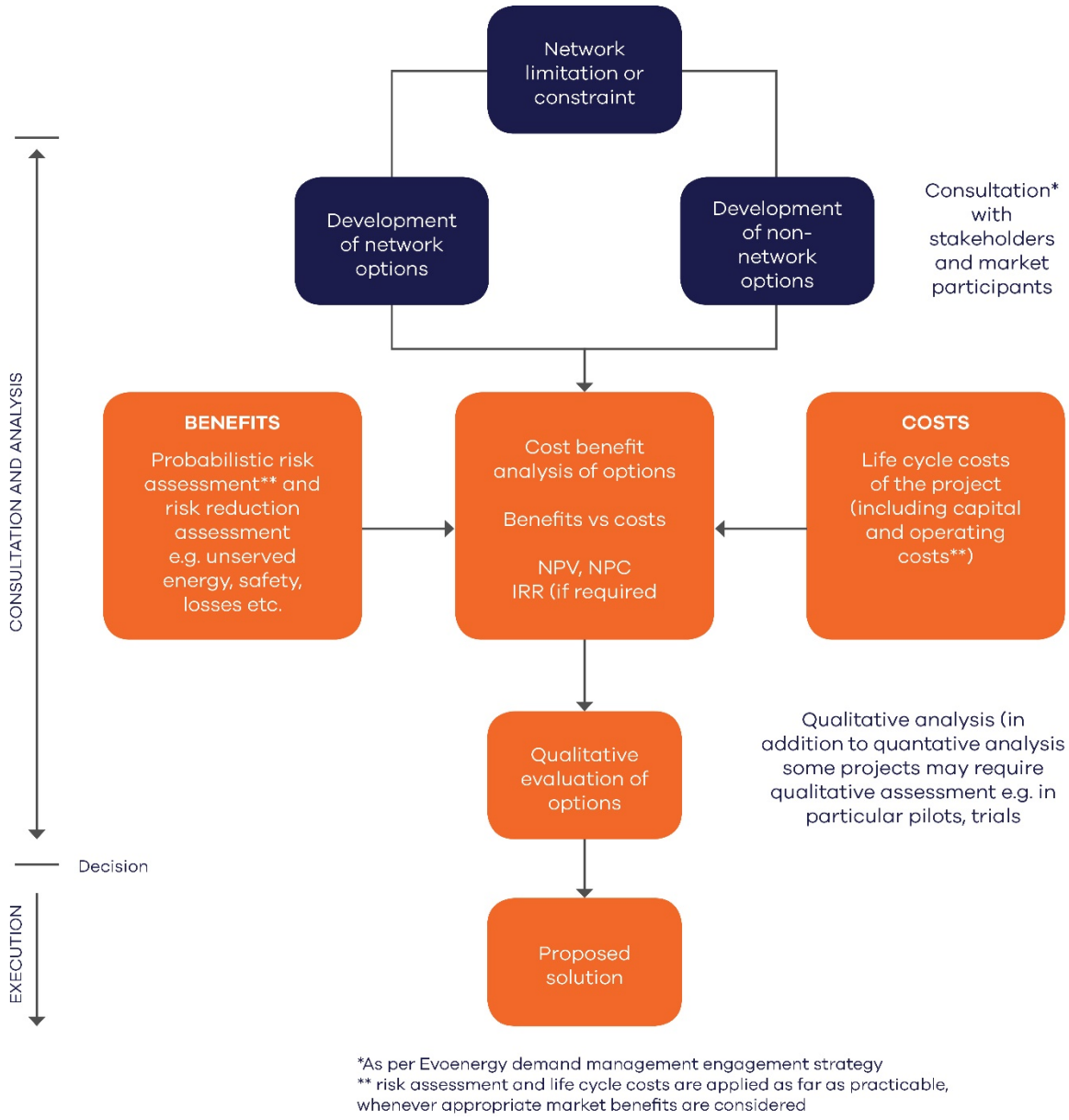
As a starting point, deterministic criteria n- 1 are used to identify parts of the network where demand may exceed supply capacity. These deterministic criteria allow for a limited backup capacity for the critical parts of the network in an event of credible contingency event. The deterministic criteria also provides the indication of the existing and emerging network capacity limitations. The Advanced Distribution Management System (ADMS) network analysis tools use demand forecast to analyse and identify network limitations including capacity and power quality constraints. Synergies with asset replacement and retirement program are considered and captured at the same time. The identified constrains are further assessed through application of probabilistic planning methods.

## 3.3 Risk based probabilistic planning

Risk management is fundamental to all Evoenergy's investment decisions. Although the methodology may vary for different asset classes, the risk management is integrated with asset management decisions and network planning. Network investment is designed to mitigate existing or emerging risks. As far as practicable, the risk reduction from various solutions is assessed for each investment option. This method forms the basis for the business case and the Net Present Value (NPV) calculation. Projects driven by compliance requirements are often assessed on the Net Present Cost (NPC) basis rather than NPV basis.

Figure 14 provides a high level overview of the risk based approach to investment decisions. It shows that risk assessment and as far as practicable valuation of risk is a critical step in investment decisions. Unbiased consideration of non-network and network solutions is a mandatory step in the process.

**Figure 14.** Overview – probabilistic risk based investment decisions




For the identified network limitations the probabilistic planning methods are used to quantify the existing and emerging risks. As far as practicable, the methodology is applied to network capacity constraints and asset renewal projects. This risk is often related to the risk of 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) is approved by the AER.

Apart from the risk of supply interruption, typical risk assessment may include safety and environmental 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 that comparison is

considered as a benefit. The approach is consistent with the AER's applications notes on asset replacement planning[6].

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

Appendix D – provides more details on Evoenergy asset management approach.

## 3.4 Management of the existing assets

Evoenergy's approach to the management of the existing assets aims at optimising the 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 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 asset maintenance philosophy complements asset retirement and renewal approach. Risk Centred Maintenance (RCM) is discussed in the next section.

The main output from the process are Asset Specific Plans (ASPs) for all network asset classes and groups. The ASPs include planned asset retirement, renewal and maintenance. ASP are the results of the bottom up analysis based on the available asset data.

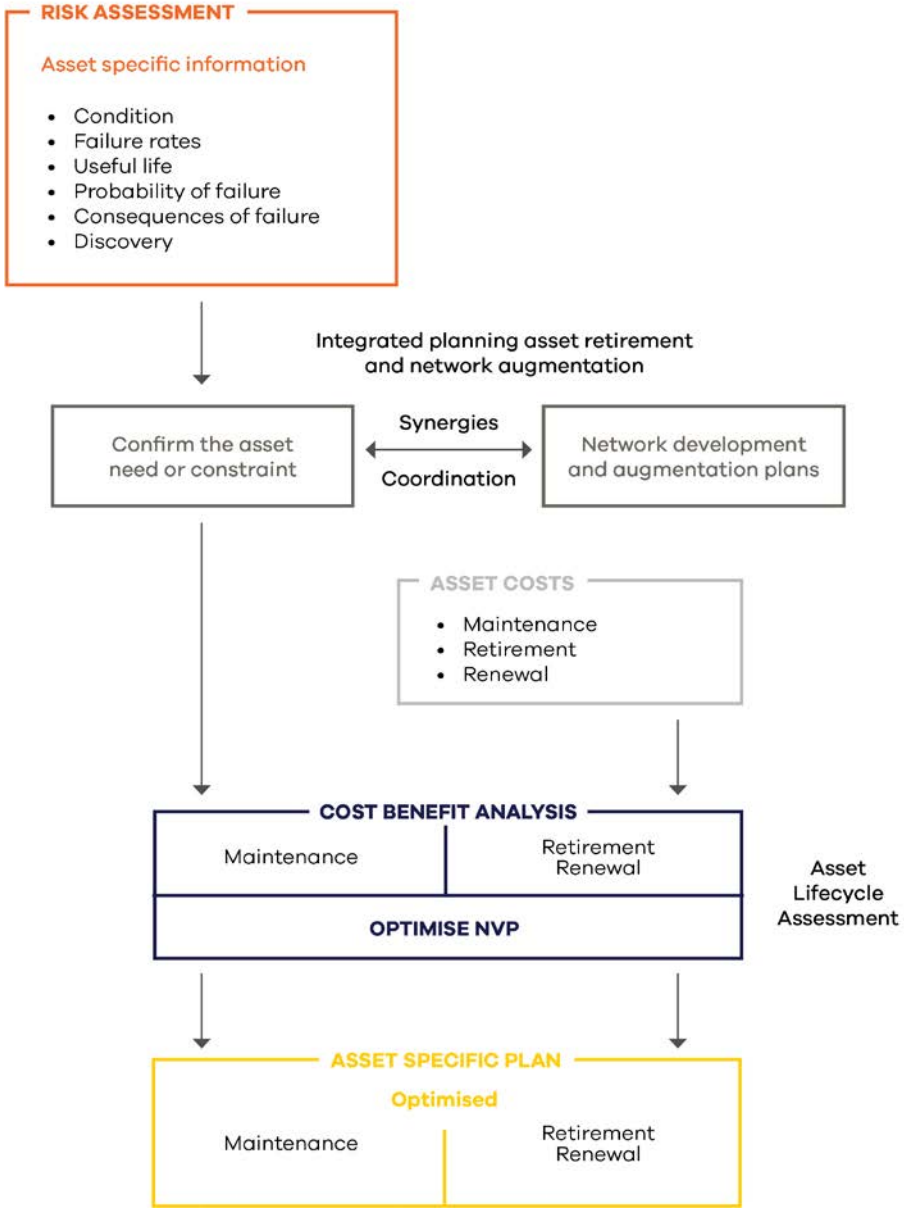
An additional step is to optimise the investment across asset classes. The top down analysis across ASPs ensures that investment dollars are allocated to the assets where the overall benefits (e.g. risk reduction) are greatest.

Appendix D –provides additional details and commentary on the Evoenergy asset management approach. Chapter 6 discusses outcomes of the planning review for the asset retirement and renewal.

Figure 15 shows an overview of the life cycle optimisation process.

[6] AER January 2019. Industry practice application note. Asset replacement planning.

**Figure 15.** Optimising asset retirement and renewal – an overview




## 3.5 Asset Maintenance

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

The process of developing an RCM 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 RCM methodology is extended to Failure Mode Effect Analysis (FMEA) 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 scheduled maintenance program that is based at reliability characteristics of the equipment in the operating context (function and criticality) in which it is used.

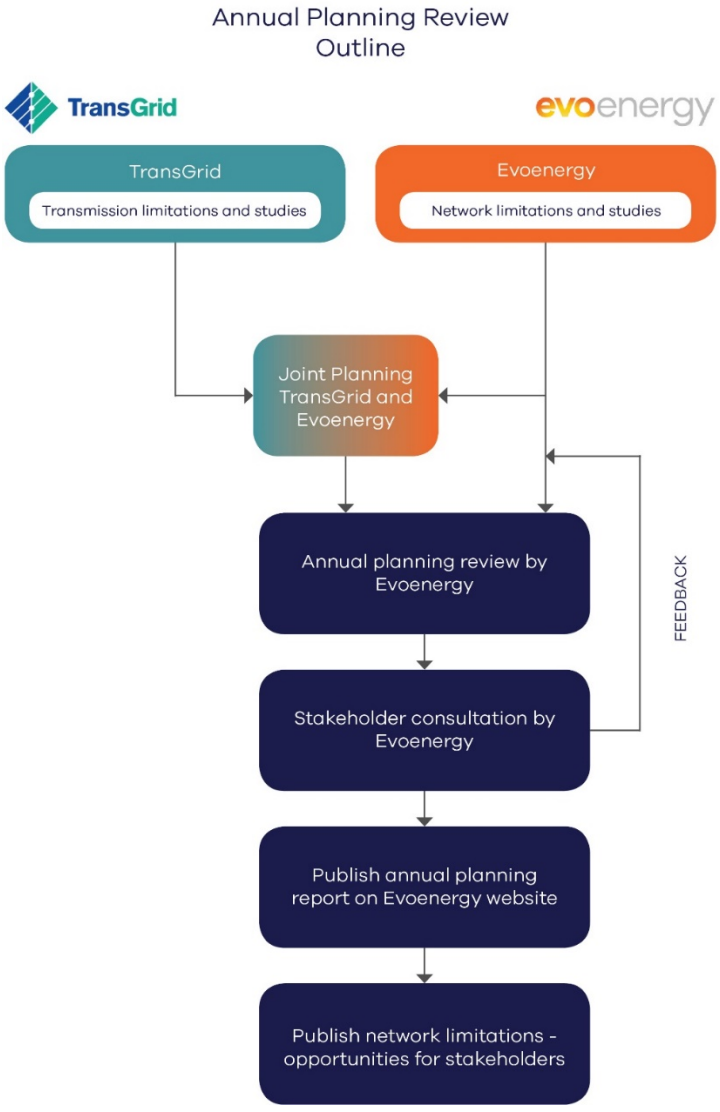
## 3.6 Annual planning report

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 network and ten years for the transmission network. 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 stakeholder to explore the full range of non-network and demand management solutions.

Figure 16 below provides an overview of the planning review process including joint planning with TransGrid, the operator of the transmission network in NSW with which ACT network connects.

**Figure 16.** 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 its customers 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 customers. Our strategy is to maintain the overall network reliability performance and implement set initiatives targeting specific improvements.

In the past 5 years, network reliability performance has remained consistent with minor departure from the AER's Service Target Performance Incentive Scheme (STPIS) supply reliability targets for the duration of outages (SAIDI). Our network reliability performance and forecast performance is shown in Figure 17 and Figure 18.

**Figure 17.** SAIDI- unplanned interruptions per customer (minutes per customer per year)

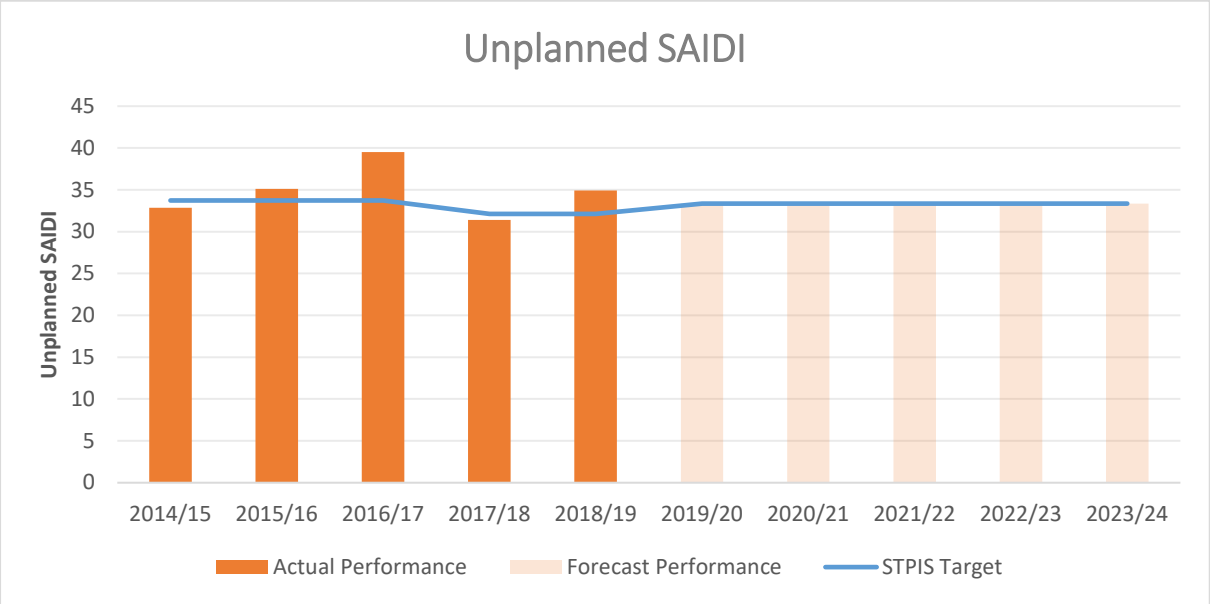
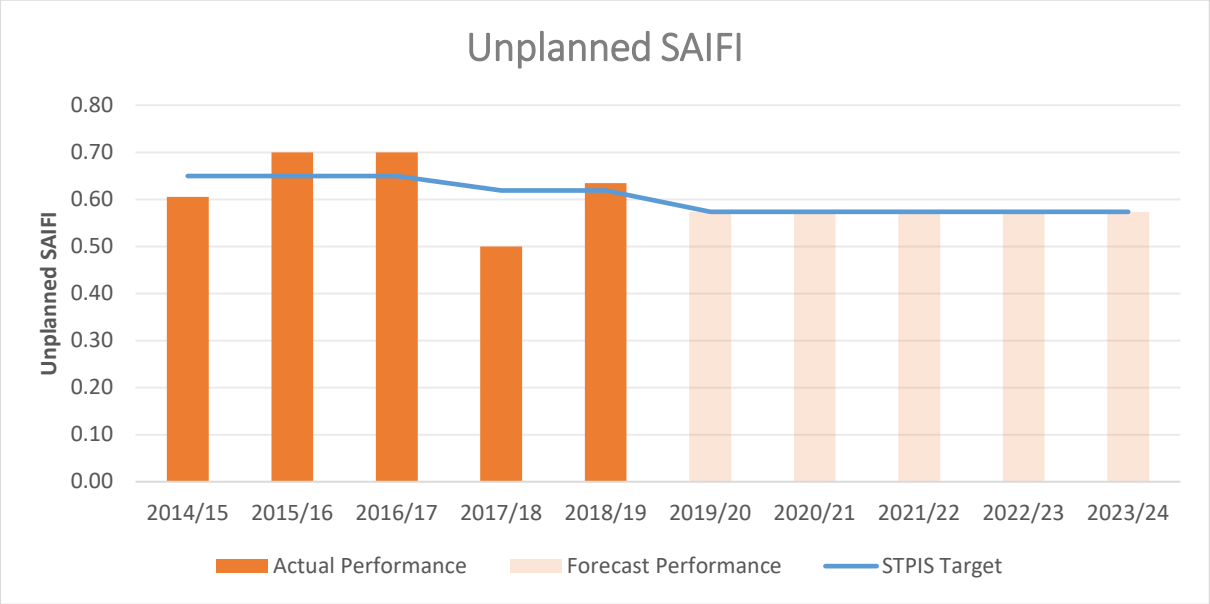


**Figure 18.** SAIFI- unplanned interruptions per customer (number of interruptions per customer per year)




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

### 4.1.1 Reliability – what are the main challenges

The overall network reliability performance for unplanned outages is one of the best in Australia. Network reliability performance is continually monitored to identify emerging trends of poor network performance by worst performing feeders and worst served customers.

## Duration of outages

Our customers value fast restoration when outages occur. This was expressed by customers when Evoenergy consulted with customers through our ECRC. The majority of our customers prefer faster restoration compared to fewer outages.

Evoenergy's average duration of unplanned outages per customer (SAIDI) has slightly increased over the last 10 years. Evoenergy's reliability strategy aims at addressing this issue.

## Worst served customers and worst performing lines

Some customers (worst served customers) experience poorer performance compared to the network average. The customers may be impacted by planned and unplanned outages. Evoenergy monitors planned and unplanned outages for all customers and identifies customers who experience the reliability well below average.

For those customer, the root cause(s) of supply interruptions are analysed to determine credible solutions.

## Power Quality

Our reliability strategy extends to minimising interruptions to customers grid connected PV inverters. Power quality, specifically LV voltage regulation is affecting customers grid connected PV inverters causing outages to those PV inverters. This is addressed through our power quality strategy however is related to the reliability our customers experience.

## Integration with asset management and maintenance

Areas of the network experiencing poor reliability are investigated to determine the cause of poor performance and solutions analysed to improve reliability. There are selected parts of the network in which the reliability performance is well below average and needs to be addressed through asset maintenance, redesign or renewal measures. Furthermore reliability of some assets such as older underground distribution cables is being closely watched and tested. The increased risk of failure of old underground distribution cables is addressed through the asset renewal program discussed in Chapter 6.

Large sections of Evoenergy networks are located in bushlands, backyards and other heavily vegetated areas. Vegetation management and maintenance of clearances between vegetation and network assets is an important preventive measure designed to maintain reliability and safety of operations.

### 4.1.2 Reliability – what we have achieved in the last year

Evoenergy's network reliability improvement initiatives implement economic options to reduce supply interruptions to customers. Our reliability initiatives have focused on the fast and safe restoration of supply as it was outlined in the previous section as one of our reliability challenges. In 2018/19 we took a number of steps to address reliability issues:

- Installed remote controlled automatic reclosers on five (5) overhead feeders to minimise customers affected by faults and quickly restore supply to customers on healthy sections.
- Deployed Fault Passage Indicators (FPIs) on one (1) overhead feeder to reduce restoration time of outages.
- Installed FPIs in new ground mount substations (padmount substations) to reduce outage restoration time.
- Reconfigured underground distribution feeders in Gungahlin to improve reliability by reducing the frequency of outages and minimising customers affected when faults occur.
- Installed wildlife deterrents on overhead feeders experiencing outages caused by wildlife e.g. possum barriers on overhead networks.
- Decommissioned legacy assets that have failed and are not required in the network. Seven (7) distribution substations, one (1) switching station and one (1) overhead air break switch were removed, thereby reducing the likelihood of these legacy assets causing outages in the future.

### 4.1.3 Reliability – planning outcomes

## Reliability strategy and tactics

Our overall strategy is to maintain existing levels of reliability for customers and make improvement to match customer's value of reliability.

Our reliability plan uses the following tactics to maintain network performance for customers:

- **Prevent** outages from occurring;
- **Minimise** the number of customers affected when faults occur and;
- **Fast and safe** restoration of supply to customers.

Appendix F – contains a full list of prevention, minimisation and restoration tactics considered by Evoenergy.

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

- Installing remote controlled automatic reclosers on our overhead network to minimise customers affected by faults and quickly restore supply to customers on healthy sections. In 2019/20 this program is planned on four (4) overhead feeders.
- Deployment of remote control switchgear with fault indication on overhead networks to reduce the duration of outages. In 2019/20 this program is planned on four (4) overhead feeders
- Installation of remote control switchgear with fault indication on underground networks to reduce the duration of outages. In 2019/20 this program is planned on one (1) underground feeder.
- Maximising use of network augmentation to optimise network load and connected customers to reduce the frequency and impact of faults when they occur.

Our medium term strategy includes evolution to automatic network switching to restore supply to customers when a fault occurs. This strategy further seeks value from our deployment of remote control switchgear and network monitoring by using Fault Location Isolation and Supply Restoration (FLISR) functions with centralised control from our Advanced Distribution Management System (ADMS). For further information about this initiative refer to the Chapter Chapter 9 which discusses use of more advanced technologies.

## 4.2 Power quality

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

Power quality issues manifest themselves in voltage, current or frequency deviation, which result in premature failure, reduced service life or incorrect operation of customer equipment.

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 ACT Electricity Distribution Supply Standards Code stipulates power quality standards to be met by Evoenergy. Evoenergy's Service and Installation Rules describe the applicable power quality design and operating criteria that must be met by our customers. Optimisation of network power quality enhances asset lifetimes due to reductions in operating stresses (e.g. lower transformer iron losses and resultant heating from harmonic voltage distortion) and may increase life of electrical appliances.

The objective is to maintain power quality to provide a safe and secure source of electricity to our customers.

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 issues in the low voltage network. Bulk of the current challenges relate to increasing penetration of the distributed photovoltaic (PV) generation within Evoenergy network, particularly rooftop photovoltaics. The growth in embedded generation continues at a high rate, with the 24% increase in installed capacity in the last year alone. As the result, some parts of the low voltage network are increasingly subject to reversed power flows. Consequently, Evoenergy is recording increasing numbers of overvoltage incidents particularly in locations where the penetration of the PV generation is high or generation clusters exists. A significant proportion of inverters installed with PV generation are not configured correctly exacerbating the high voltage regulation issues. Evoenergy predicts that hosting capacity limits for PV generation will be increasingly challenged in the future.

In addition to the voltage regulation Evoenergy is taking steps to resolve existing issues relating to voltage unbalance in some parts of the low voltage network. The ways to remedy unbalance are being investigated with the intention to identify problem areas and to develop a structured long-term program.

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, however there is potential for hazards to remain undetected. A monitoring system utilising customer smart meter's is being considered to address neutral integrity issue.

### 4.2.2 Power quality - what we have achieved during the last year?

During the last year Evoenergy conducted proactive power quality monitoring programs, investigated and resolved a number of network power quality issues and researched and trailed new methods.

Evoenergy investigated and resolved the following power quality enquiries from customers who reported power quality issues including

- 287 high voltage level issues associated with solar PV installations).
- 96 other instances relating to the level of voltage.
- 29 low voltage level complaint.
- 2 EMF related enquiries and corresponding advice.

In addition to the investigations of the power quality complaints Evoenergy conducted proactive power quality monitoring in 100 randomly selected sites including voltage level, voltage unbalance,

voltage fluctuations and harmonics. Evoenergy also participates in the national power quality program and benchmarking conducted by the University of Wollongong.

Last year, Evoenergy took the following steps to remedy over-voltage in the network:

- Tap changer voltage regulation settings in 10 zone substations were reviewed and adjusted downwards
- Off load tap changes settings in over 250 distribution substations were changed

A multi-year program of installing monitoring equipment in distribution substations was progressed with around 150 distribution substations fitted out with the power quality equipment.

### 4.2.3 Power quality – planning outcomes

Evoenergy has developed Power Quality Strategy and a set of projects and initiatives designed to manage power quality issues within the network.

The main existing components of that power quality program are summarised below.

## Proactive mobile monitoring

Evoenergy has a proactive program to survey power quality across the distribution network. This program features the following:

- 100 randomly selected survey sites per year;
- for each site, measurements are taken at the customer's point of supply; and
- over time Evoenergy develops a network-wide picture of power quality through a structured randomised program

This program is compliant with *AS.61000.4.30* - Testing and measurement techniques - Power quality measurement methods.

Power quality is measured by the installation of mobile power quality analysers and monitors in various locations on the distribution network. Measurements are taken on both a proactive and reactive basis. In case of any identified of non-compliance, Evoenergy takes appropriate actions to investigate and find the main source of the problem. If the non-compliance is resulting from the Evoenergy network, corrective action is immediately initiated to bring the network within compliance. If the non-compliance is a result of customer installation, the customer is immediately notified to take appropriate corrective actions.

## Permanent monitoring of power quality (proactive)

Evoenergy commenced a program of installations of power quality monitors in distribution substation to permit proactive energy and voltage management as an alternative to network reinforcement and additional asset replacement expenditure. The proposed network monitoring solution will offer customers an overall lower cost compared with other options such as additional network asset investment. Evoenergy's project justification report for Distribution Substation Monitoring is available on the on the AER website[1]. This project is proposed for the 2019-24 regulatory period and to date approximately 150 monitoring devices are installed on various distribution transformers.

## PQCA National Survey and Benchmarking

As part of the pro-active approach to power quality management, Evoenergy participates in the Power Quality compliance audit with the *University of Wollongong and Quality of Supply Audit with the Utilities Technical Regulator (UTR)*. During the last UTR audit held in May 2019 a number of outcomes were identified as improvement opportunities and Evoenergy is effectively working on implementing these in order to optimize the quality of supply.

[1] https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/evoenergy-actewagl-determination-2019-24/revised-proposal.

## Investigations of power quality issues and complaints

Evoenergy investigates all instances of identified power quality issues and power quality complaints. At present, most issues impact of the distributed generation on voltage regulation. Depending on the results of investigations, Evoenergy employs usually one of the following solutions to resolve the voltage regulation issue:

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

## Standards

The requirements for the connection of rooftop generation in a way which mitigates likelihood of over-voltages are being reviewed. Evoenergy has prepared draft guidelines which are currently under consultation, which includes lagging power factor inverter settings requirements for PV installation. Lagging power factor settings will introduce reactive power loading and mitigate voltage raise in the network due to reverse flow of active energy.

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

### 4.2.4 Power Quality Issues Associated with Embedded Generation

Distribution system voltage levels have been observed to fluctuate in areas of the network where there is a high penetration of rooftop PV generation. Evoenergy is currently trialling a distribution transformer fitted with an OLTC voltage regulation capability at Denman Prospect, a new residential suburb with 100% rooftop PV penetration. For more in-depth discussion on power quality issues associated with embedded generation, please see Appendix G.

# Chapter 5 System load and energy demand, and the supply-demand balance

## 5.1 Introduction

This chapter describes a ten-year forecast of maximum 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.

Parts of the network that may become overloaded due to load growth and require augmentation, and to identify other parts of the network where spare capacity may be available. 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, technology, economic factors and consumer preferences. Evoenergy expects that in the future demand will be also increasingly driven by the government energy policies such as ACT's zero emission 2045 target. The target would require transportation and gas to be transferred or substituted by alternative energy sources such as electricity. At the time of preparation of this APR, ACT government discussion paper on energy policy was subject to public consultation. At this stage, the potentially significant impacts of some policy scenarios on the electricity network could not be included in the demand forecast. Once the policy discussion is settled, future forecasts will be updated to account for the policy impacts.

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

## 5.2 System demand

### 5.1.1 Historical demand

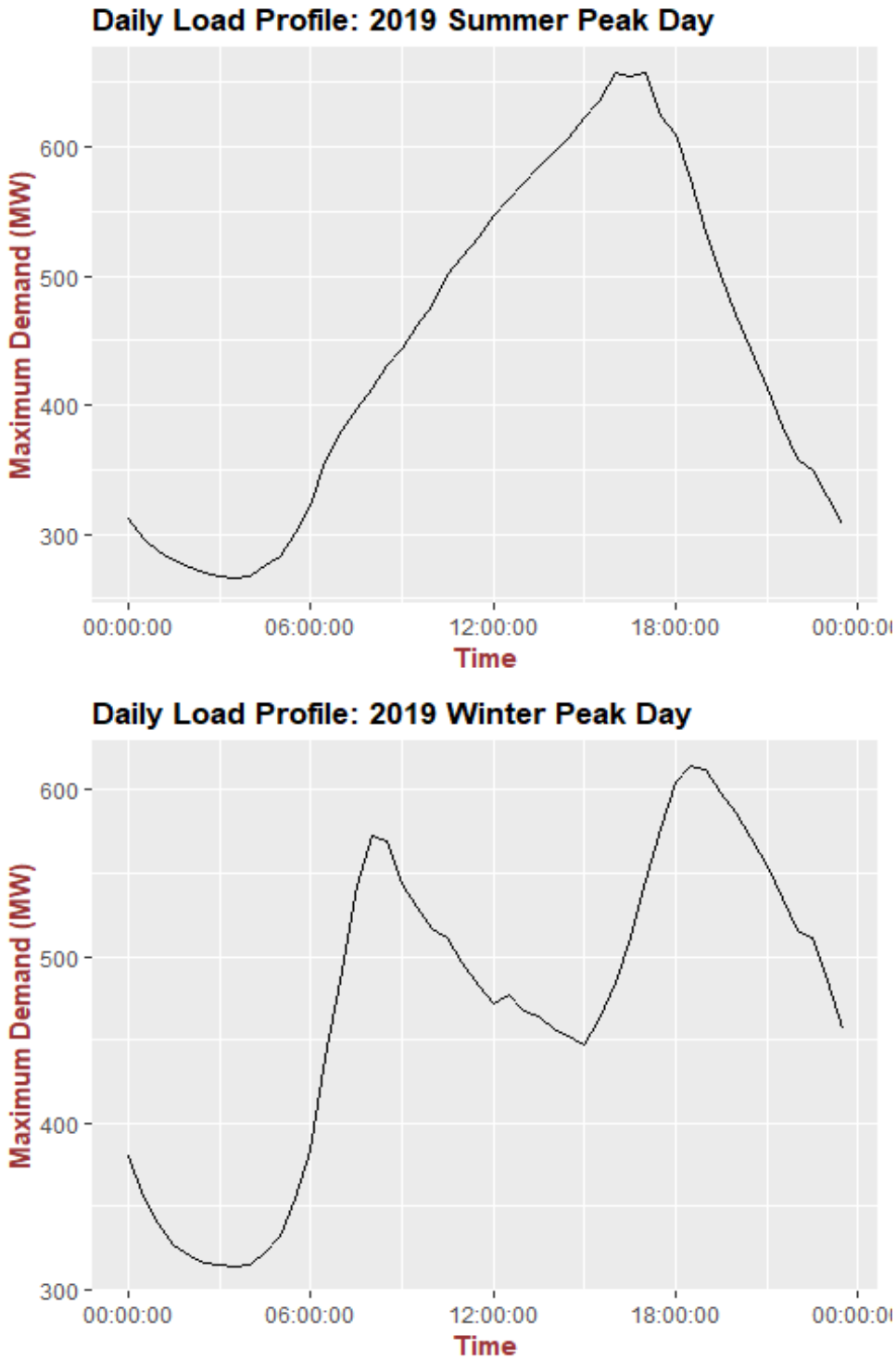
Key features of the historical demand over the past 10 years are as follows:

- Summer maximum demand is very weather dependent. For example summer 2012 and 2015 maximum demands fell below 500 MW due to mild weather conditions and summer 2019 maximum demand rose above 650 MW due to persistent widespread heat, exceptional heatwaves, and below-average rainfall.
- The weather corrected 50% PoE Summer maximum demand has been steady since 2007, despite a fast growing population in ACT. This is due to the increasing penetration of the rooftop solar generation initially supported by feed-in-tariffs and subsequently a larger scale generation.
- Winter maximum demand has been more stable than summer. Improvements in the energy efficiency of new buildings, space heating and household appliances have resulted in small growth only of winter maximum demand despite an increasing customer base.

- In the 2018-19 summer period, a new record system peak demand of 657 MW occurred at 5:00 pm on Thursday 17 January 2019 as the result of sustained heatwave conditions. The maximum summer temperature of 41.6° C was reached on 16 January 2019.
- In the 2019 winter period, the coldest day was 23 August 2019, whereas the peak winter demand occurred at 18:30 am on 9 August 2019 and was 614 MW.

The futures below show the daily demand curve for summer and winter days with distinctly different profiles for summer and winter.

**Figure 19.** 2019 summer and winter maximum demand day load profiles.



### 5.1.2 System summer and winter maximum demand forecast

Factors that influence load forecasts include climatic conditions, economic and demographic conditions, and emerging technologies such as solar PV generation, battery storage systems, electric vehicle charging, instantaneous hot water heating systems, energy efficiency schemes, and the trend away from gas to 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. Evoenergy's maximum and minimum demand forecasts for the ten year period 2020–29 are presented in Figure 20.

**System forecast**

The summer demand is very volatile and subject to weather conditions. However, the forecast summer demand trend is relatively flat with only small (around 2%) increase projected over the ten year period. Winter demand is projected to reduce slightly over the same period. Consequently, no new capacity limitations are expected at the system level.

**Figure 20.** 10-year summer and winter maximum demand forecast.

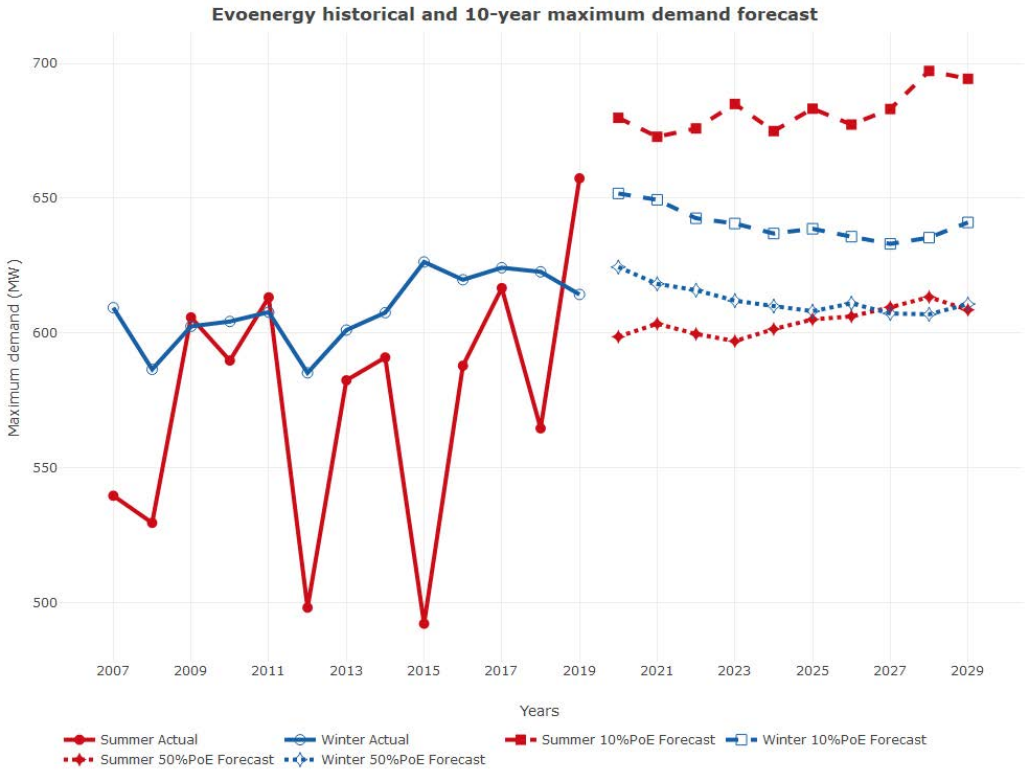



Table 5 provides summer and winter forecast demand (MW) numerical values for three probability of exceedance levels to complement Figure 20.

**Table 5.** 10-year Summer (S) and Winter (W) maximum demand (MW) forecast.

| | Summer | | | Winter | | |
|---|---|---|---|---|---|---|
| Year | POE90 | POE50 | POE10 | POE90 | POE50 | POE10 |
| **2020** | 532 | 599 | 680 | 598 | 625 | 652 |
| **2021** | 533 | 603 | 673 | 594 | 618 | 649 |
| **2022** | 527 | 600 | 676 | 592 | 616 | 643 |
| **2023** | 523 | 597 | 685 | 588 | 612 | 641 |
| **2024** | 531 | 602 | 675 | 584 | 610 | 637 |
| **2025** | 532 | 605 | 683 | 584 | 608 | 639 |
| **2026** | 536 | 606 | 677 | 588 | 611 | 636 |
| **2027** | 539 | 610 | 683 | 583 | 607 | 633 |
| **2028** | 542 | 613 | 697 | 581 | 607 | 635 |
| **2029** | 542 | 609 | 694 | 584 | 611 | 641 |

Some of the summer system demand forecast highlights are:

- Historically, the summer maximum demand has fluctuated significantly due to weather conditions. This is why the spread between 50%PoE and 10%PoE of summer forecasts are much wider than the winter forecasts in Figure 20.
- Summer maximum demand over the next five years is forecast to remain relatively flat, but it is likely to grow from 2025 onward driven by material increase uptake of EV. This increase may be further strengthened by the ACT Government energy policy choices in a lead up to the 2045 zero emission target.

## Summer demand components

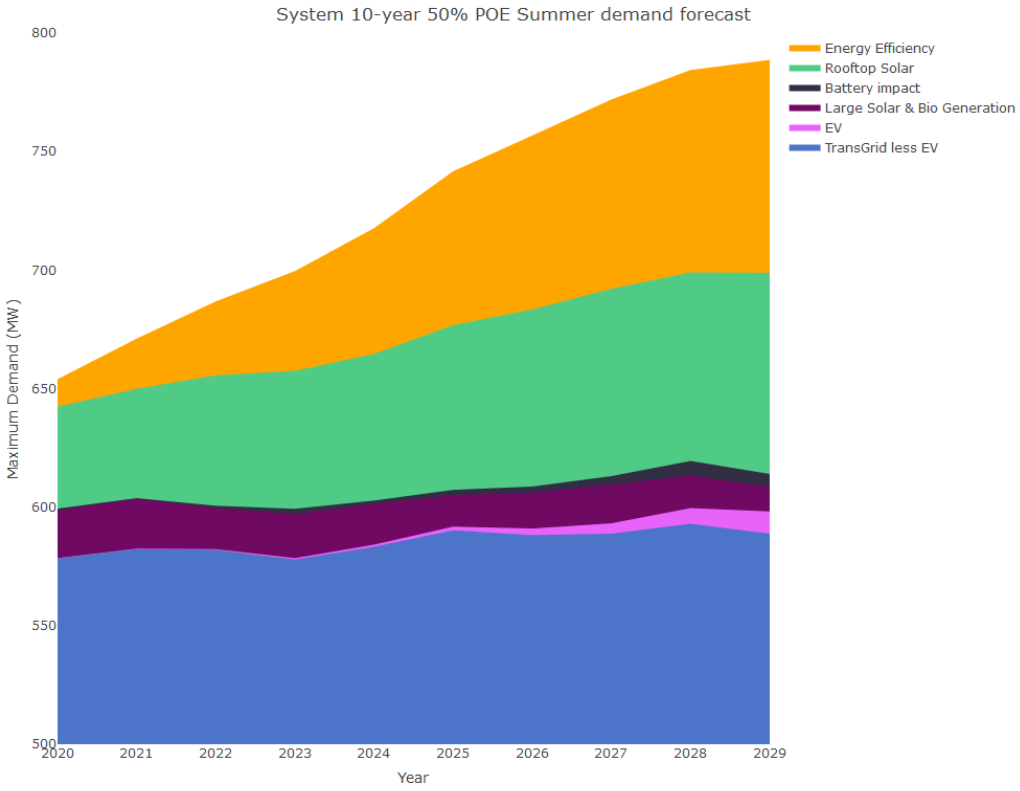
Figure 21 demonstrates the vertical analysis or the break-down of 50% PoE demand forecast. The figure shows the theoretical demand break down to various components. The figure is derived from AEMO forecast allotted to the ACT. The energy efficiency and rooftop PV are major contributors to reducing the summer maximum demand over the forecast period.

**Demand components**

Increasing proportion of underlying energy consumptions is projected to come from small scale behind the meter generation and embedded renewable generation. In the future, smaller proportion of demand is projected to come from the TransGrid network.

## Vertical analysis of 50% PoE summer maximum demand forecast.

**Figure 21.** Components of 50% PoE Winter maximum underlying demand forecast




Source: Derived for the ACT from AEMO projections.

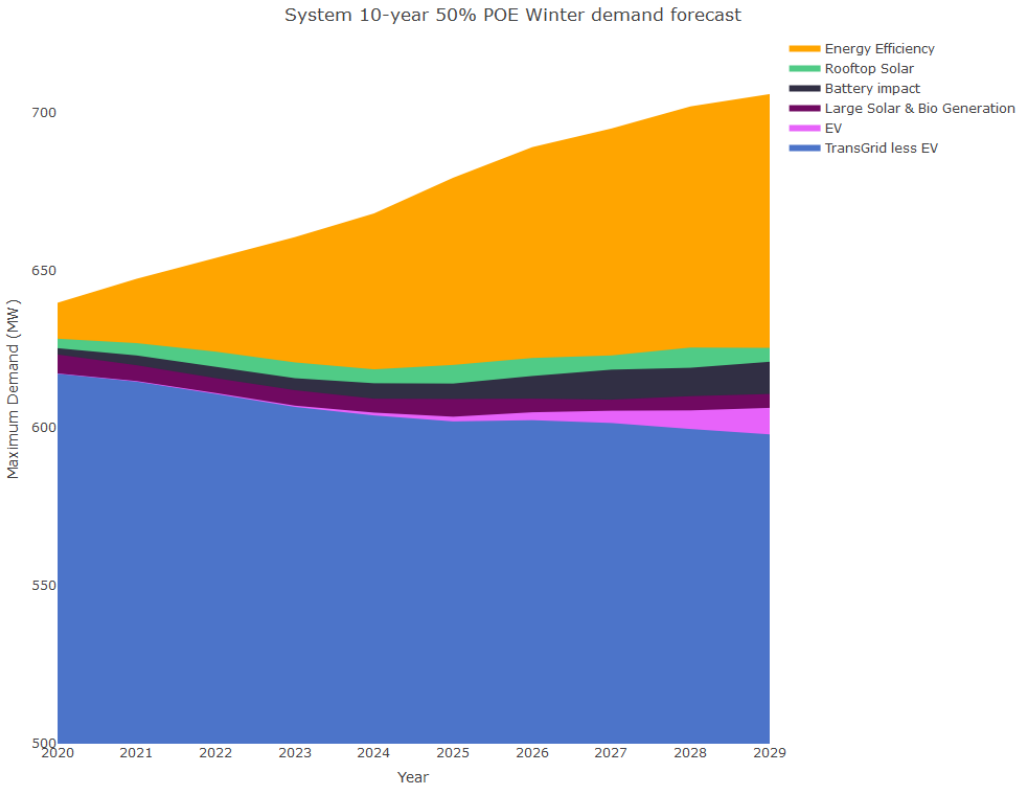
## Winter maximum demand forecast

Some of the winter system demand forecast highlights are:

- In the past, the winter maximum demand has been much more consistent and steady than summer demand. However, the winter demand has shown the sign of declining since 2015.
- Figure 22 shows the behind the meter battery storage has more impact on winter demand than summer demand. The impact is relatively small but slowly increasing.
- Winter maximum demand over the next five years is forecast to decline slightly mainly driven by forecast warmer climatic conditions and continuous improvement in energy efficiency.

Figure 22 shows projected slight reduction in the winter system demand.

**Figure 22.** Components of 50% PoE Winter maximum underlying demand forecast.




Source: Derived for the ACT from AEMO projections

### 5.1.3 System summer and winter minimum demand forecast

Figure 23 shows the projected minimum demand in the system over the ten year period. The forecast curves indicated forecasted minimum demand which needs to be satisfied from TransGrid's transmission network. Evoenergy is required to prepare the minimum forecast for grid stability assessment.

**Minimum demand**

Minimum demand in the system is forecasted to reduce sharply over the next decade, predominantly as the result of the significant growth in "behind the meter" distributed generation resources and solar embedded generation installations. The impact of solar generation on reduction of demand is much stronger in summer than in winter.

The total capacity of rooftop PV has grown by around 24% during 2018/19 financial year. Future Rooftop PV installations are projected to be double in the next decade.

Under some scenarios, during minimum demand periods, ACT will be exporting power to NSW in just over 10 years.

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.

**Figure 23.** 10-year summer and winter minimum demand forecast.

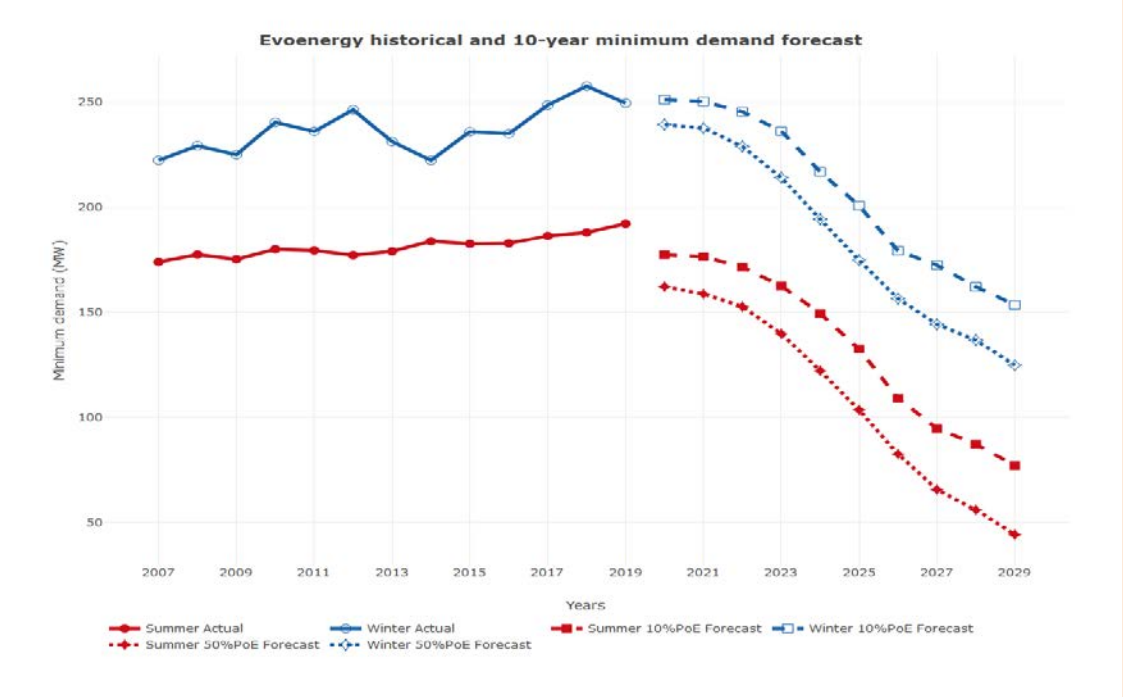



Table 6 provides minimum demand (MW) numerical values to complement the minimum forecast Figure 23. As it can be observed, the 90% probability of exceedance forecast approaches by 2029 zero (i.e. a cross over to the energy export to NSW). The cross over to below zero would indicate energy export to the NSW grid.

**Table 6.** 10-year Summer (S) and Winter (W) minimum demand forecast (MW).

| | Summer | | | Winter | | |
|---|---|---|---|---|---|---|
| **Year** | POE90 | POE50 | POE10 | POE90 | POE50 | POE10 |
| **2020** | 147 | 162 | 177 | 229 | 240 | 251 |
| **2021** | 140 | 159 | 177 | 224 | 238 | 250 |
| **2022** | 126 | 153 | 172 | 210 | 229 | 246 |
| **2023** | 113 | 140 | 163 | 192 | 214 | 236 |
| **2024** | 89 | 122 | 149 | 170 | 194 | 217 |
| **2025** | 67 | 104 | 133 | 151 | 175 | 201 |
| **2026** | 47 | 83 | 109 | 129 | 157 | 179 |
| **2027** | 33 | 66 | 95 | 116 | 144 | 173 |
| **2028** | 21 | 56 | 87 | 110 | 137 | 162 |
| **2029** | 13 | 44 | 77 | 98 | 125 | 154 |

## 5.2 Zone Substation Load Forecasts

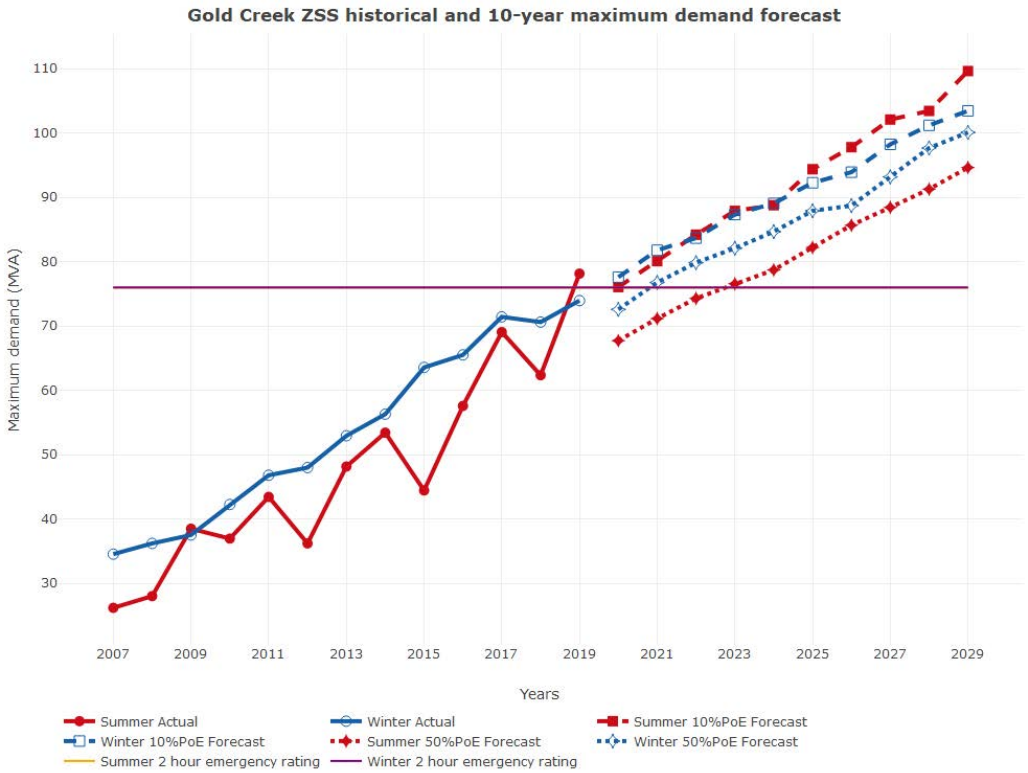
This section provides the highlights of the zone substation demand forecast. The figures below show summer and winter ten year forecast for selected zone substations shown against substation two hour emergency rating. Appendix E – contains the full set of forecast graphs and figures for zone substations.

### Gold Creek Substation

**Zone substation limitation**

In addition to the capacity limitations in newly developing areas Ginninderry and Molonglo Valley, we have identified one emerging limitation in existing zone substation capacity at Gold Creek Substation. Both summer and winter 50% PoE forecasts are expected to exceed the two hour emergency ratings within the 2019-24 regulatory period. Temporary installation of mobile zone substation, adding third transformer in Gold Creek Zone Substation, building new Mitchell Zone Substation or transfer of the load to Belconnen Zone Substation as well as non-network are among options being investigated to address this constraint.

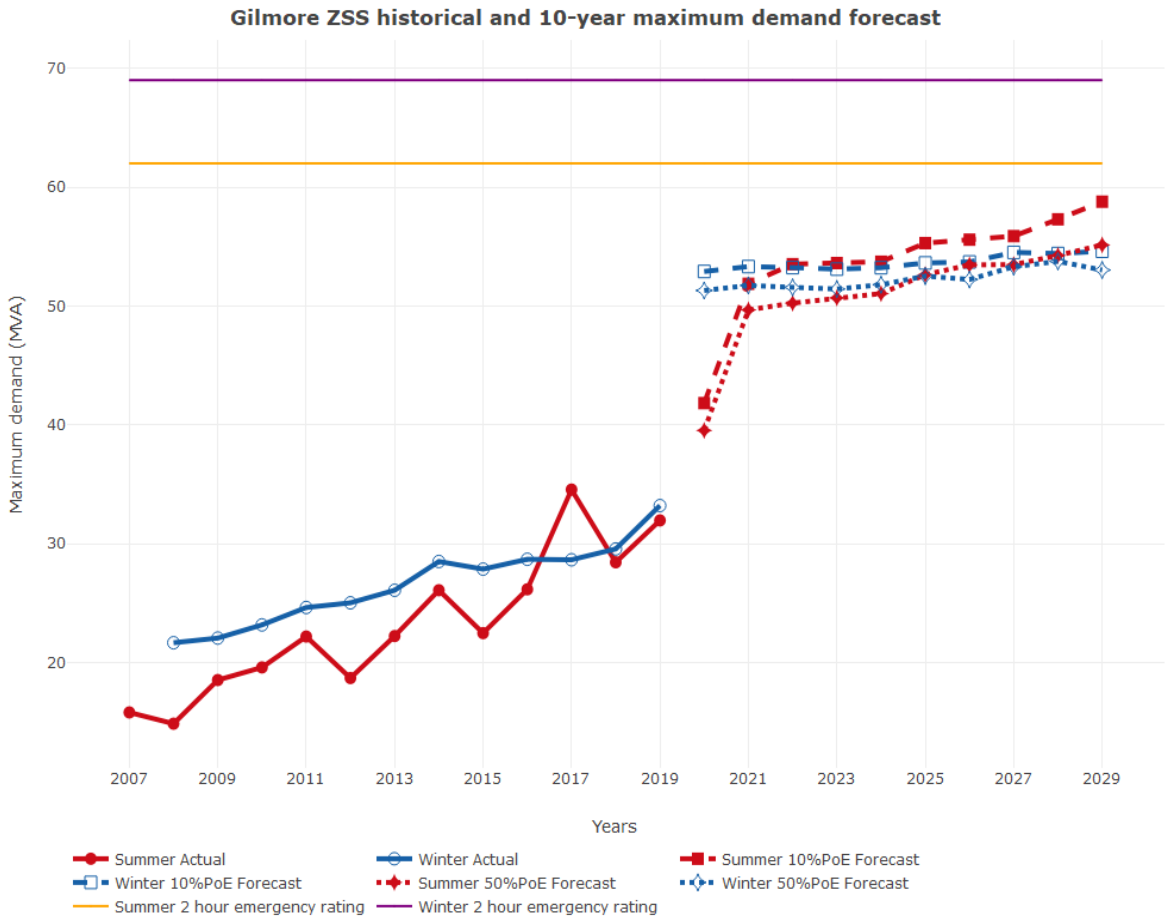
**Figure 24.** Gold Creek Substation 10-year forecast.



## Gilmore Substation

Gilmore Zone Substation (ZSS) forecast (Figure 25 is expected to have the biggest load growth (probability adjusted total of 16 MW) in the next 5 years due to the expansion of commercial load in the area, primarily the data centers. However, the projection is that the existing capacity can cater for that load increase.

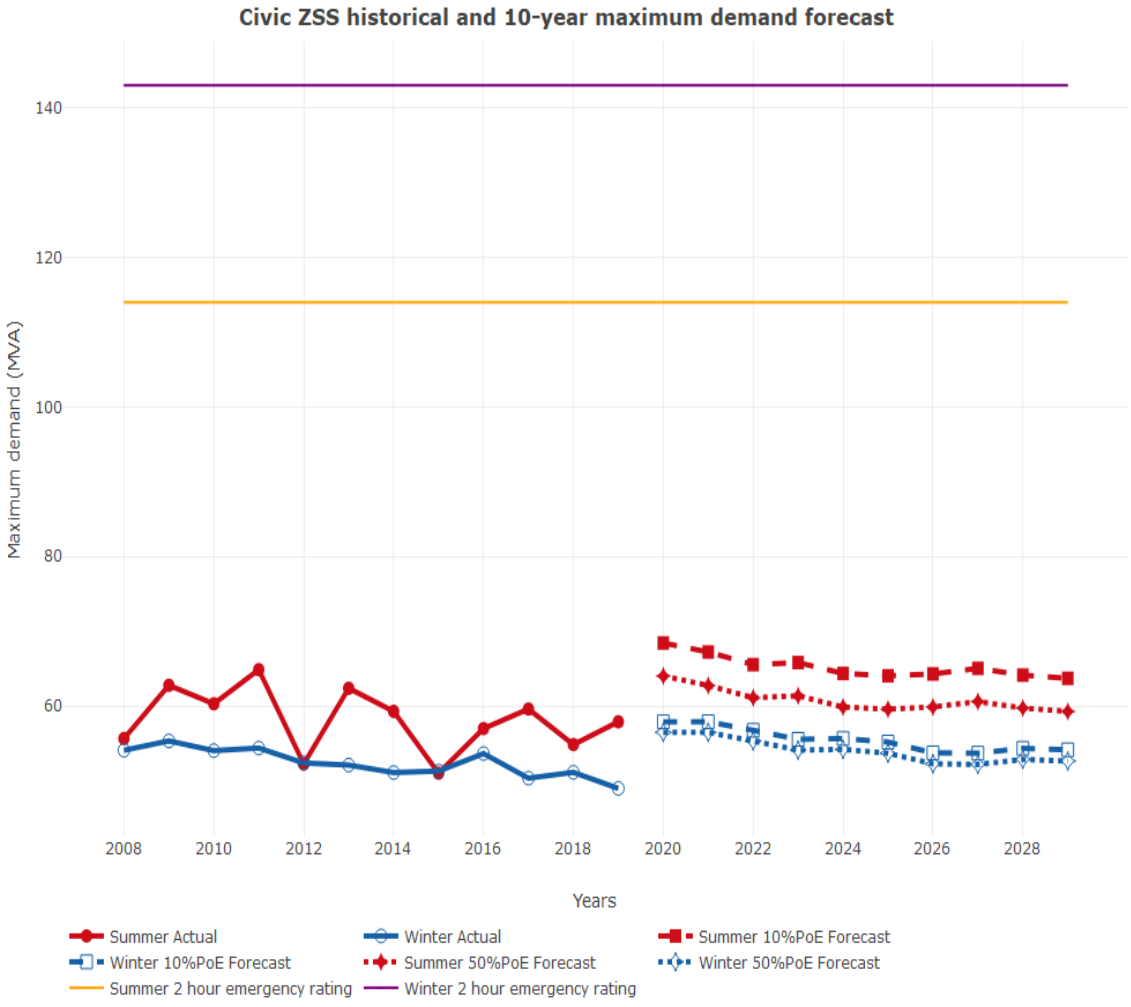
**Figure 25.** Gilmore Substation 10-year forecast



## Civic Substation

Civic Zone Substation (ZSS) has the second most significant projected load increase. The total of 11.5 MVA (probability adjusted) new load is projected to be connected within this regulatory period largely contributed by expansion of Australian National University and Canberra CBD.

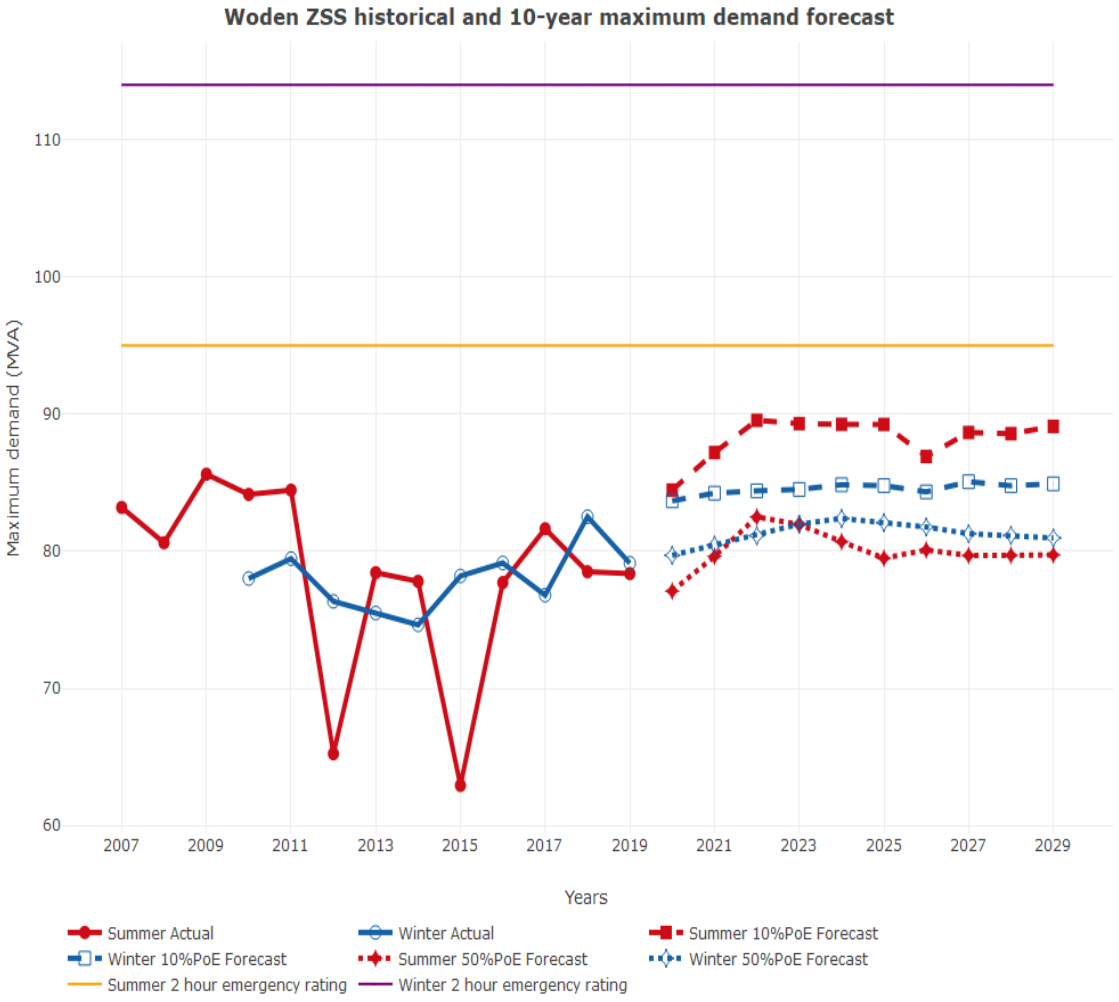
**Figure 26.** Civic Substation 10-year forecast.



## Woden Substation

The residential load growth pressure from Molonglo Valley development has been relieved for Woden Zone Substation after significant load transfer from Woden to Wanniassa ZSS in early 2019. The load growth in the Molonglo Valley residential developments are expected to be catered for by a construction of Molonglo Substation. However, all options will be considered as part of the RIT process. Thus, the projected demand for Woden Substation shows only a small increase over the ten year period.

**Figure 27.** Woden Substation 10-year forecast.




Appendix E –provides the detailed zone substation load forecast results and graphs.

## 5.3 Load Transfer Capability

Table 7 shows the load transfer capability (MW) between Evoenergy's zone substations. Transfer capability is calculated based on spare capacity of zone substation transformers and spare capacity of interconnecting 11 kV feeders between substations.

**Table 7.** Load Transfer Capability (MW) between Evoenergy's Zone Substations

| | Zone Substation | To | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Belconnen | City East | Civic | East Lake | Fyshwick | Gilmore | Gold Creek | Latham | Telopea Park | Tennent | Theodore | Wanniassa | Woden |
| From | Belconnen | | 4.9 | 6.1 | | | | | 11.6 | | | | | |
| | City East | | | 17.3 | 0.1 | | | | | 11.6 | | | | |
| | Civic | 5.4 | 16.6 | | | | | | 0.7 | 2.0 | | | | 1.9 |
| | East Lake | | 0.6 | | | | | | | 5.8 | | | | |
| | Fyshwick | | 0.2 | | 10.0 | | 3.6 | | | 0.2 | | | | |
| | Gilmore | | | | | | | | | 0.2 | | 6.4 | 19.0 | |
| | Gold Creek | 2.0 | | 2.6 | | | | | 2.1 | | | | | |
| | Latham | 6.1 | | 5.9 | | | | | | | | | | |
| | Telopea Park | | 14.9 | 2.2 | 0.8 | | 5.1 | | | | | | 7.1 | 16.0 |
| | Tennent | | | | | | | | | | | | | |
| | Theodore | | | | | | 6.6 | | | | | | 5.7 | |
| | Wanniassa | | | | | | 23.9 | | | 0.7 | | 10.3 | | 16.6 |
| | Woden | | | 3.3 | | | | | | 4.3 | | | 19.0 | |

# Chapter 6 Managing existing assets

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

Risk management is integrated with Evoenergy's asset management decisions. The asset retirement and maintenance decisions manage risk based on health, age and criticality of assets. Whenever practicable, the life asset costs including maintenance are considered to optimise the timing of asset renewal/replacement. Risk Centred Maintenance (RCM) philosophy underpins out maintenance regime. Two dominant risk categories is terms of assessed value of risk is reliability and safety.

Furthermore, asset retirement or renewal decisions are coordinated with network development plans to identify possible savings. Asset renewal decisions are also supporting 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 –provides more details on the Evoenergy asset management methodology and philosophy including policy, strategy and plans.

## 6.1 Network primary assets

### 6.1.1 Existing assets - what are the main investment drivers?

Network assets are being continually monitored and asset management plan reviewed as new information becomes available in relation to asset condition, performance or failure rates. The assets are being maintained, inspected, tested and monitored to mitigate and to identify existing and emerging asset needs. The data is analysed in the development of asset specific plans.

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

- Continuing focus on the aging network assets particularly to identify increased risk of failure of critical assets
- The risk profile of some 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. capstan links, earthing) , the dominant risk driver is safety of people or property

### 6.1.2 Asset Specific Plans

Evoenergy prepares Asset Specific Plans (ASP) in alignment with the asset management policy, strategy and objectives. Our ASPs manage groups of assets and are grouped by asset type, For example, Evoenergy's Distribution Poles ASP summarises our strategy and plan to coordinate asset management for our distribution pole fleet.

To maximise value for customers from our assets over the entire asset lifecycle, our ASPs 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 requires and monitoring to meet the asset management objectives.
- **Asset Failure Modes** – applies Risk Centred Maintenance (RCM) to our assets assessing how assets can fail, the likelihood and consequences of failing to forecast the risk of our assets.
- **Asset Class Strategy** – outlines the optimal asset class lifecycle strategy and alternative options considered.
- **Asset Health and Expenditure** – forecast expenditure (CAPEX and OPEX) for the optimal asset class lifecycle strategy and future health of our assets.

Evoenergy's assets are managed by the ASPs listed in Table 8.

**Table 8.** Asset Specific Plans (ASP)

| Asset Specific Plan (ASP) | Asset Group(s) | Asset Qty | Average Age |
|---|---|---|---|
| **Distribution Overhead Network** | | | |
| **Poles** | **Total** | **49,315** | **37** |
| | Concrete Pole | 11,350 | 22 |
| | Fibreglass Pole | 3,925 | 18 |
| | Timber Pole | 27,753 | 46 |
| | Steel Pole | 5,930 | 34 |
| | Stobie Pole | 357 | 72 |
| **Pole Substations** | **Total** | **1,396** | **34** |
| | Pole Substation | 1,396 | 34 |
| **Overhead Lines and Pole Hardware** | **Total** | **22,540** | **50** |
| | Overhead HV Conductors | 6,354 | 48 |
| | Overhead LV Conductors | 16,186 | 51 |
| **Overhead Switchgear & Automation** | **Total** | **7,916** | **62** |
| | Gas Switch | 111 | 14 |
| | HV Link | 1,531 | 49 |
| | Surge Diverter | 2,694 | 4 |
| | Fault Passage Indicator | 397 | 5 |
| | Drop-out Fuse | 1,609 | 108 |
| | Auto-Recloser | 38 | 18 |
| | Air Break Switch | 1,530 | 47 |
| | Load Break Switch | 6 | 40 |
| **Overhead Service Conductors** | **Total** | **59,368** | **14** |
| | Overhead Service Cable | 59,368 | 14 |
| **Distribution Underground Network** | | | |
| **Distribution LV Switchboard Assembly** | **Total** | **4,725** | **29** |
| | LV Circuit Breaker | 1,127 | 50 |
| | LV Switchboard | 3,598 | 26 |
| **Underground LV Cables** | **Total** | **103,461** | **29** |
| | Underground Service Cable | 77,201 | 29 |
| | Underground LV Cable | 26,260 | 29 |

| Asset Specific Plan (ASP) | Asset Group(s) | Asset Qty | Average Age |
|---|---|---|---|
| **LV Pillars** | **Total** | **18,697** | **25** |
| | LV Pillar | 15,385 | 24 |
| | Point of Entry Cubicle | 3,312 | 29 |
| **Earthing** | **Total** | **12,645** | **34** |
| | Substation Earth | 6,916 | 30 |
| | Overhead Asset Earth | 5,729 | 39 |
| **Distribution Substation/Switching Station Sites** | **Total** | **3,317** | **27** |
| | Padmount Substation | 2,479 | 26 |
| | HV Switching Station | 350 | 33 |
| | Chamber Substation | 482 | 27 |
| | Stockade Substation | 6 | 38 |
| **Distribution HV Switchboard Assembly** | **Total** | **657** | **16** |
| | HV Circuit Breaker | 459 | 15 |
| | HV Switchboard | 198 | 21 |
| **Ground Mounted Transformers** | **Total** | **3,826** | **26** |
| | Ground Transformer | 3,826 | 26 |
| **Underground HV Cables** | **Total** | **17,785** | **44** |
| | Underground HV Cable | 17,543 | 44 |
| | Underground HV Feeder | 242 | 44 |
| **Ring Main Units** | **Total** | **3,784** | **44** |
| | Ring Main Unit | 3,784 | 44 |
| **LV Pits** | **Total** | **400** | **10** |
| | LV Underground Pit | 400 | 10 |
| **Earthing Distribution** | **Total** | **16** | **28** |
| | Earth Mats | 16 | 28 |
| **Zone Substations** | | | |
| **132kV & 66kV Air Insulated Switchgear** | **Total** | **630** | **26** |
| | 132kV & 66kV Circuit Breakers | 67 | 26 |
| | 132kV & 66kV Current Transformers | 282 | 17 |
| | 132kV & 66kV Isolators | 149 | 37 |
| | 132kV & 66kV Voltage Transformers | 89 | 28 |
| | 132kV & 66kV Earth Switches | 37 | 35 |
| | 132kV Surge Diverters | 6 | 42 |
| **Zone 11kV Switchboard Assembly** | **Total** | **444** | **31** |
| | 11kV Oil Circuit Breakers | 125 | 42 |
| | 11kV Vacuum Circuit Breakers | 231 | 23 |
| | 11kV Earth/Test Trucks | 58 | 34 |
| | 11kV Switchboards | 30 | 30 |

| Asset Specific Plan (ASP) | Asset Group(s) | Asset Qty | Average Age |
|---|---|---|---|
| **Power Transformer Assembly** | **Total** | **155** | **28** |
| | Power Transformers | 32 | 33 |
| | Power Transformer 132kV & 66kV Bushings | 93 | 24 |
| | Online Tap Changers | 30 | 35 |
| **Other Transformers** | **Total** | **51** | **38** |
| | Auxiliary Transformers | 23 | 36 |
| | Neutral Earthing Transformers | 28 | 39 |
| **Gas Insulated & Mixed Technology Switchgear (GIS & MTS)** | **Total** | **105** | **4** |
| | 132kV GIS/MTS Voltage Transformers | 30 | 2 |
| | 132kV GIS/MTS Earth Switches | 43 | 4 |
| | 132kV GIS/MTS Circuit Breakers | 11 | 6 |
| | 132kV GIS/MTS Isolators | 18 | 6 |
| | 132kV GIS/MTS Current Transformers | 3 | 6 |
| **Backup Generator Auxiliary** | **Total** | **28** | **11** |
| | Generator Auxiliary | 14 | 11 |
| | Automatic Transfer Switches | 14 | 11 |
| **Transmission Network** | | | |
| **Overhead Transmission Lines** | **Total** | **1923** | **33** |
| | Concrete Pole | 851 | 26 |
| | Timber Pole | 425 | 43 |
| | Overhead conductors | 446 | 34 |
| | Steel Tower | 201 | 43 |
| **Underground Transmission Lines** | **Total** | **5** | **12** |
| | Underground cables | 5 | 12 |

### 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. No major asset replacements were undertaken during the period.

Table 9 provides a summary of Evoenergy's asset replacement completed during the last year.

**Table 9.** Completed asset replacement program

| Asset Specific Plan (ASP) | Task | Number of Replacements |
|---|---|---|
| **Distribution Overhead Network** | | |
| **OH Switchgear and Automation** | Replace Overhead Gas Switch | 10 |
| | Replace Surge Diverter | 43 |
| **Poles** | Replace Pole | 335 |
| **Pole Substations** | Replace Single Pole Substation | 4 |
| | Replace Two Pole Substation | 2 |
| **Distribution Underground Network** | | |
| **Distribution Substations / Switching Station Sites** | Replace Padmount | 3 |
| **LV Pillars** | Replace Pillar | 54 |
| **Underground LV Cables** | Replace LV Pothead | 29 |
| | Replace Service Pothead | 31 |

### 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.

## Retirements of major assets

Table 10 below summarises review outcomes which relate to transmission and distribution with the value above $200 000 (NER, schedule 5.8(b2) refers). Evoenergy ASPs apply the ten year planning horizon for the 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 10.** Identified retirements of major assets

| Area | Network Element | Primary Driver | RIT-D | Estimated Cost | Consult | Decision | Date Required |
|---|---|---|---|---|---|---|---|
| **Latham Zone Substation** | Substation Switchboard | Asset condition & performance | No | $3.1m | Dec 2022 | June 2023 | June 2024 |
| **Wanniassa** | Distribution Line Underground Cable | Asset condition & performance | No | $4.3m | Dec 2022 | June 2023 | June 2024 |

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.

## Latham Zone Substation Switchboard

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

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

Two options have been considered to manage risk associated to the 11kV indoor switchgear at Latham zone substation;

Option 1 – Do nothing

Option 2 – Replace 11kV switchgear

The preferred technical and economic option is option 2, replace 1 x 11kV switchboard at Latham Zone Substation with modern equivalent at an estimated cost of $3.1million. This replacement is planned in 2024 however maintenance programs continues to monitor this assets condition to enabling Evoenergy to manage this risk.

## Wanniassa Distribution Line Underground Cable

An 11kV underground feeder from Wanniassa zone substation supplies over 1,200 customers in the Tuggeranong district. This feeder was installed in 1976 and has experienced several failures and its failure rate is increasing.

The 11kV underground feeder is comprised of PILC and XLPE cable continuing to deteriorate in condition, resulting in more frequent failures and outages for customers. As the failure rate increases, customers experience more frequent unplanned outages an Evoenergy's network performance is affected.

Two options have been considered to manage the network reliability risk associated with an 11kV underground feeder from Wanniassa zone substation;

Option 1 – Do nothing

Option 2 – Replace 11kV underground cable

The preferred technical and economic option is option 2, replace 11kV underground cable from Wanniassa zone substation at an estimated cost of $4.3 million. This replacement is planned in 2024 however maintenance programs continues to monitor this assets condition to enabling Evoenergy to manage this risk.

## Grouped asset retirement plan

This section describes our grouped asset retirement plans. These plans include groups of asset retirements of the same type and 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 decommissioning distribution substations 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 2019-24 regulatory determination is shown in Table 11. Sections 6.1.5, 6.1.6 and 6.1.7 provide further commentary on respective programs.

**Table 11.** Identified group asset retirements

| Asset Specific Plan (ASP) | Estimated Quantity and Cost in 2017-18 dollars | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | | 2020 | | 2021 | | 2022 | | 2023 | | Total | |
| | Qty | $Million | Qty | $Million | Qty | $Million | Qty | $Million | Qty | $Million | Qty | $Million |
| **Distribution Overhead Network** | | | | | | | | | | | | |
| Overhead Lines and Pole Hardware | 390 | $1.21 | 390 | $1.21 | 390 | $1.21 | 390 | $1.21 | 390 | $1.21 | 1950 | $6.07 |
| OH Switchgear & Automation | 13 | $0.23 | 13 | $0.23 | 13 | $0.23 | 13 | $0.23 | 13 | $0.23 | 65 | $1.16 |
| Pole Substations | 9 | $0.52 | 8 | $0.47 | 8 | $0.47 | 8 | $0.47 | 9 | $0.52 | 42 | $2.44 |
| Poles | 462 | $4.78 | 442 | $4.58 | 452 | $4.68 | 462 | $4.78 | 482 | $4.99 | 2300 | $23.81 |
| **Distribution Underground Network** | | | | | | | | | | | | |
| Distribution HV Switchboard Assembly | 2 | $0.40 | 2 | $0.40 | 2 | $0.40 | 2 | $0.40 | 2 | $0.40 | 10 | $2.01 |
| Distribution LV Switchboard Assembly | 5 | $0.68 | 5 | $0.68 | 5 | $0.68 | 5 | $0.68 | 1 | $0.14 | 21 | $2.84 |
| Distribution Substation/ Switching Station Sites | 5 | $0.47 | 5 | $0.47 | 5 | $0.47 | 5 | $0.47 | 5 | $0.47 | 25 | $2.34 |
| LV Pillars | 40 | $0.23 | 40 | $0.23 | 40 | $0.23 | 40 | $0.23 | 40 | $0.23 | 200 | $1.14 |
| UG LV Cables | 1 | $0.25 | 1 | $0.25 | 1 | $0.25 | 1 | $0.25 | 1 | $0.25 | 5 | $1.24 |
| **Transmission Network** | | | | | | | | | | | | |
| Transmission Structures | 5 | $0.10 | 5 | $0.10 | 6 | $0.10 | 6 | $0.10 | 6 | $0.10 | 28 | $0.52 |

### 6.1.5 Distribution Overhead Network

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

## Overhead Lines and Pole Hardware

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

## 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 out, or damage caused by lighting, wind or vegetation.

### Pole Substations

Pole substations are replaced when the reach to their end-of-serviceable life. Replacement drivers include poor condition or the supporting pole, pole top, defective transformer (such as oil leaks). This program includes replacement if 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.

### Poles

The distribution poles replacement program is a risk based replacement or refurbishment program. This is Evoenergy's largest cost asset replacement 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

### Distribution HV Switchboard Assembly

This program replaces HV switchgear in distribution substations and switching stations. Replacement is driven by network reliability and safety risk. Currently this program replaces Reyrolle and Yorksire switchgears which are in poor condition and not supported by manufactures for spare parts and are the highest risk switchgear in this class.

### Distribution LV Switchboard Assembly

Distribution LV switchboard assembly includes LV switchboard and LV circuit breakers in distribution substations. The driver for this replacement program is predominantly safety risk. This replacement program currently focus on replacing Capstan Link LV Switchboards. This type switchboard was installed in Evoenergys network up to 1975 and are of very basic design with exposed live equipment on all sides. As well as exposure to live equipment, during switching it is possible to create a short circuit resulting in a flashover and may cause serious injury or death to personnel. The Capstan Link switchboard replacement program also prioritises replacement with LV CB's containing asbestos material.

### Distribution Substation/Switching Station Sites

The distribution substation and switching station replacement program includes ground mounted substation and switching station replacement and is driven by asset condition and risk. Substations selected for replacement have high risk HV or LV switchgear or defective transformers.

### LV Pillars

The LV pillar replacement program replaces aged pillars in poor condition and assets shared with Canberra and City Services (TCCS). The shared asset arrangement comes from some LV pillars being contained within streetlight columns and are referred to as "Pregnant Columns".

### Underground LV Cables

The underground LV cables replacement program replaces a type of LV mains cable to manage reliability and safety risk. This type of cable is referred to as LV CONSAC cable and Evoenergy is experiencing high failure rates causing outages to customers. This cable has also been

associated to the loss of neutral connection from high degradation of the neutral conductor presenting safety risk for the public.

### 6.1.7 Transmission Network

The transmission 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

Schedule 5.8 (b1) and (b2) requires Evoenergy to report on asset retirements and de-ratings. Table 10 summarises identified retirement of assets above $200 000. Table 11 identifies programs for grouped small asset renewals and replacements.

During the last year Evoenergy did not de-rate any distribution or transmission 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 TCCS to Evoenergy, and the responsibility for inspections of privately owned electrical infrastructure outside the network boundary 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 is also trialling the deployment of intelligent switching as an alternative to traditional reclosers to reduce the potential for bushfires resulting from recloser action.

## 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 enable network operation, control of switching, monitoring and data acquisition.
- Telecommunication system which supports network protection, SCADA, telephony, video and corporate data services
- Protection systems which enable fault clearing and isolation, protection of network equipment and enhance safety of operations.
- Consumer metering which is employed to measure consumer consumption for billing purposes

This section provides information on the current challenges, main secondary system projects progressed or completed over the last year and 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, assessing operational risks, compliance requirements and future network needs. Compliance requirements are derived from NER, technical codes and Australian standards.

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

- Compliance with the NER requirements in relation to the fault clearance times and duplicate systems for transmission assets
- Concerns in relation to reliability of some of the existing protection assets in zone substations
- Continuing need for testing and replacement ( by external metering providers) of the existing revenue meter fleet
- The need to replace old damaged and failing pilot cables used for 11kV feeder unit protection and SCADA communications.
- The need for the increased speed, capacity, and reach of the telecommunication system to support our operations
- Protecting secondary assets from cyber security threats

### 6.2.2 What we have achieved in the last year

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

- Upgrade of 11kV feeder protection relays at Gold Creek ZSS.
- Replacement of SCADA remote terminal units at Gold Creek
- Replacement and upgrade of 132kV transmission line protection at City East ZSS and Gold Creek ZSS.
- Installation of OPGW between Transgrid's Canberra Substation and Woden.
- Installation of Under Frequency Load Shedding Systems at Woden and Wanniassa.
- Testing of around 900 revenue meters

### 6.2.3 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 ASPs and Project Justification Reports . Chapter 3 provides more details on the Evoenergy Asset Management approach. Appendix H – includes additional description of the network technical parameters and systems.

Table 12 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 12.** Secondary system projects

| Constraint/Need | System | Timeframe | Driver |
|---|---|---|---|
| **Installation of Optical Fibre between Gold Creek Z/S and S9109 Civic.** | Communications | 2019-2020 | NER compliance<br>Safety<br>Reliability |
| **Upgrade of 132kV transmission line protection at Woden Z/S, Telopea Park Z/S and Latham Z/S** | Protection | 2019-2020 | NER compliance<br>Safety<br>Reliability |
| **Installation of Under Frequency Load Shedding Systems at City East, Belconnen, Eastlake and Civic Z/Ss.** | Protection | 2019-2021 | NER compliance<br>Reliability |
| **Upgrade of 11kV feeder protection and SCADA at Belconnen Z/S** | Protection, SCADA | 2019-2021 | Safety<br>Reliability |
| **Upgrade of 132kV transmission line protection at Belconnen Z/S** | Protection | 2020-2021 | NER compliance<br>Safety<br>Reliability |
| **Upgrade of 11kV feeder protection at Telopea Park Z/S** | Protection | 2021-2023 | Safety<br>Reliability |
| **Upgrade of power transformer protection at Woden, Belconnen and Telopea Park Z/S** | Protection | 2021-2024 | Safety<br>Reliability |
| **Upgrade of 11kV feeder protection at City East Z/S** | Protection | 2023-2024 | Safety<br>Reliability |
| **Upgrade of 132kV transmission line protection at Gilmore and Theodore Z/S** | Protection | 2022-2023 | NER compliance<br>Safety<br>Reliability |
| **Secondary Systems Cyber Security Program** | Protection, SCADA | 2020-2023 | Safety<br>Reliability |
| **Upgrade of Zone Substation HMIs** | SCADA | 2020-2024 | Safety<br>Reliability |

The above list is based on the ASPs for the secondary systems. In addition to the above projects, Evoenergy runs group programs groups of smaller assets such as consumer metering managed in accordance with metering asset management plan required by NER (section 6.2.8).

### 6.2.4 SCADA

SCADA is a key component of the overall electricity network and is the source of field data and control for the ADMS and other operational systems. Zone substations and controllable distribution assets are critical elements of the electricity network and SCADA has traditionally been applied to these areas. SCADA is increasingly being called on to provide additional data for monitoring, control and asset condition monitoring.

Evoenergy's 2020-25 protection renewal program includes the following:

- Renew and upgrade SCADA RTU and HMI at Belconnen Z/S is programmed in 2020
- Renewal of SCADA RTUs and HMIs at Latham Z/S, Woden Z/S, Telopea Park Z/S and Wanniassa Z/S are programmed to be upgraded over the 2021-25 period in conjunction with planned protection relay replacement projects.

### 6.2.5 Protection

Protection assets are located in Evoenergy zone substations, switching stations and distribution substations, and are used to isolate faulty electrical equipment within the substations and connected transmission 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 any potential damage to network infrastructure.

Evoenergy has identified the need to replace a number of failing poor condition protection relays that have reached end-of-life. These relays are integral to the safe and secure performance of the network.

While asset condition remains 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 2020-25 protection renewal program includes the following:

- Upgrade protection and install 132kV line differential protection using the new OPGW network (Latham Z/S, Wanniassa Z/S, Woden Z/S, Belconnen Z/S).
- Replace poor condition 11kV feeder protection (Woden Z/S, Belconnen Z/S and Telopea Park Z/S, City East Z/S)
- Replace poor condition transformer protection (Woden Z/S, Belconnen Z/S and Telopea Park Z/S, City East Z/S)

### 6.2.6 Telecommunication Systems

Evoenergy's telecommunications system 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. The telecommunications network also supports corporate WAN, *VoIP (Voice over Internet Protocol*) telephony, engineering LAN, CCTV monitoring and access control to sites.

### 6.2.7 Planned telecommunications projects – fibre optic network:

Evoenergy has a program to install Optical Ground Wire (OPGW) within our network to replace aged communications bearers such as radio. This involves replacing the existing overhead earth wire on 132 kV transmission lines with hybrid OPGW cables to provide an optical fibre communications capability to meet the following regulatory and business requirements:

- Upgrading our 132 kV transmission line protection systems to meet current NER network performance standards, ensuring regulatory compliance and safety for the community. Currently some 132 kV transmission line protection systems within the Evoenergy transmission network are non-compliant with the required fault clearance times under the NER and need to be upgraded.

- Providing a secure SCADA communication network enabling the Control Centre to monitor and operate zone substations in the Evoenergy network.
- Providing inter control centre SCADA communications and communications to the TransGrid and AEMO control centres, required by our role as a Transmission Network Service Provider (TNSP) in the national grid.
- Providing communications for security monitoring of substations and other operational communication services.

## Communications Wide Area Network Deployment:

Evoenergy has a program to roll out a Multiprotocol Label Switching (MPLS) based Wide Area Network (WAN) to corporate office and zone substation locations. The WAN utilises the fibre optic and microwave links. This will deliver the business requirement for a secure SCADA communication network for the effective operation of the electrical network. In addition the network provides network protection, substation VoIP telephones, security systems and corporate data access.

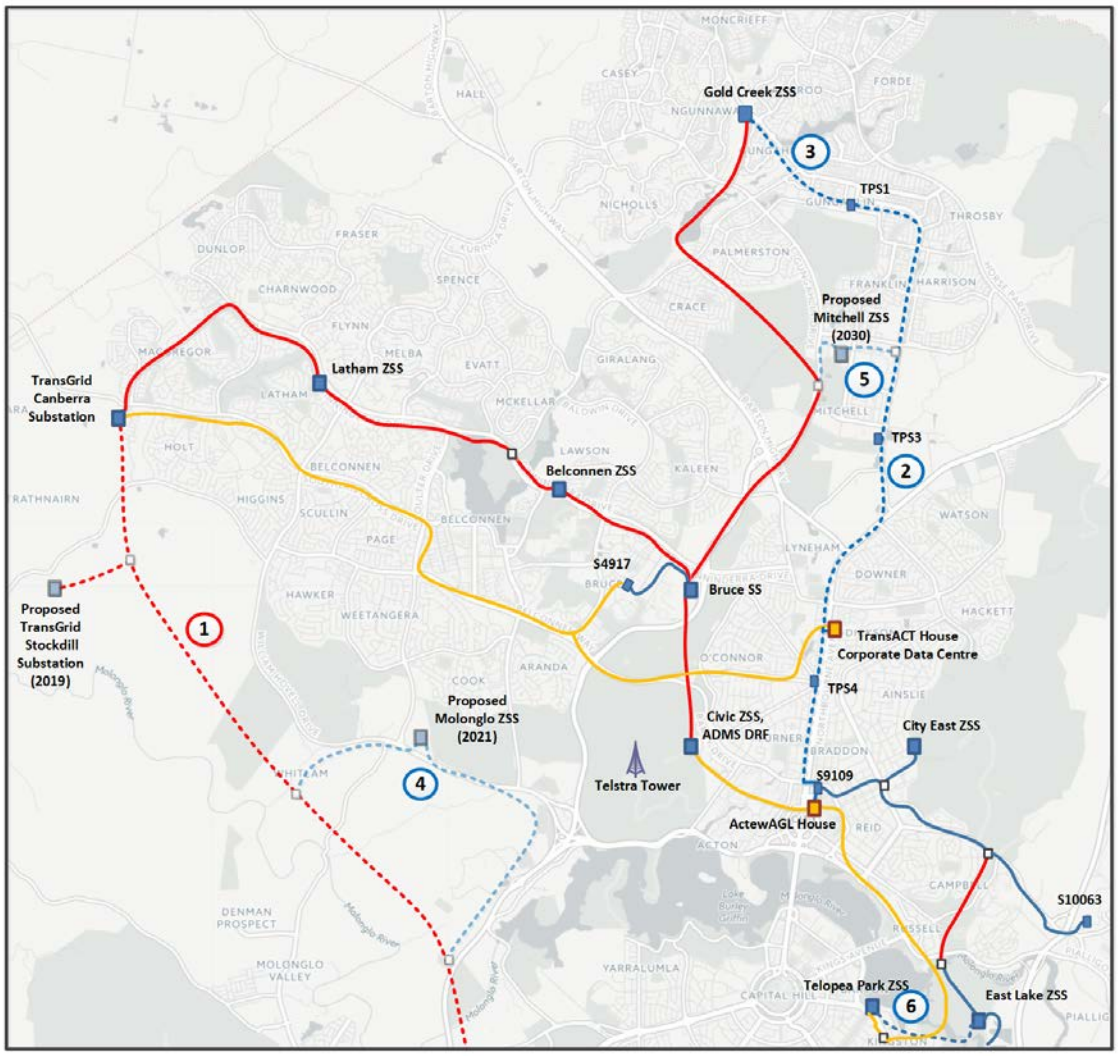
The MPLS telecommunications upgrade program provides communications to all zone substations in the Evoenergy transmission network and was completed in 2019.

## Other telecommunications upgrade programs include:

- Replacement of aging copper pilot cables with Optical Fibre cables. Pilot cables are used for 11 kV feeder protection and SCADA communications. This is necessary for providing safety and reliability in the 11 kV network.
- Progressive replacement of radio equipment in the SCADA Digital Data Radio Network (DDRN). This program will replace SCADA data radios as they reach the end of their serviceable life.

Figure 28 and Figure 29 depict the proposed communications network program.

**Figure 28.** Fibre Optic Network – Northern ACT




**Legend**

- Existing OPGW
- Proposed OPGW
- Existing underground optical fibre
- Proposed underground optical fibre
- Existing leased fibre
- External splice point
- Zone Substation
- Chamber Substation
- Office or Data Centre
- Radio communications site

**Current OPGW Projects**

1. Proposed TransGrid Stockdill Substation (2020)
   OPGW TransGrid Canberra to Stockdill to Woden

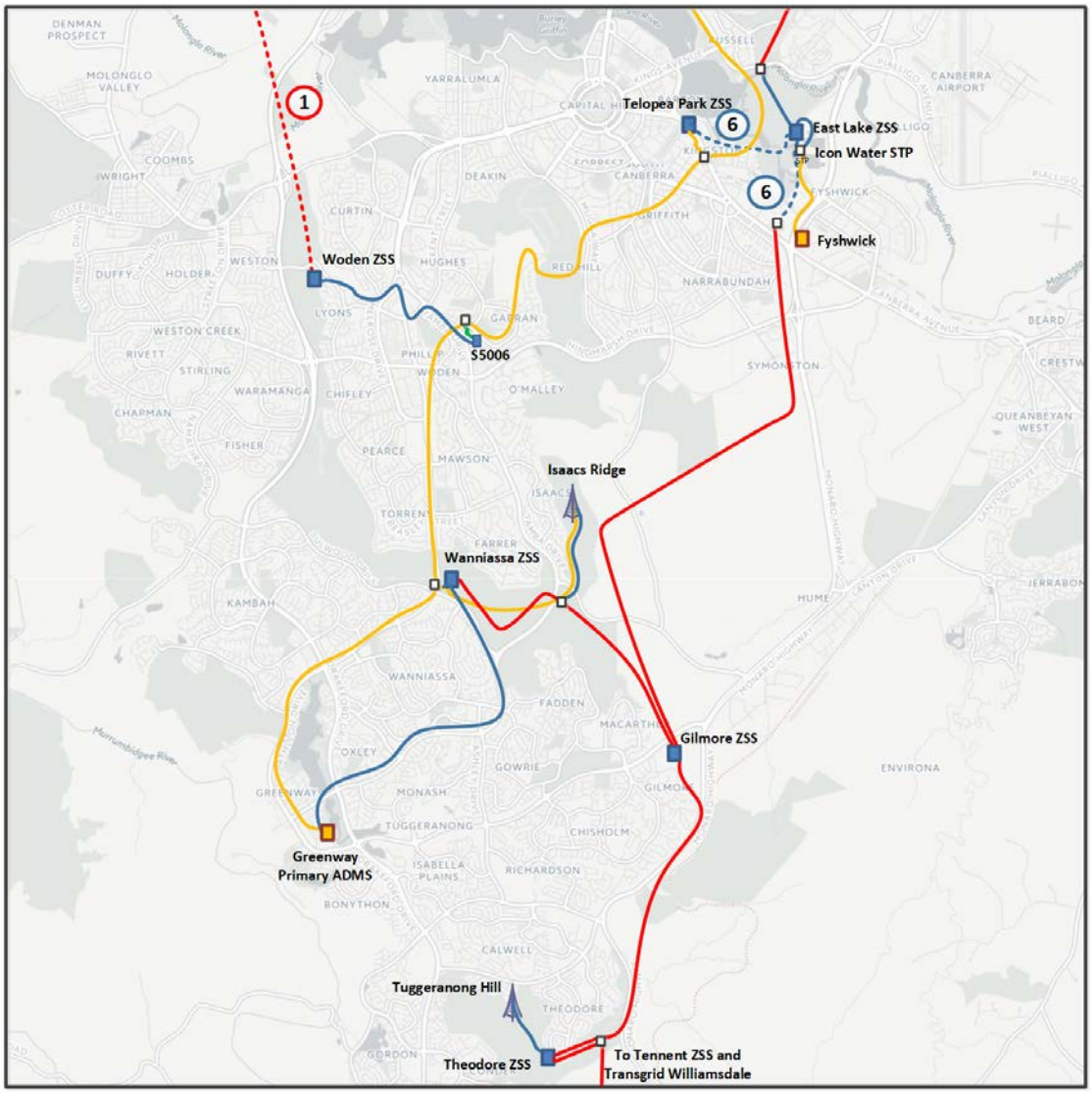
**Current UG Optical Fibre Projects**

2. Canberra Metro UG Optical Fibre
   TransACT House DC to TPS1
3. Optical Fibre with Gold Creek to
   Gungahlin Feeders Project

**Proposed UG Optical Fibre Projects**

4. Proposed Molonglo Zone Substation (2021)
   Underground 132 kV line and Optical Fibre
5. Proposed Mitchell Zone Substation (2030)
   Underground 132 kV line and Optical Fibre
6. East Lake Stage 2
   Underground 132 kV line and Optical Fibre

**Figure 29.** Fibre Optic Network – Southern ACT




### 6.2.8 Consumer metering

Evoenergy owns and operates a fleet of around 195 000 consumer meters. The primary purpose of the meters is to record energy consumption for billing purposes. These meters are managed in accordance with NER requirements and in accordance with Evoenergy's Metering Asset Management Plan. Under the plan Evoenergy's role is to maintain and test existing meter fleet, but not to install new meters or replace existing meters. .

In December 2017 the Power of Choice government regulatory reforms introduced changes to the metering arrangements. Firstly, all new and replacement meters installed from 2017 have to by advanced meters classified as Type 4 meters under NER. Secondly, installation of the meters is done by the authorised service providers who provide service on competitive basis. Evoenergy no longer installs the meters. The advanced meters have additional functionality which can be used for consumer information, power quality and network operations. Appendix H –provides additional information on the capabilities of advanced meters.

## 6.3 Information Technology

Information technology and operational technology systems are crucial to the management of network assets. These systems support full range of functions including asset management, design, planning and operations. Continuous improvement philosophy is applied to the management of these systems to achieve ongoing efficiency improvements.

Evoenergy utilises a set of core IT applications that forms our customer and asset information systems to manage the electricity network. Our focus continues to be one where we are consolidating and leveraging these information systems to support the business in continuous innovation and realisation of benefits. To this end, a number of key projects have either been completed, are underway or are at planning stage, including:

### Automating Data Flow between Systems

- The integration of all our core customer and asset information systems including Velocity, ArcFM GIS, ADMS, Oracle, PowerPlan and Aurion systems.
- This enables the automatic synchronising of meter installations, increasing the speed by which our network information is updated while decreasing manual effort.
- Automated scheduling and actioning of service energising and de-energising.
- With customers mapped to network supply points, the accuracy of customer notifications of planned outages is improved.
- Visualisation of customer related incidents, asset location and connectivity and planned service interruptions and maintenance or augmentation works.
- This supports improvements in financial management and reporting services, human resource planning and time management and enhanced analysis and forecasting services.
- Forecasting and scheduling the operational program of works to support efficient and effective use of resources and minimising service interruptions.

Delivered in works related to Programs #2, #4.3, #8.

### Field Mobility

This enables work crews to execute key works management activities in the field including creation, actioning and closure of work orders, leading to improved timeliness, availability and accuracy of data, improved response times to address priority field activities, increased field force productivity as well as minimising the use of paper and manual process.

Delivered in works related to Programs #3, #4.1

### Customer Portal

- The customer portal enables customers to register and log in to a portal to view consumption data, schedule service activations or disconnections, provide feedback and view detailed information regarding planned and unplanned (emergency) service interruptions or network outages.

Delivered in works related to Programs #3, #4.1, #7

## Data Warehouse and Data Lake

- Data analytics and reporting oriented projects will support improvements in overall service delivery through use of data from a variety of sources consolidated to a single source.
- Enhanced analytic techniques will also be applied to the consolidated data set to deliver product and service delivery enhancements and to provide multidimensional insights that, for example schedule activities that relate to maintenance of existing assets or installation of new or replacement assets with minimum interruption to services and impacts on Customers.

  Delivered in works related to Program #8

## Regulatory, Governance and Compliance

- Changes to address new or changed regulatory, governance and compliance requirements.
- New data structures and information previously not recorded or retained for normal business operations are being included into functional scopes for technology systems with respect to existing asset types and classes and new classes of assets such as Solar Panels, Battery Storage, Smart Meters and other such technologies.
- Enhanced reporting and analytic services to support provision of accurate forecasting capabilities, self-service customer reporting and support services and collection storage and management of more detailed and more granular customer and core networks data.

  Delivered in works related to Programs #4.2, #5, #7, #9

## Program of Work Management

- Upgrades to and augmentation of existing asset information systems will provide a more sophisticated toolkit for accurately forecasting and planning services that involve change to network assets.
- Predicting which assets need to be maintained using a risk weighted data driven process will support scheduling and works planning to have the minimum possible number of service interruptions for Customers and supply partners.

  Delivered in works related to Programs #1,

The future state of the customer and asset information systems environment is one that embodies a single, integrated, geospatial solution, built upon enterprise integration that improves data visibility and has a clear customer focus.

The functionality of customer and asset information systems will continue be developed to meet key business capabilities: enabling, managing and coping with disruption, operational effectiveness and efficiency and improving customer services and experiences. This will be achieved through continuous functionality releases, upgrades, augmentations or system replacements alongside implementation of enterprise integration and data architecture, advanced data management and analytics techniques and ongoing improvements to the systems and services that empower the Customer and Evoenergy staff.

The following are areas of IT focus for Evoenergy:

### 6.3.1 Customer Engagement

Providing our customers with more information about their energy consumption and network outages are key aspects of improving data visibility and strengthening the relationship with our customers. In addition, we are digitising customer interactions, making it easier for our customers to work with us and to obtain the information they require, and receive an overall improved experience. The expected benefits include:

- Timely and accurate data that enables customers to better manage their energy use and to visualise and plan their energy futures.
- Ensuring that our industry customers see interactions with us as adding value to their business.
- Greater capability for customers to view and act on managing their services.

### 6.3.2 Data Visibility and availability

The value in our data is not in the collection or analysis, but using the data to change processes and improve outcomes. Evoenergy is implementing a data architecture and associated management assets that enables data to be more readily accessed, easily viewed, analysed, reported and displayed across the business and to our customers. The expected benefits are:

- Reduction in the effort involved in creating new reports.
- Visualisation techniques that bring together multiple data sources and types to create insight that was previously unavailable.
- More in-depth trend analysis that can be leveraged to improve end to end business processes.
- Ability to make more meaningful information available to customers to improve interactions and enable our customers to have greater management, control and insight to their energy usage.

### 6.3.3 Field Digitisation

With the implementation and continued enhancement to works management mobility systems, there is an opportunity to continue to build on the mobility platform and devices to further digitize workforce activities. This includes the provision of offline, regularly updated, network maps and safety work method statements. These additional digitization initiatives will follow the creation of an approved Mobility Roadmap, which will identify the overall strategy for field digitization as well as the various applications and platforms, ensuring the continued roll out is implemented effectively, and only delivering activities that have clear benefits to the customer. The benefits anticipated from further building on field mobility include:

- Faster data capture and higher degree of accuracy, enabling richer data analysis, and further improving the end to end process for planned outage notifications to customers.
- Data collection from multiple previously inaccessible sources to increase ability and insight to field workers in their interactions with industry partners and customers.
- Continuing to improve the safety of our workforce and the public through increased availability of accurate up-to-date information.

### 6.3.4 Enterprise integration

The customer and asset information systems are closely integrated though point to point bespoke services that are highly complex and require ongoing care and maintenance. The integration between our works management and meter data and billing system for example, consists of a total

of nine point to point integrations. Evoenergy will implement a consistent integration architecture to simplify the overall systems environment, and ensure customer and asset information systems can be managed in a more efficient and prudent manner. The following benefits are expected:

- The integration architecture will enable the removal of point to point system integrations, enabling applications to be built, maintained, and released independently of other works programs. This will in turn reduce implementation risk associated with large scale projects by reducing scope, complexity, number of different technologies involved and ultimately reducing project costs, delivery times and impacts of customers and industry partners.
- More effective integrations will ensure that information is not lost between applications, is consistent across all platforms and supports development of reliable and transparent business process flows.

### 6.3.5 What we have achieved - Information technology change and improvement

Since the previous reporting period there have been fundamental changes in the way services are provided and work is supported from the technology teams through to Field Force.

Generational change has taken place across core systems that are used across the Evoenergy business including Works Management, Geographic Information Systems (GIS mapping services) and Billing and Customer Management systems.

Significant changes have also taken place with physical upgrades to Field and Office use of technology with latest mobility devices deployed and bespoke software applications installed to support Enhanced safety programs, operational flexibility and productivity improvements.

Cost of service provision and capacity acquisition from the core Business Services Division (Information Technology) has transformed with core infrastructure technology platforms shifting from physical on premise hardware hosted in Corporate Data Centres to latest Cloud based virtual hardware. This step-change introduces a degree of capacity and financial elasticity and responsiveness not accessible with fixed investment hardware, which will continue through upcoming systemic change programs.

### 6.3.6 Information technology – planning outcomes

Whilst there is an ongoing process of review for major customer and asset systems changes, with particular attention given to Customer, Market and Regulatory Compliance related activities the key strategic investments are expected to be focused on the following major program of works.

**Table 13.** Summary of information technology and operation technology program

| Program | Project Title | Timeframe | Planned Outcomes |
|---|---|---|---|
| **1** | PowerPlan Update | Q3 and Q4 2019 | Deliver enhanced Program of Work planning and development capability. |
| **2** | Integration Architecture Update | Q1 through Q4 2020 | Replace customised integrations with a standard integration architecture. |
| **3** | Cityworks Portfolio Update | Several programs running from Q1 2020 through to Q2 2024 | Enhanced mobility and customised field force services, reporting and data management improvements. |
| **4.1** | ArcFM GIS Platform Update | Q1 through Q2 2020 | Support and maintenance program, introducing enhanced visualisation tools and techniques and field force functional enhancements. |
| **4.2** | ArcFM GIS GDA2020 Datum | Q2 through Q4 2020 | Industry data exchange compliance program and greatly increased accuracy and consistency in mapping and visualisation services. |
| **4.3** | ArcFM GIS Maintenance | Several programs running from Q2 2021 through to Q2 2024 | Ongoing maintenance and support updates alongside functional and visualisation improvements. |
| **5** | Five Minute Global Settlements | Q4 2019 through Q2 2021 | Regulatory Compliance program. |
| **6** | Cloud Migration | Q2 2020 through Q2 2022 | Transformation program to move all core systems to a Cloud based infrastructure architecture way from on premise based infrastructures. |
| **7** | Digital Platform | Q1 2020 through Q2 2024 | Enhanced Customer Portal services. |
| **8** | Data Lake and Warehouse | Q3 2020 through Q2 2024 | Enhanced Data oriented services for Customers, Staff and industry partners alongside data analytics and insight services. |
| **9** | Billing Systems Augmentation | Ongoing to Q2 2024 | Compliance and Tariff related changes along with functional improvement and operational support changes. |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# Chapter 7 System planning

This chapter summarises identified network limitations 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 or embedded generation support required to defer the emerging issues.

System planning is the process of investigating present and future system capability, optimising assets utilisation, and identifying, evaluating and initiating system solutions where required and where economically justified to do so. Long term system planning is necessary to ensure that security of the power system is maintained, and that capacity is available to meet the future needs of our customers.

The planning methodology draws on various data sources including demand forecasts, customer connections, demographic and economic data. System planning studies are undertaken to assess the adequacy of the transmission 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 AER requirements for each identified network limitation are published on the Evoenergy website.

Chapter 3 and Appendix D –provide additional information on asset management and planning methodology.

Chapter 4 and Appendix F –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 forecast to be relatively flat. The summer demand is forecast to grow slightly (around 2.5% over the next decade). The winder demand is forecast to reduce slightly during the same period (around 2% over the next decade). The network minimum demand is forecasted to reduce sharply over a decade with increasing possibility of ACT exporting power to NSW by the end of the decade. Chapter Chapter 5 and Appendix E – provides 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 medium density residential, high density residential and commercial developments pushing the capacity limits within the distribution system in several established areas
- Continuation of greenfield developments and expansion into the areas poorly serviced by the existing network

- Increasing proportion of medium and high density residential developments in the greenfield areas which increases electrical load density within serviced areas
- Distributed energy resources impacting voltage regulation on LV distribution network and therefore creating network constraints (usually within low voltage network)
- The network is planned within the long term context of the ACT Government energy policies which includes 2045 zero emission target and perpetual neutral carbon target for electricity. Pending consideration discussion and consideration of energy options and scenarios, the impact of the policy is not fully factored into the 2019 APR.
- 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 ACT government energy policy is subject to public consultation at the time of preparation of this report. The long term impact of ACT Government energy policies including 2045 zero emissions targets need to be factored into the network planning process once the policy choices are settled.

## 7.2 Joint planning with TransGrid

Evoenergy and TransGrid hold joint planning meetings bi-annually. The joint planning process ensures that the most economic solutions to issues are implemented, whether they are a network or non-network option, transmission 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.

Previous joint planning meetings discussed and initiated improvement of security of supply to ACT to comply with the ACT regulations introduced by ACT Government. In response TransGrid's Stockdill Drive 330/132 kV bulk supply point substation (the second bulk supply to the ACT) and interconnecting transmission lines are being constructed respectively by TransGrid and Evoenergy (refer to section 7.5.1). Regular project meetings and exchanges of information (e.g. design drawings) are exchanged as such projects progress, and construction works are carried out in a coordinated manner.

This year's joint planning meeting was held in Evoenergy's Greenway office in April 2019. Evoenergy and TransGrid also have regular discussions in addition to the formal joint planning meetings, to discuss and resolve technical issues. In June 2019, a joint training exercise was held between Evoenergy and TransGrid system to simulate the actions required to be taken by both parties in the event of a major system contingency that requires a total system restart (black start).

TransGrid proposes to carry out replacement of some of its aging major assets at Canberra Substation, including the retirement of two 330/132 kV single phase transformer banks. Evoenergy will liaise closely with TransGrid throughout the implementation of this project to ensure continuity and security of supply to the ACT is maintained. For details refer to TransGrid's Transmission Annual Planning Report 2019[7].

[7] https://www.transgrid.com.au/news-views/publications/Documents/Transmission%20Annual%20Planning%20Report%202018%20TransGrid.pdf

## 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 Integrated System Plan[8] (ISP) in July 2018 and is currently working on the 2019-20 ISP. The ISP is a cost-based engineering optimisation plan that forecasts the overall transmission system requirements for the National Electricity Market (NEM) over the next 20 years.

The ISP discusses the integration of renewable generation and emerging technologies to the transmission grid, and the trend of expenditure to replacing ageing infrastructure outweighing investment in new network capacity. Ancillary services such as Network Support and Control Ancillary Services (NSCAS) and Frequency Control Ancillary Services (FCAS) are not regarded as an issue for Evoenergy due to the relatively small size of our network compared with other networks in the NEM, and the relatively small percentage of embedded generation connected to our network.

The ISP forecasts significant growth of renewable energy generation throughout the NEM, in particular solar and wind powered generation. Residential rooftop PV generation growth is projected to continue and be complemented by growth in residential battery storage systems, home energy management systems, and smart appliances.

The ACT lacks consistent wind resource but has long hours of sunshine throughout the year, so growth in solar farms and rooftop solar PV generation is predicted to continue. Low cost of new rooftop solar PV systems continue to encourage their uptake. It is also predicted that there will be significant increase in residential battery storage systems as prices continue to fall and battery technology improves.

Evoenergy has no network infrastructure above 132kV operating voltage and none of the proposed projects described in this chapter will have a material inter-regional impact, i.e. they will not impose power transfer constraints or adversely influence the quality of supply to adjoining transmission or distribution networks.

## 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.

[8] http://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2018/Integrated-System-Plan-2018_final.pdf

## 7.5 Planning outcomes -network constraints and limitations

Table 14 lists identified locations where the network is constrained or limited or where the network limitations are likely to emerge. The identified network limitations will be subject to further investigations and engagement with interested parties in relation to demand management/non-network solutions. Chapter 1 provides more information on the consultation process. Chapter 7.9 discusses current asset management and network initiatives.

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 14. The following is the list of the major residential developments planned within the five year planning horizon which we have identified during the planning review:

1. Ginninderry Estate, West Belconnen – residential development. Stage 2 to supply 814 dwellings currently in design.
2. University of Canberra residential blocks, Bruce
3. Lawson – 132 kV Transmission line relocations to enable development of surrounding land.
4. Approximately 1.6 km of overhead 132 kV transmission lines that currently run approximately 800 m northwest and southeast of Belconnen Zone Substation (sections of Latham–Belconnen and Belconnen–Bruce lines) are to be relocated and replaced with 132kV UG cables to enable development of surrounding land.
5. Jacka Estate, Gungahlin – residential development. Stages 2 and 3 in currently undergoing Development Approval.
6. Throsby Estate, Gungahlin – residential development.
7. Denman Prospect Estate, Molonglo Valley – residential development. Future stages totalling approximately 4,000 dwellings in various stages of development.
8. Whitlam Estate, Molonglo Valley – residential development. Stages 1 & 2 for approximately 900 dwellings currently in design with more future stages to come.

#### 7.5.1.2 COMMERCIAL AND MIXED DEVELOPMENTS

Planned commercial and mixed developments cause some of the anticipated network limitations summarised in Table 14. The following is the list of commercial and mixed developments identified during the planning review:

1. Canberra Central Business District – several residential and commercial developments.
2. Canberra North – several residential and commercial developments.
3. Gungahlin Town Centre East – residential and commercial development.
4. Belconnen Town Centre – multiple high-rise residential and commercial developments.
5. Woden Town Centre, electric bus charging station
6. Mitchell, data centre
7. Canberra Airport precinct, various commercial developments
8. Kingston Foreshore, Kingston – residential and commercial development
9. South Quay, Tuggeranong Town Centre – multiple high-rise residential and commercial developments.

#### 7.5.1.3 EMBEDDED GENERATION PROJECTS

The following projects are currently under consideration and are subject to connection enquiries:

1. Proposed 700 kVA battery storage to be installed at Majura.
2. Proposed 20 MW solar farm to be constructed at Symonston. Connection options being evaluated.

3. ACT government plans to have up to 250 MW of renewable generation (with the substantial proportion of generation likely to be located outside ACT) coupled with 20 MW / 40 MWh of battery storage connected to the electricity network.

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

**Table 14.** Network limitations

| Location | Network Element | Limitation | RIT-D | MVA Required | | | | | Dates | | | Estimated Cost | Project Driver(s) | Project Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2020 | 2021 | 2022 | 2023 | 2024 | Consult | Decision | Required | | | |
| **Canberra CBD Central** | Feeder | Capacity | No | 0.3 | 2.8 | 5.3 | 7.8 | 8.5 | Dec-19 | Mar-20 | Dec-20 | $1.3m | See section 7.5.1.2.1 | See section 7.8.1 |
| **Gungahlin Town Centre** | Feeder | Capacity | No | 5.6 | 11.9 | 15.2 | 17.1 | 19.6 | Dec-19 | Mar-20 | Dec-20 | $3.5m | See sections 7.5.1.1.5, 7.5.1.1.6 and 7.5.1.2.3 | See section 7.8.2 |
| **Dickson - Dooring St** | Feeder | Capacity | No | 0.7* | 2.1 | 2.5 | 2.9 | 2.9 | Dec-19 | Jun-20 | Dec-21 | $3.5m | See section 7.5.1.2.2. | See section 7.6.3 |
| **Molonglo Valley** | Zone Substation stage & Feeders | Capacity | Yes | | 1.5 | 6.8 | 10.4 | 12.5 | Mar-20 | Jun-20 | Dec-21 | $31.2m | See sections 7.5.1.1.7 and 7.5.1.1.8 | See section 7.8.3 |
| **Strathnairn** | Feeder | Capacity | No | | | 1.0 | 2.1 | 3.1 | Jun-20 | Dec-20 | Jun-22 | $2.2m | See section 7.5.1.1.1 | See section 7.8.4 |
| **Belconnen Town Centre** | Feeder | Capacity | No | | | 2.4 | 4.7 | 7.1 | Dec-20 | Jun-21 | Dec-22 | $1.8m | See sections 7.5.1.1.2 and 7.5.1.2.4 | See section 7.8.5 |
| **Canberra CBD East** | Feeder | Capacity | No | | | 0.9* | 2.4 | 6.2 | Dec-21 | Jun-22 | Dec-23 | $2.3m | See section 7.5.1.2.2 | See section 7.6.3 |
| **Fyshwick** | Zone Substation | Asset Condition | Yes | | | | | 32 | Jun-21 | Dec-21 | Jun-24 | $5.6m | See section 7.8.6 | See section 7.8.6 |
| **North Canberra** | Transmission | Voltage | No | | | | | | Jun-21 | Dec-21 | Jun-24 | Tbc | See section 7.6.1 | See section 7.6.1 |
| **Mitchell / Gold Creek** | Zone Substation | Capacity | Yes | 2024-29 period | | | | | | | | | See section 5.2 | See section 7.8.7 |
| **Strathnairn** | Zone Substation | Capacity | Yes | 2024-29 period | | | | | | | | | See sections 7.5.1.1.1 and 7.8.4 | See section 7.8.4 |

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

**Table 15.** Locations where constraints are no longer applicable

| Location | Reason for Revision |
|---|---|
| **Pialligo** | Customer requirements and timing have been revised |
| **Kingston Foreshore** | Timing of new connections driving this constraint have been revised |
| **Griffith, Red Hill, Forrest & Narrabundah** | Timing of new connections driving this constraint have been revised |
| **Tuggeranong** | Timing of new connections driving this constraint have been revised |

## 7.6 Projects Currently In Progress

### 7.6.1 Security of Bulk Supply to the ACT

The commissioning of TransGrid's Williamsdale 330/132 kV Substation in February 2013 introduced a second 132 kV bulk supply point into the ACT to address power system security requirements by providing two geographically independent 330 kV points of connection to the ACT network. Williamsdale Substation is linked to Evoenergy's network at Theodore and Gilmore 132 kV Zone Substations (refer Figure 9).

The latest version of the *ACT Electricity Transmission Supply Code* states:

*TransGrid must plan, design, construct, test, commission, maintain, operate and manage its electricity transmission networks and geographically separate connection points that supply customers in the ACT and that will operate at 66 kV and above, whether or not those networks and connection points are in the ACT, to achieve the following:*

*a) the provision of two or more geographically separate connection points operated at 132 kV and above to supply electricity to the ACT 132 kV network;*

*b) at all times provide continuous electricity supply at maximum demand to the ACT 132 kV and 66 kV network throughout and following a single credible contingency event;*

*c) until 31 December 2020, provide electricity supply at 30 MVA to the ACT 132 kV or 66 kV network within one hour following a single special contingency event and 375 MVA within 48 hours of this event; and*

*d) from 31 December 2020, provide continuous electricity supply at 375 MVA to the ACT 132 kV network immediately following a single special contingency event and agreed maximum demand within 48 hours of this event.*

To meet the above criteria TransGrid proposes:

Item (a) is met already by Canberra and Williamsdale 330/132 kV bulk supply point substations.

Item (b) is met already by Canberra and Williamsdale 330/132 kV, and Queanbeyan 132/66 kV bulk supply point substations, all of which have N-1 security.

Item (c) can be met by supplying 30 MVA via Queanbeyan 132/66 kV (to Fyshwick 66/11 kV Zone Substation) in the event of a special contingency event affecting Canberra Substation (and consequently affecting Williamsdale Substation also as Williamsdale is connected radially at 330 kV from Canberra). Queanbeyan Substation is normally supplied at 132 kV via Canberra Substation, but this supply can be switched to Yass Substation by TransGrid via remotely operated switches at Spring Flat Switching Station. The 375 MVA criteria within 48 hours requirement would be met by constructing a temporary 330 kV connection between the Upper Tumut–Canberra line and the Canberra–Williamsdale line, thus bypassing Canberra Substation.

To comply with Item (d) TransGrid proposes to construct a new 330/132 kV Substation at Stockdill Drive, West Belconnen. This will have one 375 MVA transformer. The Upper Tumut–Canberra 330 kV line will be diverted to Stockdill (bypassing Canberra Substation). The Canberra–Williamsdale 330 kV line will be reconnected to Stockdill Substation to become the Stockdill-Williamsdale line. A new 330 kV line will be constructed from Stockdill to Canberra.

Evoenergy will construct a new double circuit 132 kV line section from Stockdill to connect to the Canberra–Woden 132 kV line to form a Stockdill–Canberra circuit and a Stockdill–Woden circuit. This arrangement will provide the immediate 375 MVA back-up capability to the ACT in the event of a total loss of Canberra Substation.

Within one hour of a special contingency event affecting Canberra Substation, TransGrid proposes to reconnect Queanbeyan 132 kV from Yass Substation (via Spring Flat Switching Station) and within 48 hours to construct a temporary connection from the Yass 330 kV line to the Canberra–Latham 132 kV line and reconnect to Yass 132 kV bus. This would provide full load capacity to the ACT.

TransGrid proposes to retire two aged single-phase transformer banks at Canberra Substation.

No non-network alternative to this project has been identified. Estimated cost of the Stockdill Substation to Canberra–Woden132 kV transmission line plus installation of OPGW on the Canberra–Stockdill–Woden line is $7.15 m and proposed project completion is by December 2020.

A joint Regulatory Investment Test for the Security of Supply project was completed by Evoenergy and TransGrid in 2009.

In the interim period until completion of this project, in the event of a loss of Canberra Bulk Supply Substation, a contingency plan has been made by TransGrid which has constructed assets at its Yass and Canberra substations to deal with this eventuality.

With Stockdill substation in place the originally proposed Theodore–Gilmore 132 kV line upgrade will not be required.

Figure 30 illustrates the scope of this project.

## Voltage Issues during a contingency event

The joint planning with TransGrid and pending construction of the Stockdill bulk supply point promoted re-assessment of voltage levels in the system under contingency condition. However analysis shows that in the event of a total Canberra Substation outage, voltage levels in the northern part of Evoenergy's network would fall below regulation levels. In order for voltage levels to be maintained, 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.

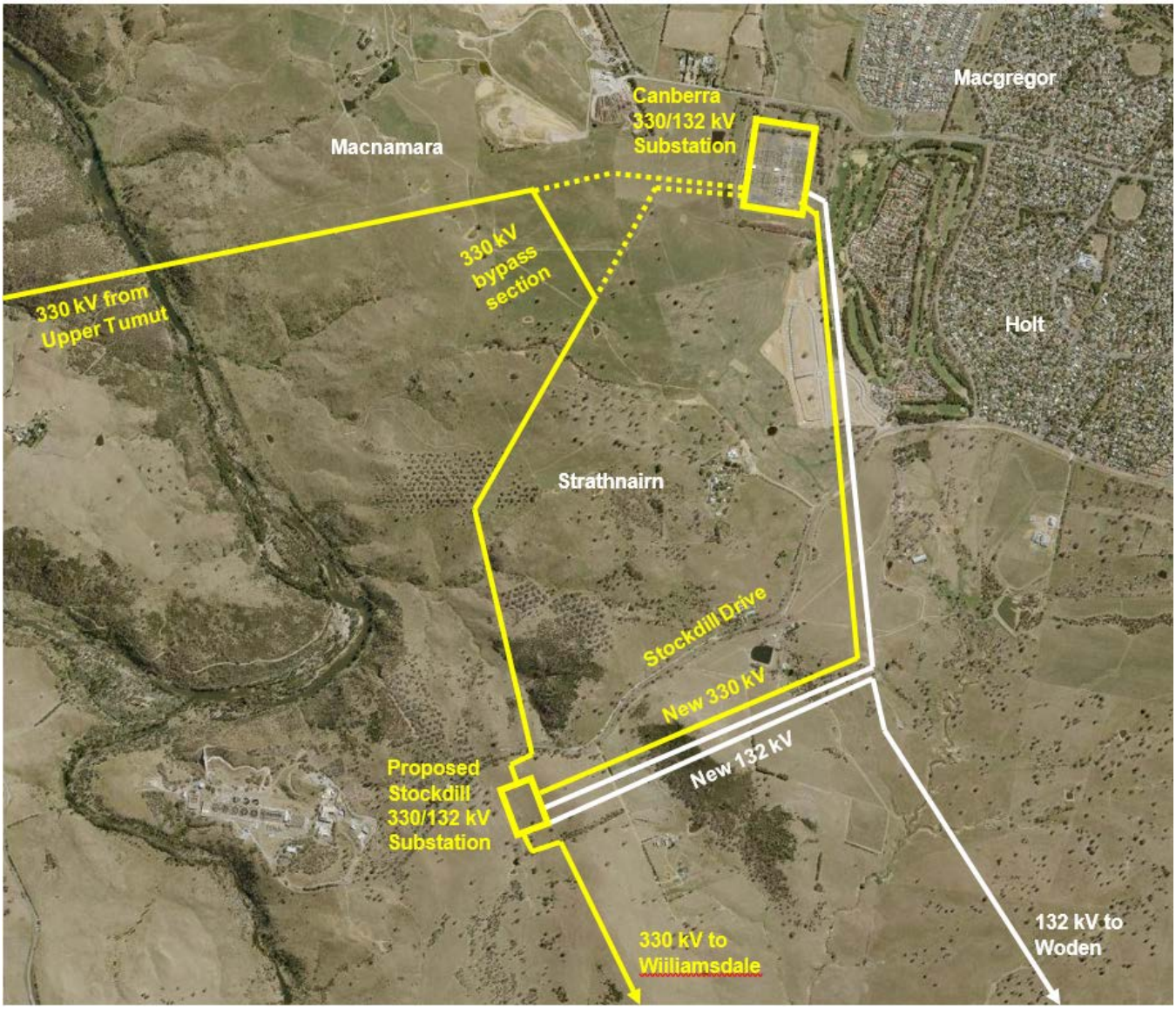
The 11 kV capacitors can be installed in stages and can be used continuously to improve 11 kV bus voltages and reduce MVA loads on zone substation transformers.

The scope and sequence of 11 kV 10 MVAr capacitor banks installation is as follows:

- Stage 1 – Latham, Gold Creek and Belconnen
- Stage 2 – Molonglo
- Stage 3 – Strathnairn

Other options investigated regarding reactive power support devices included a 132 kV 50 MVAr static synchronous compensator (STATCOM). This option is more expensive than 11 kV capacitor banks, however the STATCOM device can also provide voltage support during the daytime (not during contingency) when excess rooftop PV generation in the residential area is causing over-voltage in some parts of the network.

**Figure 30.** Proposed Stockdill Substation and 132 kV line connection



### 7.6.2 Supply to Canberra CBD West (Edinburgh feeder)

Canberra City west area is experiencing significant growth due to urban infill activities (old detached houses being replaced by multi-storey apartment buildings), particularly in the Acton and Turner areas.

There is insufficient spare capacity in existing 11 kV feeders in the area.

It is proposed to install an 11 kV cable feeder to an existing 11 kV switching station at Edinburgh St, Acton, from Civic Zone Substation to supply the required capacity. The length of this feeder will be approximately 3.3 km. The first section of this feeder (approximately 2 km) will be installed in a common trench with proposed new feeders to the Australian National University. Spare conduits will be installed along the feeder route to provide for future developments.

Proposed project completion is by November 2019.

### 7.6.3 Supply to Canberra City East, Lyneham and Dickson

This section describes the proposed solution to address the constraints in the Canberra City East and Canberra North which is a 3-stage process comprising (1) the extension of Haig feeder, (2) construction of Dooring feeder and (3) construction of Donaldson feeder.

The maximum demand in eastern part of Canberra City, Lyneham and Dickson suburbs is forecast to increase significantly with major residential and commercial developments in addition to the recently completed light rail project and ACT Government's urban renewal program.

There is insufficient spare capacity in the existing 11 kV feeders in the area.

Evoenergy has considered two options to supply the Canberra City North, Lyneham and Dickson developments as follows:

| Option | Option type | Description | Cost | Evaluation |
|---|---|---|---|---|
| **1** | Network | Extend Haig feeder to Dickson area / Construct new 11 kV cable feeder from Civic Zone Substation to Dooring St, Dickson /<br>Construct new 11 kV cable feeder from City East Zone Substation to Donaldson St, Canberra City | $7.70m | Preferred |
| **2** | Non - network | Demand side management and embedded generation | N/A | Not preferred as does not meet need |

Option 1 involves the extension of an existing 11 kV feeder and the construction of two new 11 kV feeders as follows:

- Extension of existing 11 kV Haig feeder to Dickson (project in progress) by March 2020 to supply new developments in the Dickson area.
- New 11 kV feeder from Civic Zone Substation to Dooring St by December 2021 to supply new developments in Dickson and Lyneham area. Estimated cost is $3.5 million.
- New 11 kV feeder from City East Zone Substation to Donaldson St by December 2020 to supply new developments in the Canberra City North area. The project timing has changed as the expected development at section 96 Canberra City deferred to 2023. Estimated cost is $2.3 million.

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 Donaldson and Dooring feeders to the next regulatory control period (beyond 2024), it is estimated that non-network solutions would need to cater for a maximum demand of at least 5.8 MVA.

Latent demand management within the existing customer base was investigated, with a maximum estimated capacity of 1.04 MVA, if all non-network options were implemented including customer-owned embedded generation and energy storage. This does not meet the required capacity to enable the new feeders to be deferred.

Option 2 therefore does not meet the need and not preferred. Option 1 has the lowest cost and highest NPV and is preferred.

### 7.6.4 Decommissioning of Causeway 132 kV Switching Station

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/630mm$^2$ 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/1600mm$^2$ 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.

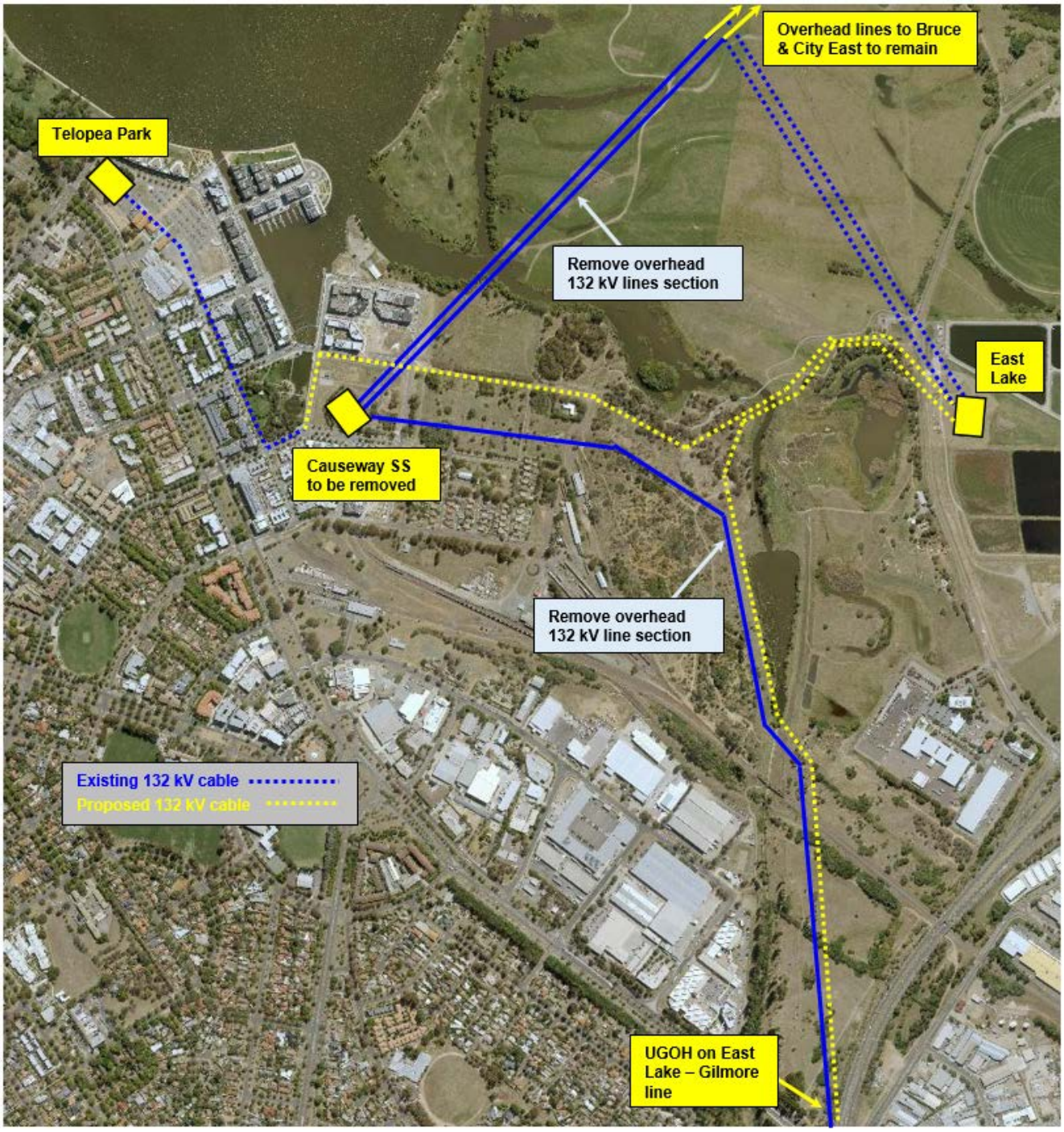
Figure 31 shows the existing Causeway 132 kV Switching Station.

**Figure 31.** Causeway Switching Station

The overhead to underground conversion works including decommissioning of Causeway Switching Station will be funded by the project proponent (developer). Approval for the amendment to the original Development Approval (DA) is currently being sought. The original proposed project completion date was December 2020, but is likely to change as the timing is driven by

Figure 32  illustrates this proposed development.

**Figure 32.** Causeway Switching Station – Proposed 132 kV Cabling



### 7.6.5 Other Projects currently In Progress

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

- 132 kV Transmission line relocations Molonglo Valley. Approximately 14.7 km of overhead 132 kV transmission 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. Development Approval (DA) for this project is currently in progress. Coupled with this proposed project, the site for the future Molonglo Zone Substation has been relocated.

- Hume – commercial development to supply a data centre requiring the construction of two 11kV Bulk Supply Points and associated 11kV feeders from Gilmore Zone Substation to supply 30MVA of requested load. Development Approval (DA) for this project is currently in progress.

- Australian National University – construction of permanent replacement 11 kV bulk supply point switching station and construction of second 11 kV bulk supply point switching station. Construction activities for this project are currently in progress.

- Proposed Harman 132/11kV Zone Substation and 2.2km of 132kV overhead transmission line to supply increased load in the surrounding area. This project is currently in design stage. This is a customer initiated project funded by the external parties.

- Proposal was submitted to increase the generation capacity at Mount Majura Solar Farm from 2 MW to 3 MW, Customer has made the payment and construction works to commence shortly.

- Proposal was submitted to increase the generation capacity at Mugga Lane Waste Transfer Station bio-gas generator from 3 MW to 4 MW. Engineering review currently in progress and design works will commence shortly.

## 7.7 Projects Completed

Significant project completed during the year include:

- Stage 1 of supply to the Capital Metro Light Rail project has been completed and includes two 11 kV traction power stations and 11 kV supply to the Capital Metro depot / control centre.
- The project to install a second 132/11 kV 30/55 MVA transformer and 11 kV switchboard at East Lake Zone Substation to meet load growth in the East Lake / Kingston / Airport / Pialligo / Fyshwick area is scheduled for completion by 30 November 2019.
- Installation of two new 11 kV feeders (Hamer and Flemington) from Gold Creek Zone Substation to Gungahlin Town Centre has been completed.
- Fyshwick – connection to energise the second data centre was completed.
- Installation of 11 kV Feeder from Civic Zone to Canberra CBD West (Edinburgh feeder) has been completed.
- Australian National University – construction of permanent replacement 11 kV bulk supply point switching station (BSP 1).
- Ginninderry Estate, West Belconnen – residential development. Stage1 reticulation to supply 311 dwellings completed and energised.
- CSIRO Ginninderra Estate, Belconnen – residential development. Reticulation completed and energised.
- Taylor Estate, Gungahlin – residential development. Reticulation completed and energised.
- Jacka Estate, Gungahlin – residential development. Stage 1 completed and energised.
- North Wright and North Coombs, Molonglo Valley – residential development. Reticulation completed and energised.

## 7.8 Proposed Network Developments

### 7.8.1 Supply to Canberra CBD Central

The maximum demand in the Canberra Central Business District (CBD) is forecast to increase by up to 9.3 MVA by 2024 with major residential and commercial developments around City Hill.

There is insufficient spare capacity in existing 11 kV feeders in the area and the ACT Government's City to the Lake long term urban renewal plan will put further pressure on the existing infrastructure in the area.

Evoenergy has considered three options to supply the Canberra CBD developments as follows:

| Option | Option type | Description | Cost | Evaluation |
|---|---|---|---|---|
| **1** | Network | Construct new 11 kV cable feeder from Civic Zone Substation to London Circuit. | $1.28 m | Preferred |
| **2** | Network | Construct new 11 kV cable feeder from City East Zone Substation to London Circuit. | $3.26 m | Not preferred |
| **3** | Non-network | Demand side management and embedded generation | N/A | Not preferred as does not meet need. |

Option 1 involves the construction of a new 11 kV feeder from Civic Zone Substation to the Canberra CBD at London Circuit. The length of this feeder would be approximately 3.6 km.

This option has the lowest cost and highest NPV and is preferred.

Option 2 involves the construction of a new 11 kV feeder from City East Zone Substation to the Canberra CBD at London Circuit. The length of this feeder would be approximately 4.0 km. This

option is not preferred. Estimated cost is $1.28 million and proposed project completion is by December 2020.

### 7.8.2 Supply to Gungahlin Town Centre

The maximum demand in the Gungahlin Town Centre East area is forecast to increase over the next five years with the development of new residential suburbs at Throsby, and Kenny, along with several commercial and residential developments in the Gungahlin Town Centre area, including commercial, retail and residential developments, medical centre, and other community facilities.

Some of this load can be met by fully utilising the existing 11 kV network in the area and by transferring loads between feeders and between zone substations. This will still leave a shortfall by approximately 7.6 MVA required to service the area.

Network and non-network options have been evaluated including a new 11 kV feeder from Gold Creek or Belconnen zone substation, demand side management and embedded generation.

Evoenergy has considered two network options to supply the Gungahlin Town Centre area as follows:

| Option | Option type | Description | Cost | Evaluation |
|---|---|---|---|---|
| **1** | Network | Construct new 11 kV cable feeder from Belconnen Zone Substation | $5.10 m | Not Preferred |
| **2** | Network | Construct new 11 kV cable feeder from Gold Creek Zone Substation | $3.46 m | Preferred |
| **3** | Non-Network | Demand side management and embedded generation | N/A | Not preferred as does not meet need |

Option 1 involves the installation of a new 11 kV cable feeder from Belconnen Zone Substation to Valley Ave, Gungahlin. There are no spare 11 kV feeder circuit breakers at Belconnen Zone Substation so the new feeder would have to be connected in parallel with an existing feeder. The length of this feeder would be approximately 12.3 km. This is not the lowest cost option and is not preferred.

Option 2 involves the installation of a new 11 kV cable feeder from Gold Creek Zone Substation to Valley Ave, Gungahlin. There is a spare feeder circuit breaker available at Gold Creek Zone Substation. The length of this feeder would be approximately 5.3 km.

Option 3 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 Valley feeder to the next regulatory control period (beyond 2024), it is estimated that non-network solutions would need to cater for a maximum demand of at least 7.6 MVA.

Latent demand management within the existing customer base was investigated, with a maximum estimated capacity of 1.62 MVA, if all non-network options were implemented including customer-owned embedded generation, energy storage and voluntary load curtailment. This does not meet the required capacity to enable the new feeder to be deferred.

Option 3 therefore does not meet the need and not preferred.

Option 2 has the lowest cost and highest NPV and is preferred. Estimated cost is $3.5 million and proposed project completion is by December 2020.

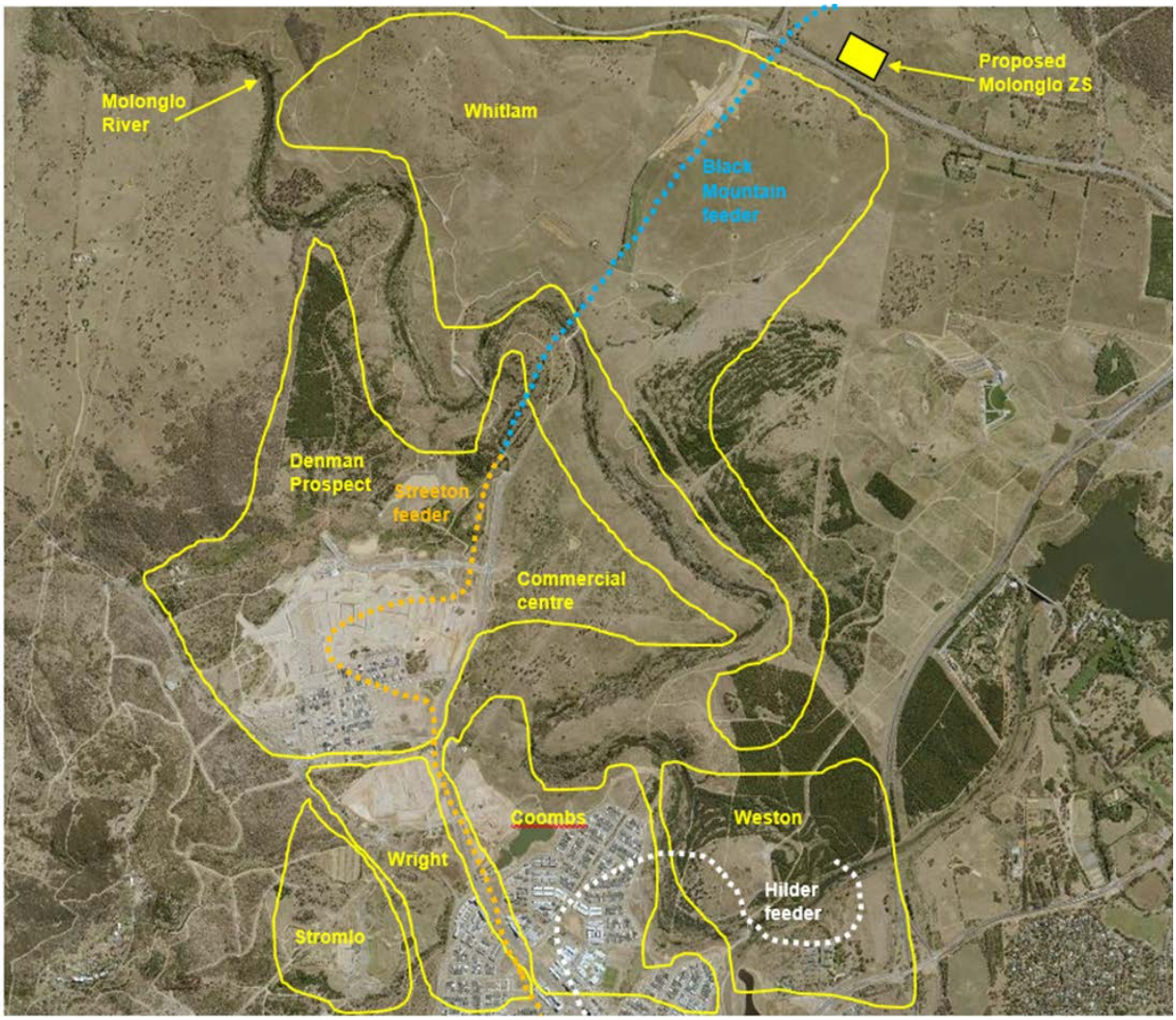
### 7.8.3 Molonglo Zone Substation

The Molonglo Valley District is situated in Canberra's west, approximately 10 km from the Canberra Central Business District (CBD). It lies to the north of the urban areas of Weston Creek and south of Belconnen. The area is being developed by the Suburban Land Agency as a residential district. Land servicing has commenced for the initial developments and when fully developed over the next 30 years, the Molonglo Valley District including the new suburbs of North Weston, Coombs, Wright, Denman Prospect and Whitlam will support an estimated 21,000 dwellings plus shopping centres, schools and community facilities, plus the proposed Stromlo Forest Park Aquatic Centre and Leisure Centre.

The first phase of development of the Molonglo Valley is underway, comprising Denman Prospect, Wright and Coombs suburbs. Supply is being provided to these developments through two extended 11 kV feeders from Woden Zone Substation and one extended 11 kV feeder from Civic Zone Substation. The first stage of the new Whitlam suburb is due to commence construction in 2019. Initial supply to Whitlam will be provided by the Black Mountain feeder from Civic Zone Substation.

Figure 33 shows the proposed areas of development of the Molonglo Valley and the routes of existing 11 kV feeders. It also shows the site of the proposed Molonglo Zone Substation.

**Figure 33.** Development of Molonglo Valley



Load forecasts indicate that these feeders will reach their capacity limits by mid-2021 as the load of new developments in the Molonglo Valley increases. The maximum demand in the Molonglo Valley is forecast to increase steadily to 50 MVA over the next 30 years. Evoenergy proposes to provide long-term capacity and security to the Molonglo Valley District by constructing a new 132/11 kV Molonglo Zone Substation at a site on the northern side of William Hovell Drive, east of Coulter Drive.

The *Electricity Distribution (Supply Standards) Code* sets out certain performance standards for the distribution network in the ACT. A Distribution Network Service Provider (DNSP) 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'. The processes defined in these criteria serve to limit network augmentation expenditure to instances where the increase in demand is clear and above the secure or firm capacity.

The proposed Molonglo Zone Substation is required to meet the *Electricity Distribution (Supply Standards) Code*.

Evoenergy has considered four options to supply the Molonglo Valley District as follows:

| Option | Option type | Description | Cost | Evaluation |
|---|---|---|---|---|
| **1** | Network | Do nothing – connect all loads to existing feeders and operate to their thermal ratings | N/A | Not preferred as does not meet need |
| **2** | Network | Construct new 11 kV cable feeders to Molonglo Valley from Latham and Civic zone substations | $42.18m | Not preferred |
| **3** | Non-network | Demand side management | N/A | Not preferred as does not meet need |
| **4** | Network | Construct new Molonglo Zone Substation in three stages and construct new 11kV feeders to Molonglo valley developments | $31.2m | Preferred |

Options 1 is discounted as the existing feeders do not have sufficient spare capacity to meet the forecast demand.

Option 2 is discounted due to its high capital cost and the limited availability of spare feeder circuit breakers at Latham and Civic zone substations.

Option 3 considers demand side management initiatives including demand reduction and alternative supply measures such as embedded generation. The majority of demand of these developments is residential dwellings. The developer of Denman Prospect has incentivised the installation of rooftop solar PV generation systems on all detached dwellings. This has the potential of reducing energy demand, however, a significant uptake of energy storage, e.g. battery storage installations, is needed for this to have a major impact on the overall maximum demand of the network. In particular winter demand usually occurs around 6:00pm throughout the months of July and August when there is no PV generation, so peak shaving would require the use of battery storage devices. Evoenergy intends to explore the installation of the network batteries in collaboration with the ACT Government reversed auction participants.

Other demand reduction measures such as on-site generation, co-generation and tri-generation[9] which are associated with commercial and industrial businesses will not be applicable in the immediate future and are therefore not considered further.

[10] https://www.evoenergy.com.au/residents/pricing-and-tariffs/peak-demand-tariffs/reducing-peak-demand

Option 4 proposes to establish a new 132/11 kV zone substation at Molonglo by summer 2021. The new Molonglo Zone Substation will be equipped initially with Evoenergy's 132/11kV 14 MVA mobile substation (previously installed at Angle Crossing). Stage 2 comprising installation of one 132/11 kV 30/55 MVA transformer and one 11 kV switchboard is proposed to be completed by the end of the 2025-26 financial year though this will depend on the actual rate of load growth. Stage 3 comprising installation of a second 132/11 kV 30/55 MVA transformer and second 11 kV switchboard is proposed to be completed by the end of the 2029-30 financial year though this will depend on the actual rate of load growth.

Ultimate maximum demand of Molonglo Zone Substation is forecast to reach 53 MW by 2046 based on a 30-year development plan for the Molonglo Valley. 132 kV connection will be via loop-in-loop-out to the Canberra–Woden 132 kV circuit.

Option 4 is the preferred option with estimated cost for construct Molonglo Zone Substation of $31.2 million. Proposed project completion is by December 2021 for Stage 1, June 2026 for Stage 2 and June 2030 for Stage 3.

Seven new 11kV feeders are proposed to connect the proposed Molonglo Zone Substation to supply existing and new loads in Molonglo Valley. The total estimated cost is $6.86 million.

The augmentation cost of this proposal exceeds $6 million so this project will be subject to the Regulatory Investment Test (RIT). Evoenergy proposes to commence the RIT process in December 2019.

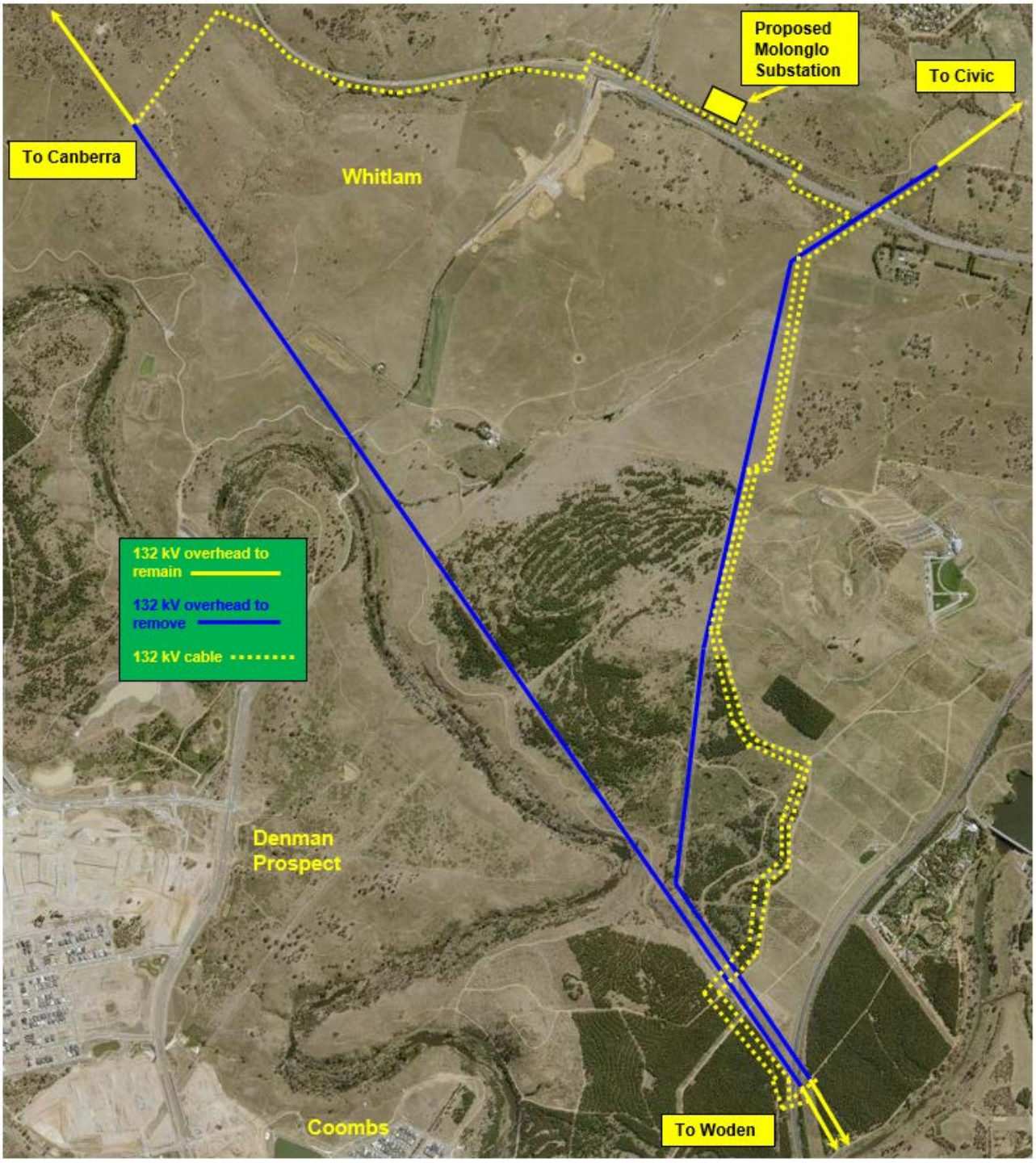
Viable proposals from third parties that can significantly reduce maximum demand of the Molonglo Valley developments and enable Evoenergy to defer construction of the Molonglo Zone Substation are welcome. It is estimated that such proposals would be required to provide an increasing reduction in maximum demand of approximately 4.3 MW in 2021, 8.3 MW in 2022, and 13.1 MW in 2023 and so on, to enable the Molonglo Zone Substation project to be deferred. This would be in addition to currently proposed rooftop PV installations on all detached dwellings.

As part of the proposed residential developments, the Suburban Land Agency has requested the replacement of sections of two Evoenergy 132 kV transmission 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 by mid-2020.
- Stage 2: Civic–Woden line section approximately 2030.

Figure 34 shows the site of the proposed Molonglo Zone Substation and associated undergrounding of 132 kV transmission lines (yellow dashed lines denote proposed underground cable sections).

**Figure 34.** Proposed development of Molonglo Valley




New 11 kV feeders from Molonglo Zone Substation will be installed to supply the new suburbs and eventually inter-tie with Civic, Woden, Belconnen and Latham zone substations, with the opportunity to offload these zone substations onto Molonglo Zone Substation. These 11 kV feeders from the new zone substation will be installed progressively to serve the residential areas as they develop and the load increases.

### 7.8.4 Supply to Strathnairn

This section describes the proposed solution to address the constraint in the Strathnairn district which comprises the extension of existing O'Loghlen feeder in the first instance (to defer the Strathnairn zone substation to the next regulatory period) and the construction of the zone substation and corresponding feeders subsequently as the population and load grow.

The development of the West Belconnen District is being carried out by a joint partnership between the ACT Government's Suburban Land Agency and Riverview Developments Pty Ltd. 11 kV feeders along with low voltage reticulation will be installed throughout the new suburbs of Strathnairn and Macnamara as they are developed. The maximum demand in the West Belconnen District is forecast to increase steadily to 45 MVA over the next 30 years as development proceeds. The development of this area will include 11,500 residential dwellings, plus commercial and community facilities. Maximum demand is forecast to grow initially at approximately 0.8 MVA per annum.

Evoenergy proposes to construct a new Strathnairn Zone Substation to supply this area with timing scheduled for approximately 2025-26.

There are two existing 11 kV feeders to this area, Macrossan and Latham feeders from Latham Zone Substation, with minimal available spare capacity.

To meet demand until the Strathnairn Zone Substation is constructed, it is proposed to extend the existing O'Loghlen feeder from Latham Zone Substation to Strathnairn. Load transfers will be made from this feeder to other adjacent feeders to provide sufficient spare capacity to meet the forecast demand.

With expected 100% penetration of rooftop generation, the network also faces hosting capacity constraints. Evoenergy proposes to incorporate a demand management non-network solution to help manage demand within the capacity of the Macrossan, Latham and O'Loghlen feeders. This may include controlling the output and use of rooftop solar PV generation and battery storage systems via in-home demand management systems. These systems may be used to manage the combined load on the feeders. Evoenergy is progressing the pilot project to confirm feasibility of the "behind the meter" battery solution. In addition, Evoenergy intends to explore the installation of the network batteries in collaboration with the ACT Government reversed auction participants. The results may impact the timing of the project. If required the annual planning report will be updated accordingly.

Estimated cost for extending the O'Loghlen feeder to the Strathnairn development is $2.21 million with proposed completion by June 2022. The project timing has changes assuming the demand management options can be utilised to reduce maximum demand and peak lopping of existing two feeders, Latham and Macrossan.

Future feeders will be installed from the proposed Strathnairn Zone Substation in stages as development and load increases.

### 7.8.5 Supply to Belconnen

There are several proposed developments in the Belconnen Town Centre area that will increase demand in the area over the next few years. Developments such as the Republic, a precinct of five proposed apartment buildings, is driving residential growth, and proposed development of the Belconnen Trades Centre is driving commercial and light industrial growth. There are also proposed development at the University of Canberra.

Load is forecast to increase by 2.7 MVA by 2024 and there is insufficient spare capacity in existing 11 kV feeders in the area.

Evoenergy has considered two options to supply this load as follows:

| Option | Option type | Description | Cost | Evaluation |
|---|---|---|---|---|
| **1** | Network | Construct a new 11 kV cable feeders from Belconnen Zone Substation to Belconnen Town Centre | $1.8m | Preferred |
| **2** | Non-network | Demand side management | N/A | Not preferred as does not meet need |
| **3** | Non-network | Delayed preferred network option using grid battery | $5.5m | Not selected as deferral not economical |

Option 1 involves the installation of a new 11 kV cable feeders from Belconnen Zone Substation to the Belconnen Town Centre area. The length of the feeder would be approximately 5.6 km.

This option has the lowest cost and highest NPV and is preferred.

Estimated cost is $1.8 million and proposed project completion is by December 2022.

### 7.8.6 Decommissioning of Fyshwick Zone Substation 66 kV Assets

Fyshwick Zone Substation was constructed and commissioned in 1982. It was a lost cost construction which included second hand transformers. It is supplied radially from TransGrid's Queanbeyan 132/66 kV Substation via two single circuit wooden pole 66 kV 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 supplying and at Fyshwick Zone Substation are approaching the end of their economic lives. The two 66 kV transmission lines from Queanbeyan to Fyshwick (3.6 km) were constructed in 1982 with wooden poles and Lemon 30/7/3.00 ACSR/GZ conductor. Most of the 52 x 66 kV poles have been nailed and will require replacement within the next 5-10 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 5-10 years.

Secondary assets such as 66 kV protection relays are also approaching the end of their economic lives.

Approximately $9.7 million will need to be expended over the next 5-10 years to upgrade / replace these 66 kV assets.

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/400mm$^2$ 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.

The proposed cable route length from East Lake to Fyshwick is approximately 2.7 km. Three spare 150 mm diameter PVC conduits exist from East Lake Zone Substation approximately 1.8

km towards Fyshwick. Thus only 900m would be required to be directional drilled and have conduits installed to Fyshwick Zone Substation.

Estimated cost is $5.58 million. Proposed project completion is by June 2024.

Figure 35 illustrates the condition of existing assets at Fyshwick 66/11 kV Zone Substation.

**Figure 35.** Fyshwick Zone Substation: Outdoor wooden pole strung busbars. Indoor 66 kV electromechanical protection relays

### 7.8.7 Mitchell Zone Substation / Gold Creek 3rd Transformer

The maximum demand in the Gungahlin District is forecast to increase over the next ten years with the development of new residential suburbs at Throsby, and Kenny, along with several commercial and residential developments in the Gungahlin Town Centre area, including commercial, retail and residential developments, medical centre, and other 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.

The objective of this project is to provide capacity to the growing industrial load in the Mitchell area. There is insufficient spare capacity in existing 11 kV feeders to the area and insufficient spare capacity in the two nearest zone substations at Gold Creek and Belconnen.

Evoenergy has considered two options to supply this load as follows:

| Option | Option type | Description |
|---|---|---|
| **1** | Network | Install the 3rd transformer at Gold Creek Zone Substation |
| **2** | Network | Construct a new zone substation at Mitchell |

Option 1 involves the installation of the 3rd transformer at Gold Creek zone substation to meet the growing demand.

Option 2 involves the construction of a new zone substation at Mitchell, which is closer to the locations of the new industrial loads at Mitchell and new residential areas at Kenny, Throsby and North Watson.

Option 1 is likely to be the lowest (initial) cost option but will incur high cost in the future due to longer 11kV feeder runs from Gold Creek and higher electrical losses, which are estimated in the form of Distribution Loss Factor (DLF).

Option 2 is going to cost more initially but subsequent feeder runs will be shorter which results in lower costs and lower electrical losses while also resulting in a network with higher resilience due to more diversified interconnection.

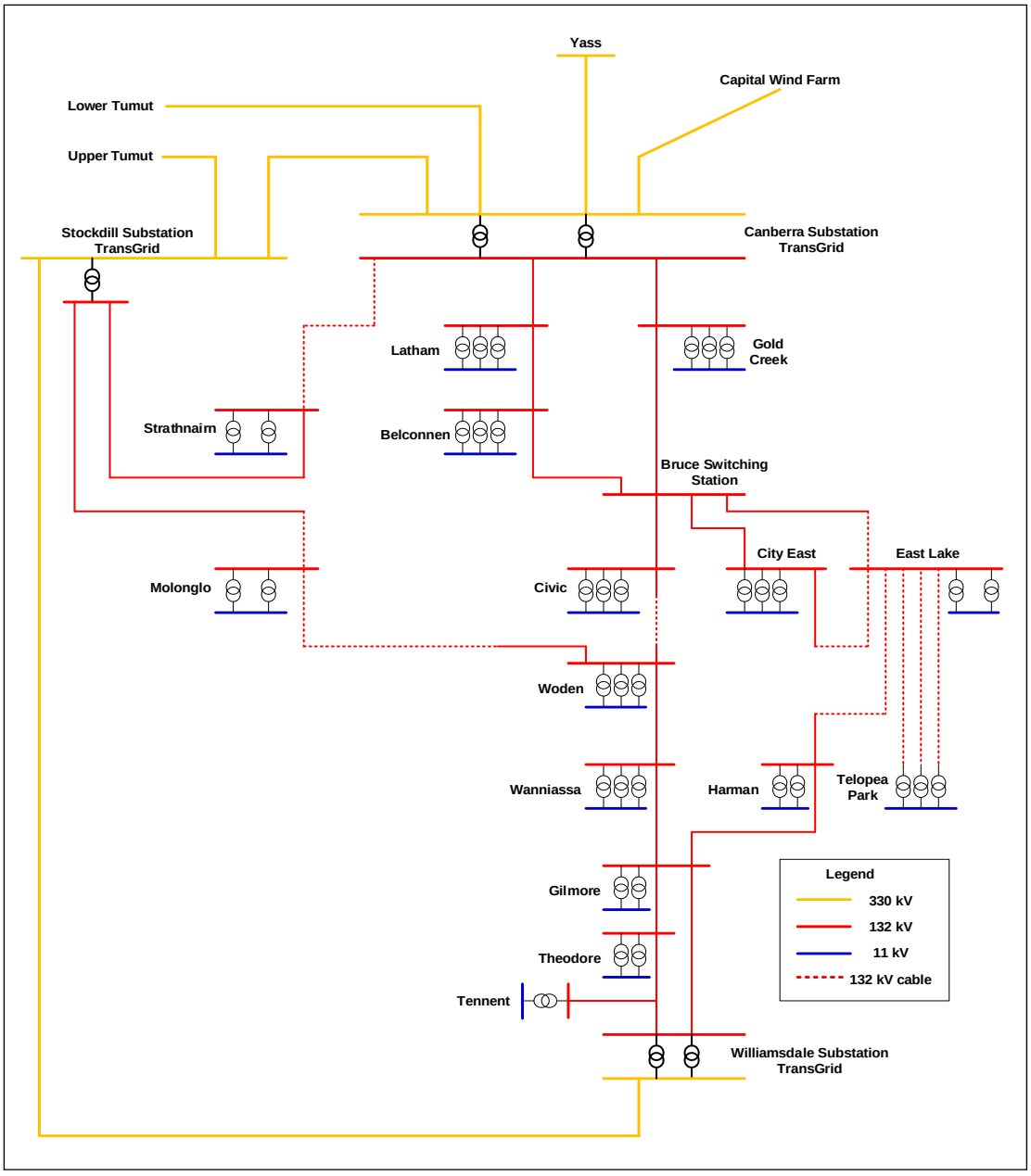
The above table lists two primary network options for augmentation of capacity in the Gold Creek and Mitchell areas. In addition, non-network options will be investigated as part pf the RIT-D

process. The rating of the Gold Creek Zone Substation is based on the 2 hour emergency rating of the 132kV/11 kV transformers. In case, of emergency (network contingency) at the time of maximum demand on the substation part of the load would have to be transferred away from Gold Creek. Therefore, Evoenergy needs to investigate transfer capacity from Gold Creek Substation to other substations in more detail to support transfer capacity through network and non-network options. The current estimated capacity is around 6.7 MVA which is not sufficient to fully load the Gold Creek Substation. Depending on the result of investigations, the timing of the constraint may change including possibly an earlier need for additional capacity or demand management. Annual Planning Report will be amended accordingly if required.

### 7.8.8 Future Transmission Network

Figure 36 shows future development of the transmission network over the next ten years.

**Figure 36.** Future (10 years) Transmission Network



## 7.9 Regulatory Investment Test

Under NER projects above $6 million funded by Evoenergy are subject to regulatory investment test. During last year Evoenergy did not conduct regulatory investment tests. The network limitations identified during the planning review include three limitations which are likely to require regulatory investment test: Molonglo, Gold Creek/Mitchell and Strathairn.

# Chapter 8 Demand Management

Demand management is deliberate action taken to reduce energy demand from the grid, rather than increasing supply capacity to meet increased demand.

## 8.1 What are the current challenges for Demand Management?

The current electricity distribution framework under which Evoenergy operates is designed for one-directional flow of electricity. As such with DM solutions coming to the forefront, Evoenergy is facing numerous barriers to a full-fledged DM capability. These include regulatory barriers that are limiting the collaborative efforts for Evoenergy to participate with market proponents. The Australian Energy Market Commission has also acknowledged these concerns and has proposed to pilot a sandbox arrangement for DNSPs to participate and overcome challenges with innovation projects. Additionally the implementation of DM solutions within the ACT is not targeted with the retailers responsible for many of the interactions with the end use customers. This also is due to the fact that the incentive that can be provided from a DNSP for DM solutions do not always stack up for the customer or a market proponent to implement the solution. These incentives that can be further provided from Evoenergy to the end use customer needs to be further drawn out or enhanced either jurisdictionally or from a regulatory standpoint to further promote DM activity within the ACT. With the proposed ACT Government energy policy changes, Evoenergy will have to change the way electricity is supplied to the residents in Canberra and with it the DM programs that Evoenergy is involved in. To understand the risks and opportunities this will bring, Evoenergy is proactively engaging in projects that will lead to a greater capability to meet the needs of the future. These are discussed further in Chapter 9.

## 8.2 What has Evoenergy done in the DM space during the last year?

While acknowledging that Evoenergy is limited in its ambition to have DM solution implemented, we are still investing in broad-based customer centric behavioural programs. This includes incentive based peak demand reduction program for both a sub-set of our residential customers as well as the large electricity users within the ACT. This includes the Energy Share SMS program as well as the Demand Response contracts with the large electricity users in Canberra. These provide our customers incentives to partake in our DM programs while understanding their drivers and barriers to DM uptake. This further helps Evoenergy to develop and target DM programs for the future while also deferring the need to augment our network to meet peak demand for summer and winter periods. These program and further discussed in Section 8.3.

As part of tariff reforms Evoenergy has modified and introduced new network tariffs which provide greater incentives for customers to manage their demand. The tariffs have been adjusted for commercial customers to increase demand management incentives. For the first time, new cost reflective tariffs also include demand tariffs for residential customers. The demand tariff is a default tariff for all new connections and replacement meters. The customers who choose to opt out from the demand tariff, are placed on the time-of-use residential tariff. General “flat” network tariff is no longer available to new customers. This has been provided as part of Evoenergy tariff structure statement and has been approved by the AER.

### Embedded generator connections

Schedule 5.8 of NER requires Evoenergy to provide information in relation to embedded generation connections. The table below summarises data for connection enquiries and connection applications.

**Table 16.** PV installations – number of enquiries, number of applications and time to process applications

| Installation Size | Number of Enquiries | Number of Applications | Average timeframe to process connection application (days) |
|---|---|---|---|
| **< 30kW No technical review required** | N/A* | 2333 | <10 |
| **< 30kW Technical review required** | N/A* | 1127 | 2.73 |
| **> 30kW** | 68 | 65 | 42.8 |

*N/A – not applicable

In addition to the above PV installations, Evoenergy received an enquiry related to a connection of methane gas generator connection.

## 8.3 What does Evoenergy propose to do in the future in the DM space?

Evoenergy is improving understanding of customer behaviours and their willingness to engage with the utilities for DM opportunities. This means that customers are willing to participate in a DM program but are often looking for a higher incentive – monetary or otherwise which may not always be the right option for Evoenergy. To further develop our capability in delivering and strategising DM opportunities, Evoenergy will need to have further monitoring in place on customer assets either through improved appliance standards or retrofitting. The customer aversion to handover control of their behind the meter devices for network benefit is also a factor when it comes to an effective DM rollout. This is where more engagement with end users from both the utility and local and federal government will be the key. Evoenergy is investigating how our various DM opportunities can be aligned with the industry wide momentum in moving to a future operating world. Some of these projects include pilot trails of access to Home Energy Management Systems (HEMS) at residences that can provide an effective peak demand reduction through smart devices. These projects are targeted in new greenfield estates (Ginninderry etc.) but the learning and viability can be replicated in other parts of the ACT. These innovation activities that covers a broad spectrum of activity including potential DM solutions and can increase Evoenergy's DM capability is further detailed in Chapter 9.

## 8.4 Overview of demand management

Demand management (DM) is an important part of efficient and sustainable network operations. A demand management solution is referred to as a non-network solution and a demand management provider is referred to as non-network solution provider.

The need for demand management services in the ACT are needed for a variety of reasons. The major trends being observed in the ACT are as below

- Increasing load growth in Greenfield and selected brownfield areas.
- Power quality issues with embedded generators.
- Physical limitations of the infrastructure in Evoenergy's distribution network.

By reducing peak load on the grid, security of supply can be maintained without installing additional infrastructure and its associated expenditure. Growth in demand across our network is uneven; negligible in some areas and rapidly growing in others. Drivers for demand growth include the development of new Greenfield residential areas, urban renewal areas - where single level dwellings are demolished and replaced by multi-storey apartment buildings - and the development of energy-intensive businesses such as data centres.

Advances in smart metering and communications technology mean there are now a large number of methods to control energy loads, each becoming more affordable over time. A focus on peak load management, energy efficiency[10] and distributed generation will provide consumers high quality, low cost service into the future.

Additionally with embedded generators, notably solar PV and batteries, Evoenergy is facing issues with power quality where generation is coming onto the network which was only designed for one-directional flow – typically from a central substation towards homes and residences. This trend is now starting to reverse with increasing uptake of solar PV and batteries that send power back into our network and causing issues with voltage and hitting the upward limits of capabilities in our poles and wires. Specific examples in the ACT, include 100% solar suburbs such as Denman Prospect. Ginninderry development with high PV penetration is being actively investigated and researched for DM opportunities by Evoenergy. Effective DM solutions will be necessary to ameliorate these issues and avoid investment in costly upgrades. Further details of some of these solution being investigated are specified in Chapter 9.

Effective application of DM can defer the need to augment constrained parts of the network to meet demand growth. This reduces the cost of replacing ageing assets and leads to lower costs to customers. Evoenergy wants to maximise the benefits of non-network technologies such as solar PV generation and battery energy storage, and manage the use of new loads such as electric vehicle charging stations, to reduce daily system peaks and produce as smooth a load profile as possible. The future use of alternative energy sources such as natural gas, bio gas and hydrogen will also influence the demand on the electricity network.

Evoenergy also engages with consumers and non-network solution providers to identify demand management options in the pursuit of significant advances in demand management. This is detailed in Evoenergy's demand side engagement strategy. This has been summarised in in the section below.

## 8.5 Demand Side Engagement Strategy

Evoenergy's Demand Side Engagement Strategy (DSES) aims to:

- Support Demand Side Management (DSM) and provide opportunities for consumers and non-network service providers to participate in addressing network supply limitations.
- Develop and apply a transparent DSM process for network planning and development.
- Develop demand management tools and alliances to readily facilitate non-network options.

Potential non-network service providers and all customers are encouraged to participate in Evoenergy's demand management activities. It is important we ensure that a full range of solutions is considered and that emerging network constraints are resolved in a way that achieves optimal economical and technical outcomes for customers. Our DSES is published on our website[11]. Non-network service providers can register as an Interested Party[12] on our website and engage with Evoenergy to identify non-network solutions. Some demand management options will be able to generate a revenue stream, part of which will be accessible to the proponents of the demand solution.

The process overview for projects not subject to Regulatory Investment Test is shown in Chapter 1 as part of the DSES, Evoenergy will request from proponents solutions to network constraints that are a result of asset related or customer initiated works. These requests form part of Evoenergy's assessment of non-network options for an identified need.

[10] https://www.evoenergy.com.au/residents/pricing-and-tariffs/peak-demand-tariffs/reducing-peak-demand

[11] https://www.evoenergy.com.au/emerging-technology/demand-management/demand-side-engagement

[12] https://www.evoenergy.com.au/emerging-technology/demand-management

The request for proposals (RFP) is typically market tested by circulating the RFP document on Evoenergy's demand side register of interested parties. These also get published on our website.

Evoenergy undertakes an assessment of the solution by detailing a few basic characteristics of the identified need. This typically includes:

- A feeder or sub-station profile – identifying residential or commercial load.
- A geographical visualisation of the constraint location.
- Expected timeframe of the constraint arising.
- Demand characteristics including any embedded generator information.
- Description of expected solutions to ensure that proposed solutions are in line with Evoenergy and ACT Government policies.
- Expecting funding and payment regimes from Evoenergy
- Assessment criteria for the identified need includes:
    - Technical viability of each option identified;
    - Customer payback period for each opportunity identified (where applicable);
    - Cost effectiveness of the proposed demand reductions
    - Ability of each option to be measured and verified; and
    - Ability of the customer to achieve stated load reductions within required timeframes.
    - Experience in delivering non-network solutions

If a proposal is accepted, Evoenergy will enter into a contract with the DSM provider. Evoenergy will then work with the provider to ensure initiatives are undertaken and the load reductions are measured and verified so that payments can be made, in accordance with the contract.

## 8.6 Demand Side Management Programs

DSM programs are developed in a way that residential, commercial and industrial customers and third-party businesses such as demand aggregators and curtailment service providers can easily participate. These programs encourage customers to reduce their demand or use alternative energy sources for their energy needs when the network capacity is constrained.

Evoenergy has introduced initiatives under the AER's Demand Management Incentive Scheme (DMIS) that includes a Demand Management Innovation Allowance (DMIA). This capped allowance encourages distributors to investigate and conduct broad-based and targeted projects.

**Broad Based Projects**
Over the past year Evoenergy has conducted trials on the following DSM initiatives. These trials have proven the concept and it is hoped to scale these up over the next few years:

- **Energy Share SMS program** – customers with smart meters were asked to enrol in the program to reduce demand based on Evoenergy messaging.

  Through April, May and June in 2019, Evoenergy invited customers in the ACT with a smart meter to register for an Energy Share SMS trial program. Participants who registered were texted periodically over a three-month period asking to reduce their electricity use for two hours. As an incentive to be part of the program, participants were entered into a draw for gift cards for signing up as well as responding to the SMS events. The prizes ranged from $100 to $500 visa gift cards. Overall Evoenergy had 476 customers in the ACT registered in the program with an average participation rate of 57% which was very encouraging. Following the program, Evoenergy conducted a survey of the participants with results to be published after detailed assessment.

- **Load curtailment contracts** with large customers. This an agreement with large customers to reduce their demand by known amounts during peak demand or system constraint.

  Canberra typically has a predominantly winter peak for the electricity demand. Due to the relatively longer winter period, Canberrans use more electricity due to use of heaters and air conditioners. In 2019, the summer peak demand exceeded the 2018 winter peak demand and the summer period is increasingly becoming the time of maximum use for electricity in the ACT. In addition as part of an interconnected electricity system in the east coast of Australia, the ACT is also beholden to market events or generation issues in other states where the market operator (AEMO) will direct networks to load shed to maintain the security of the electricity system across all states.

  In order to mitigate any forced outages to the customers in the ACT, Evoenergy proactively contracts with large industrial and commercial electricity users to reduce their usage and be available to curtail their electricity use upon direction from Evoenergy. This process was initiated as a trial and even though Evoenergy has not had to direct any customers to curtail their usage, it is an active tool in Evoenergy's response arsenal for any such events. In addition, special note must be made of voluntary load reduction by some large customers in the ACT who willingly reduce the load on the network when asked by Evoenergy. Currently we have contracted four large commercial entities to be on load curtailment contracts who have standby supply or mechanisms to switch of non-essential equipment and provide relief to the network during such events.

- **Virtual Power Plant** – the stored energy from the residential battery systems of around 900 customers is remotely dispatched back into the grid at times of peak demand (refer to Section 9.2).

**Targeted Projects**

During 2019, Evoenergy did not conduct any targeted projects in the demand management space. This was due to a variety of reasons, where the expected load growth did not occur in the anticipated timeframe or the preliminary network assessment showed the need for a network solution exceeded the non-network options available. None of the projects were market tested, as existing infrastructure was managed to maintain the needs of Evoenergy.

As part of Evoenergy's planning process, a number of limitations in the distribution network have been identified which could have opportunities for demand management solutions. These constraints area are identified in the Table 1 in the Executive Summary and Table 14 in Chapter 7.

In addition to these broad based and targeted projects, Evoenergy is also actively investigating, and is partnering in innovative projects that will assist with demand management solutions within the ACT. These projects and solutions are discussed further in the next chapter.

## 8.7 Demand Management considerations

As part of the regular planning and network analysis that Evoenergy conducts for the distribution network, projects have either a business case and or a project justification report to provide rigour around the process for internal stakeholders. It also demonstrates the best practice for Evoenergy to ascertain that non-network options are considered and optimal solution is identified. Non-network options consideration include embedded generation, large or medium – scale storage, hybrid options (combining generation and storage), energy efficiency and load management options, which can be achieved in a reasonable timeframe to avoid augmentation. These analyses provide Evoenergy assurance that optimal solution is identified and cost benefit impact for network and non-network options are considered.

Over the past year, Evoenergy has conducted analysis of these non-network options for various business cases and overwhelmingly the magnitude of the load constraint and time restrictions in

achieving the desired outcome are key factors for the non-network option not progressing. Additionally options such as embedded generation including storage are still economically prohibitive for the network to invest in. Evoenergy also has energy efficiency options to provide demand management services, but the jurisdictional scheme that is responsible for the targets in this space is rolled out through the local retailers. This puts an additional layer of complexity to achieve a preferred non-network outcome for Evoenergy. The above summary is a generalisation and most option analysis is done on a project by project basis. Evoenergy expects the outcome to change with decreasing costs of the options.

Evoenergy also publicised its intention to engage for demand management and non-network solutions from external parties through public forums at Evoenergy's launch of the 2018 Annual Planning Report as well as through direct stakeholder engagement with end users and developers in the ACT including engineering groups and key groups in the building and property sectors.

# Chapter 9 Future ways of working

## 9.1 Overview

The generation, transmission and distribution of electrical energy are changing rapidly with new advances in technology. These emerging technologies are impacting on all parts of the supply chain, and particularly for Evoenergy in the distribution network. As a result, Evoenergy along with other electricity distribution companies are evolving in their traditional approach to the supply of electricity. Evoenergy is keeping abreast of these emerging technologies and future network planning will embrace these technologies to shape our network and benefit our customers.

Dealing with the increasing proliferation of DER presents new challenges to Evoenergy including coping with localised network overloads due to the thermal rating of existing equipment, increased voltage fluctuations due to varying DER power output, increased fault levels and protection coordination issues. Evoenergy is exploring ways to actively manage the network by utilising real-time control and communications systems to provide better integration of DER.

DER coupled with demand management presents opportunities to defer or avoid expenditure on network assets by providing alternative power supplies to the network (refer chapter 8). Evoenergy seeks to manage the increasing prevalence of DERs connected to its network without the need for extreme control means such as generation curtailment to manage power flows and voltage levels.

Additionally, Evoenergy supports the climate change strategies of the local ACT Government. (refer section 2.4) which is aiming to achieve the legislated target of net zero emissions by 2045. This will impact Evoenergy's business and influence network planning for many years to come. Evoenergy is working collaboratively with the local authorities and the community to achieve the best outcome for the all parties.

Evoenergy is working actively to investigate the technical and economic feasibility of network batteries in Evoenergy's distribution network. In line with the recently released ACT Government Climate Change Strategy, ACT will be hosting up to 20MW of network battery within the distribution network. Evoenergy is liaising with the ACT government and individual vendors to understand the impacts of such an installation.

## 9.1 OpEN – Open Energy Networks project

Many of the challenges facing the electricity distribution sector require collaboration across the industry to resolve which Evoenergy takes seriously. As a result we have been part of the Energy Networks Association (ENA) and the Australian Energy Market Operator (AEMO) Open Energy Networks consultation process which began in 2018.

The joint OpEN project which was setup in the face of a rapid decentralisation of the energy system, follows on from the Energy Networks Australia's Electricity Network Transformation Roadmap 2017, which identified significant financial benefits, $1.4 billion in avoided network investment, to be gained through optimising behaviour of Distributed Energy Resources (DER).

The project is examining the possible 'future worlds' that could deliver whole-of-system optimisation in-line with the National Electricity Objective. This coordinated examination of whole-of-system optimisation is recognised broadly within the industry as key to ensuring that customers are not left with simply traditional solutions such as limiting exports from DER to the grid, upgrading the network and reforming tariffs.

## 9.2 Virtual Power Plants

A Virtual Power Plant (VPP) consists of a combination of several small scale distributed energy resources, such as rooftop PV generators and battery energy storage systems that can be controlled to act in a similar way to a large conventional power plant to minimise system demand

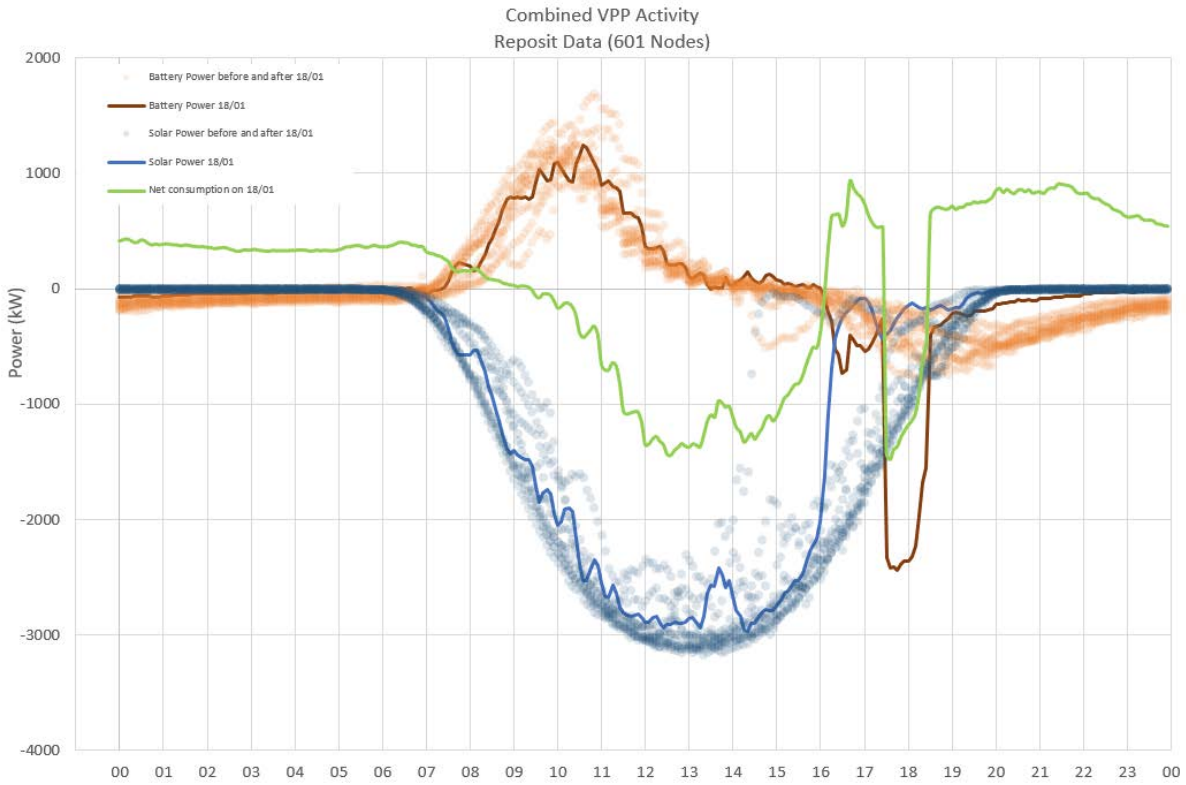
in a local area. As Evoenergy transforms into a distribution system operator it will need to either develop new tools internally or integrate with external experts.

Evoenergy is collaborating with Reposit Power to trial a VPP, enabled through residential battery storage.

Reposit Power's VPP Fleet system allows Evoenergy to dispatch a pricing signal to around 900 Canberra residential batteries offering to reimburse each household with Grid Credit for each kWh discharged from its battery.

The table below shows the various trials that Evoenergy has undertaken with the VPP fleet in its network.

| Trial 1 – All ACT | Trial 2 – Voltage Control | Trial 3 - All ACT |
|---|---|---|
| Mar 2017 to Nov 2018 | Dec 2018 – Jan 2019 | 18 Jan 2019 (Heat event day) |
| 320 nodes | 8 nodes | 601 nodes |
| 1.4 MW for one hour | 3 sets of trials with lead and lag Power Factor (PF) | 2.2 MW for one hour |



Opportunities for VPPs in ACT

- Smart meter rollout essential to capture data and cost benefit analysis – Government incentives can assist.
- Utilising batteries to control reverse power flow and charge intelligently using tariff structures or incentive payments.
- Deferring costly network investment using DM solutions aggregated through VPP rollout.
- The trials have provided Evoenergy with the following learnings:

- Proof that a VPP can be used to help reduce peak demand on the distribution network.
- Confirmation that the VPP Fleet system is capable of coordinating residential batteries to provide grid support.
- Demonstration that a third-party service engagement is a practical and effective means of supporting Evoenergy's distribution network.
- Identification of the need to continue the integration of similar dynamic data services and IoT devices for network state estimation.

Evoenergy has more to learn in order to operate in an increasingly DER and battery storage rich environment. The Demand Management team will continue to analyse data from these avenues, as well as future trials to optimise DER behaviour in Evoenergy's network.

## 9.3 Innovation projects

Evoenergy is proactively participating in innovative projects that will help shape the future working and operation of our business. These projects are in conjunction with universities, private enterprises and retailers who investigate options of maximising the consumer benefit of the existing infrastructure by providing value to customers as well as other parties. This collaboration will enhance the capabilities of Evoenergy to transition into a distribution system operator (DSO) as per our strategy to evolve the way we work.

| Innovation Projects | Status | Timing | Outcome |
|---|---|---|---|
| **Ginninderry Energy Pilot – Evoenergy co lead with Riverview** | Underway | 2019- 2024 | Assess the real time implications/outcomes from an electricity-only neighbourhood and understand interaction with the electricity grid for very high penetration of rooftop PV systems. |
| **DER Lab Project – Evoenergy partner project** | Underway | 2019- 2021 | Provide DER devices a test platform to interact with each other and assist in greater uptake of DER. |
| **Community Energy Models – Evoenergy partner** | Underway | 2019- 2020 | Analysis of community energy models in the ACT. |
| **Sponsorship of University of Wollongong Ph.D. student** | Underway | 2020 completion | Develop and test optimal control system for smart residential houses which optimises the consumption and storage of energy along with the operation of several controllable loads. |

Two of the above projects that Evoenergy is leading are discussed below.

## 9.4 Ginninderry energy pilot project

Ginninderry estate is a large new residential estate being developed in the West Belconnen area, with new suburbs to be named Strathnairn and Macnamara. Ultimately home to approximately 30,000 residents over the next 30-40 years, Ginninderry aims to showcase world leadership through its planning, design, construction and post-occupancy performance (liveability) – acting as a model for other developments to follow. As part of that aspiration, the Ginninderry Joint Venture has chosen to explore the renewable energy future for the development – through the use of solar photovoltaic (PV) systems, energy management and battery storage technologies.

In the first stage of the development, solar PV systems (ranging in size from 2 – 5 kW) are incentivised on all buildings (including single residential, townhouse, multiunit and community facilities) with the ultimate aim that the buildings within Ginninderry become a distributed energy network. This includes the exploration of the potential for extensive residential (behind the meter) and centralised battery storage systems.

The Ginninderry JV has sought permission from the *ACT Government's Environment, Planning and Sustainable Development Directorate (EPSDD) for a Territory Plan Waiver* 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.

The Ginninderry Energy Pilot Project (EPP) aims to assess the real time implications/outcomes 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. This can be done through Demand Management (DM) aggregators who can install Home Energy Management Systems (HEMS) at the residences who can integrate with Evoenergy for network services. Evoenergy intends to partner 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. This project is underway in the planning phase under the pilot project.

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 customers 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 trailed 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.

The EPP is the outcome of two years of work between the Ginninderry JV, Evoenergy, energy retailers, product suppliers, research institutions, ACT Government and energy consultants to explore options for a best practise residential energy solution.

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.

## 9.5 Electric vehicles (cars, trucks, bicycles)

Evoenergy intends to be a leader in the transformation for the energy network.

There are few privately-owned electric vehicles (EV's) on the streets of the ACT at present but it is anticipated that their prevalence will increase significantly in the coming years as costs decrease and battery range increases. Globally EV's are forecast to increase to 15% of the motor vehicle population by 2030. As travelling distances within the ACT are relatively short compared with other states, coupled with the ACT Government's plan for the territory to be carbon-emission-neutral by 2045, it is anticipated that the uptake of EV's in the ACT will exceed this. Penetration of EV's in the ACT could reach a significant proportion of vehicles by 2030. This could serve to offset the reduction in energy demand caused by embedded generation and storage systems.

**Roaming:** Network infrastructure to enable inter jurisdictional roaming that allows ACT EV charging network members to travel outside of the ACT and charge at any inter jurisdictional charge point - regardless of the network provider, hence, mitigating range anxiety.

Evoenergy is also investigating the impact of cars with bidirectional chargers that are being sold by various manufacturers. These vehicles can import and export their car battery to the grid (similar to residential batteries) which could have a detrimental impact on the network unless it is carefully coordinated and managed. Evoenergy will proactively assess the impact of such new technology over the coming years.

## 9.6 Advanced meters

Installing consumer meters is the responsibility of Energy Retailers and the newer meters currently being installed enable energy consumption data to be available to both customers and utilities on a real time basis via two-way communications networks. This visibility can assist the customer and the service provider with demand management and improved energy utilisation.

Some of the potential uses of meters are as follows (refer section for further discussion of smart meters):

- Automatic Outage management notification to the Retailer and the Distributor
- Support and enhance network modelling with improved network forecasting and planning outcomes
- Power quality monitoring
- Neutral Integrity monitoring
- Automated meter reading
- Remote connection and disconnection of customers
- Demand management - control of customer loads such as hot water, pool pumps and air conditioning
- Support smart network initiatives, e.g. battery storage and embedded generation

## 9.7 Remote area power supplies

Evoenergy's network is primarily urban, but there are some long overhead 11 kV distribution feeders in rural areas that supply remote small loads only. These feeders are under-utilised and as they age, their maintenance costs increase. Vegetation management is also costly, particularly where a feeder traverses bushfire prone areas.

Evoenergy have identified two sites on the end of long rural feeders to install Remote Area Power Supplies (RAPS). The first is the Gudgenby Homestead and Cottage at the end of the Matthews feeder, and the second is at Coring Dam, which is at the end of the Reid feeder. Installing RAPS systems at the end of these feeders allow Evoenergy to decommission 16.5 km of bushfire zone overhead 11 kV lines.

The RAPS systems will consist of solar PV system, battery energy storage, a back-up generator and demand management as well as energy efficiency improvements.

**Gudgenby Homestead and Cottage:**

The property sits within the Namadgi National Park and is owned and operated by the ACT Department of Parks, Conservation and Lands (ACT Parks). Supply to this site was via a 7 km single phase overhead 11 kV line that ran through a bushfire prone area and required significant maintenance. Evoenergy has decommissioned this section of the line and is now sourcing the power from an 18 kVA RAPS system.

There is still 300m of overhead line allowing a single raps system at the homestead to delivery power to the cottage.

Evoenergy is monitoring the loads, generation and operation of the system to ensure that the system is sized to supply a reliable source power to the homestead and cottage. The system is designed in a modular fashion so additional equipment can be installed as required by the load changing in the future. Evoenergy is also working with ACT Parks to determine the best demand management strategies for the site.

*Photo: Gudgenby Homestead before and during RAPS installation*

**Corin Dam**

Corin Dam is at the end of a 9.5 km section of three phase overhead 11 kV line (Reid feeder) which runs through bushfire prone areas in the Namadgi National Park. The site contains pumping facilities owned by Icon Water and a rangers' house owned by ACT Parks. The design of the system is yet to be finalised, but will be very similar to the design at Gudgenby.

*Photo: Corin Dam*

Evoenergy is investigating the feasibility and economics of establishing RAPS at other similar sites.

## 9.8 Drones and LIDAR Technology

Evoenergy strives to adopt new technologies and evolve practices in the ever changing landscape of the distribution business. For the last five years, vegetation inspection has been managed through a combination of helicopters and drones. The inspections involve the use of LIDAR (Light Detection and Ranging) technology which scans the network to identify where vegetation has grown within the safe clearance distance of our power lines.

During 2018 and 2019, LIDAR-enabled drones flew multiple sections of power lines capturing data on vegetation, conductors, poles and structures. The level of detail and data that a is captured by the LIDAR scan and photography of a drone flying at 30m above the ground is far greater than that of a helicopter flying at 300m above the ground. This facilitates improved defect identification and location accuracy.

Evoenergy looks forward to further testing the feasibility of the technology by scanning larger areas of our network in 2020 and using the data to proactively maintain vegetation clearance, identify network defects to keep the network safe and reliable while improving our customer service and satisfaction at the same time.

Evoenergy has also engaged in a trial using drones to perform pole top, pole equipment, transmission tower and vegetation inspections. Inspection methods include photographic imagery of distribution assets and 4k video imagery of transmission assets. The pole top photography captured is used to identify defects on the pole top, cross-arm, insulators, and conductors while the 4k video of the transmission structures provides additional context for each asset component and defect. The Imagery of the asset that is captured during the inspection provides a historical reference and assists in their long term management. Conducting the transmission tower inspections via drone removes the need to physically climb the structures, resulting in safer work practices. Evoenergy is currently considering options for the ongoing use of drones to inspect transmission towers and distribution poles.

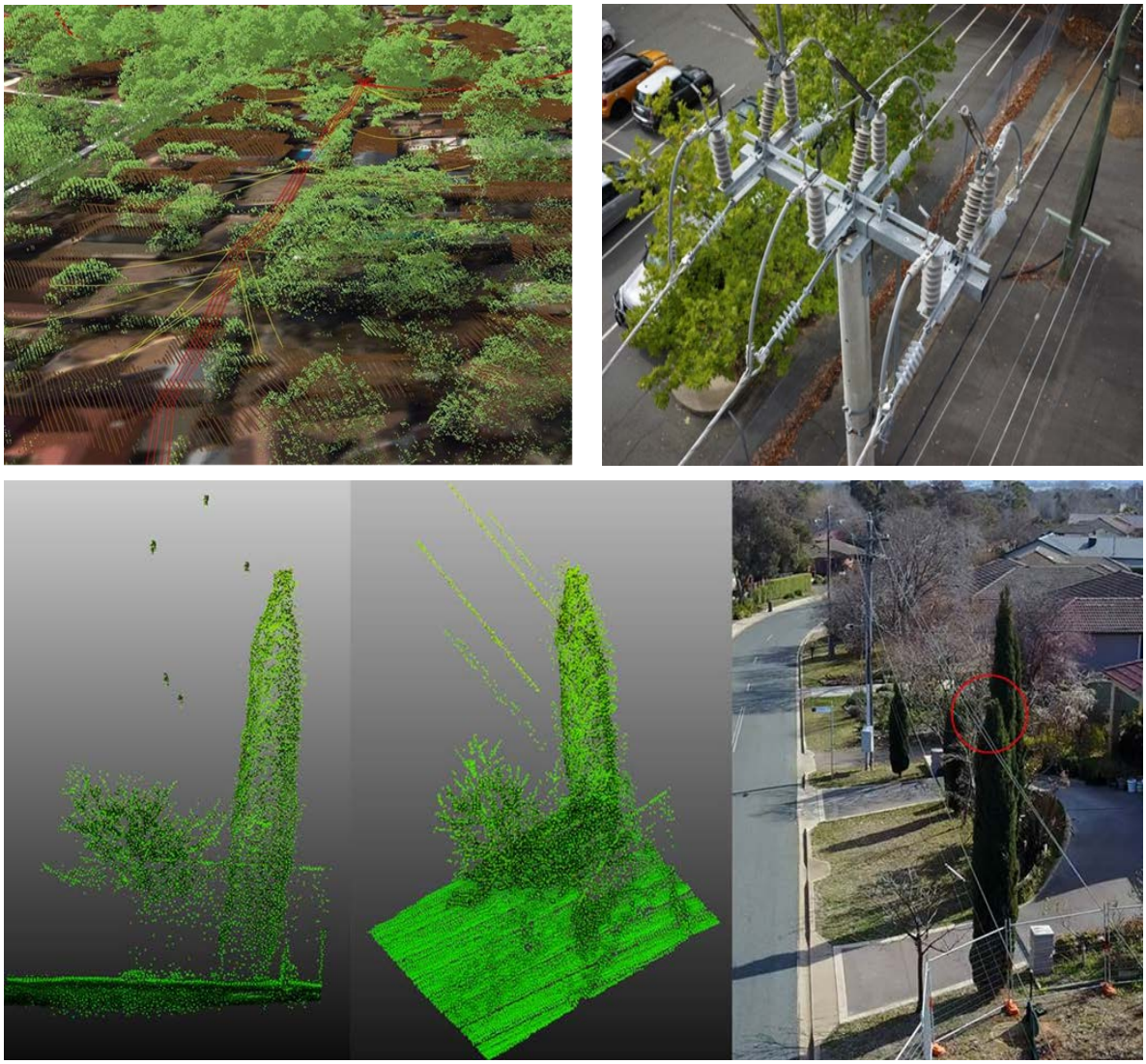


*Photo: Drones and LIDAR Technology*

## 9.9 Advanced Fault Detection and Auto-Reclosing Schemes

Electricity distribution networks inherently involve bushfire risk to the environment and the community. Evoenergy is trailing 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 trail includes installation of pulse closing S&C Intellirupters 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 grass-fire 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.

## 9.10 FLISR (Fault Location, Isolation and Supply Restoration) Automated FLISR (Fault Location, Isolation and Supply Restoration)

Automated Fault Location, Isolation and Supply Restoration (FLISR) forms part of our strategy to maintain future network performance, working our network harder and smarter. Our reliability strategy includes the implementation of an automated FLISR system in our ADMS system to minimise unplanned outages for customers and maintain network unplanned SAIDI and SAIFI reliability performance.

An automated FLISR system is a collection of components including a centralised control system (ADMS), communication systems and remote control network devices in the field. Together, these components safely and quickly isolate faulted sections of a network when faults occur and restore supply to non-faulted sections, quickly restoring supply to most customers in the process.

Our roadmap for a smarter healing network includes automated FLISR. Our plan includes the development of a centralised FLISR control system our ADMS, and deployment of switchgear with remote control and indication. Automated FLISR is planned to be introduced with deployment of switchgear with remote control and indication in our distribution network underway.

An automated FLISR process includes the following steps/applications:

1. **Fault Location**: Locating the part of the feeder with the faulted network element (e.g. faulted cable or overhead section) using appropriate methods. These methods make use of all remote control deployed equipment in the distribution system capable of fault detection and location.

2. **Fault Localisation:** Locating the part of the feeder with the faulted element using remotely and/or manually controlled switching devices. This step is used for feeders without deployed equipment for fault location, such as fault indicators and fault measurements.

3. **Element (Fault) Isolation**: This step executes a switching plan to isolate the faulted element from the remaining (healthy) part of the feeder using remote control switchgear and communication systems

4. **Service Restoration:** A switching plan is executed to re-supply customers connected to (healthy) de-energized sections on the faulted feeder via switch orders to remote control switchgear.

5. **Return to Normal State:** Returns the network to the state before the fault occurred.

To maintain reliable service, the ADMS FLISR application provides the optimal plan of control actions for detecting, locating, and isolating faults and restoring power on a distribution feeder.

**Large Area Restoration (LAR)** determines the plan for restoration of the supply of large parts of the distribution network, which remained de-energized after a fault occurs on a zone substation supply transformer or MV busbar at a zone substation or after isolation of an element for maintenance at a zone substation.

## 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** | Digtial data radio network |
| **DER** | Distributed Energy Resource |
| **DMIS** | Demand Management Incentive Scheme |
| **DMP** | Demand Management Process |
| **DNSP** | Distribution Network Service Provider |
| **DR** | Demand Response |
| **DSES** | Demand Side Engagement Strategy |
| **DSM** | Demand Side Management |
| **DSMP** | Demand Side Management Planning |
| **DSO** | Distribution System Operator |
| **DUOS** | Distribution Use of System |
| **ECRC** | Energy Consumers Reference Council |
| **ENA** | Energy Networks Australia |
| **EOI** | Expression of Interest |
| **FLISR** | Fault Location, Isolation and Supply Restoration |
| **HV** | High voltage |
| **ICRC** | Independent Competition and Regulatory Commission |
| **MVA** | Mega Volt Amperes |
| **MW** | Mega Watts |
| **NPC** | Net Present Cost |
| **NEL** | National Electricity Law |

| Term | Definition |
|---|---|
| **NEM** | National Electricity Market |
| **NER** | National Electricity Rules |
| **NPV** | Net Present Value |
| **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 |
| **Term** | Definition |
| **PoE** | Probability of Exceedance |
| **PV** | Photovoltaic |
| **QOS** | Quality of Supply |
| **RDSE** | Register of Demand Side Engagement |
| **RIT-D** | Regulatory Investment Test for Distribution |
| **RIT-T** | Regulatory Investment Test for Transmission |

## Appendix B – Network physical characteristics

In addition to the overview provided in Chapter 0 this Appendix provides more details describing Evoenergy's transmission and distribution network including capacity , security and ratings of the zone substations, transmission lines and the number of key assets.

### Configuration of the Evoenergy's network

The Evoenergy network is supplied from TransGrid NSW network through three bulk supply points. A fourth bulk point, Stockdill substation is currently under construction by Transgrid.

The Evoenergy network consists of an interconnected 132 kV transmission network supplying twelve 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 transmission security with the exception of Tennent Zone Substation which is connected via a single circuit 132 kV tee-connection. There are three bulk supply points supplying the Evoenergy network, all owned and operated by TransGrid Limited as follows:

- Canberra 330/132 kV bulk supply substation.
- Williamsdale 330/132 kV bulk supply substation.
- Queanbeyan 132/66 kV bulk supply substation.

Evoenergy's assets include 132 kV transmission lines, 66 kV sub-transmission lines, 132/11 kV and 66/11 kV zone substations, 22 kV and 11 kV distribution feeders, 22/0.415 kV and 11/0.415 kV distribution substations, low voltage 400 V circuits, and equipment such as distribution pillars and pits to provide connection points to customers. Evoenergy also owns a 132/11 kV 14 MVA mobile substation that can be deployed as required at short notice.

A second power transformer was commissioned at East Lake zone substation in November 2019. 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 N-1 transformer security.

There are currently 256 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 58% of Evoenergy's distribution network and 2% of the transmission network is underground.

The network supplies around 196 500 electricity customers. There are 25 customers directly connected at 11 kV, two customers directly connected at 22 kV, and no customers directly connected at either 66 kV or 132 kV. The remaining customers 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 1500 kVA.

Customers are primarily commercial, light industrial or residential connections. There are no major industrial customers.

Electrical energy consumed in the ACT is generated mainly outside the ACT and enters via TransGrid's transmission network. However, 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 transmission and distribution lines, digital microwave and UHF radios and associated repeater stations.

Chapter 2 includes transmission schematics and geographic representation of the Evoenergy transmission 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 transmission 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 transmission line or distribution feeder) is out of service.

There is one 66 kV bulk supply point two 132 kV point interconnecting Evoenergy network to NSW network.

The two 132 kV bulk supply points are Canberra Substation and Williamsdale Substation. As Williamsdale Substation is supplied radially from Canberra Substation at 330 kV, a constraint has been identified jointly by TransGrid and Evoenergy whereby in the event of a total outage of Canberra Substation, supply to Evoenergy's 132 kV network would be constrained. This issue is to be addressed in the current planning period by a construction of Stockdill 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 transmission 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 17

**Table 17.** Evoenergy Network Assets

| Asset Type | Nominal Voltage | Quantity |
|---|---|---|
| **Bulk Supply Points** | 330/132 kV | 2 |
| | 132/66 kV | 1 |
| **Transmission Lines** | 132 kV | 190 km Overhead |
| | 132 kV | 6 km Underground |
| **Sub-transmission Lines** | 66 kV | 7 km Overhead |
| **Switching Stations** | 132 kV | 2 |
| **Zone Substations** | 132/11 kV | 13 (+ 1 mobile substation) |
| | 66/11kV | 1 |
| **Power transformers** | 132/11 kV | 29 |
| | 66/11 kV | 3 |
| **Feeders** | 22 kV | 2 |
| | 11 kV | 256 |
| **Distribution Substations** | 22 kV/400 V | 10 |
| **Distribution Substations** | 11 kV/400 V | 4,620 |
| **Distribution Switching Stations** | 11kV | 360 |
| **Number of transmission towers and pole structures** | 132 kV | 1,425 |
| | 66 kV | 52 |
| **Number of poles** | 22 kV, 11 kV and 400 V | 49,029 |
| **Circuit km of distribution overhead lines** | 22 kV, 11 kV and 400 V | 2,160 km |
| **Circuit km of distribution underground cables** | 11 kV and 400 V | 3,075 km |
| **Number of customer connections** | 22 kV | 2 |
| | 11 kV | 25 |
| | 400 V / 230 V | 196 500 |
| **Coverage area** | | 2,358 $km^2$ |
| **System maximum demand** | | 657 MW |

## Ratings of zone substations and transmission lines

### ZONE SUBSTATION RATINGS

Evoenergy operates the thirteen 132/11 kV zone substations and one 66/11kV substation. The Table 18 summarises the total capacity and firm capacity for each substation including the year of commissioning. The firm capacity refers to the capacity of the substations available after a single credible network contingency event ( e.g. usually an outage of one of the power transformers)

**Table 18.** Evoenergy's Zone Substations

| Zone Substation | Year commissioned | Voltage | Total capacity | Firm capacity | No of transformers |
|---|---|---|---|---|---|
| **Angle Crossing (mobile substation)** | 2012 | 132/11 kV | 15 MVA | 0 MVA | 1 |
| **Belconnen** | 1977 | 132/11 kV | 110 MVA | 55 MVA | 2 |
| **City East** | 1979 | 132/11 kV | 171 MVA | 114 MVA | 3 |
| **Civic** | 1967 | 132/11 kV | 165 MVA | 110 MVA | 3 |
| **East Lake** | 2013 | 132/11 kV | 110 MVA | 55 MVA | 2 |
| **Fyshwick** | 1982 | 66/11 kV | 75 MVA | 50 MVA | 3 |
| **Gilmore** | 1987 | 132/11 kV | 90 MVA | 45 MVA | 2 |
| **Gold Creek** | 1994 | 132/11 kV | 114 MVA | 57 MVA | 2 |
| **Latham** | 1971 | 132/11 kV | 150 MVA | 100 MVA | 3 |
| **Telopea Park** | 1986 | 132/11 kV | 150 MVA | 100 MVA | 3 |
| **Tennent** | 2017 | 132/11 kV | 15 MVA | 0 MVA | 1 |
| **Theodore** | 1990 | 132/11 kV | 90 MVA | 45 MVA | 2 |
| **Wanniassa** | 1975 | 132/11 kV | 150 MVA | 100 MVA | 3 |
| **Woden** | 1967 | 132/11 kV | 150 MVA | 100 MVA | 3 |

**Additional notes on zone substation ratings:**

In addition to the ratings listed in Table 18, for network planning and operations, Evoenergy is using 2 hour emergency rating of the transformers. Two hour emergency rating refers to the estimated level of electrical load which transformer could supply for up to 2 hours.

**TRANSMISSION LINE RATINGS**

Evoenergy currently operates a number 132kV lines and two 66kV lines. Table 19 list continues rating and emergency rating of Evoenergy lines.

**Table 19.** Evoenergy Transmission Line Ratings

| LINE | | | CURRENT RATING (AMPS) | | | |
|---|---|---|---|---|---|---|
| | | | Summer Day (35ºC ambient temperature) | | Winter Day (15ºC ambient temperature) | |
| From | To | ID No | Continuous | Emergency | Continuous | Emergency |
| 132 kV | | | | | | |
| **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** | Woden | A-1 | 1955 | 2958 | 2545 | 3325 |
| **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 | 1934 | 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 |
| 66 kV | | | | | | |
| **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)
- Micro hydro

Capacities of these EGs vary from domestic solar PV systems of typically 1-3 kWs to a 20 MW solar PV farm. The total installed capacity of embedded generation is approximately 160MW. Of this 108 MWs small-scale and medium scale rooftop solar PV and the remainder is a mixture of large scale solar, hydro and gas.

There are some small embedded generation facilities in the ACT, the largest being the 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. There is a bio-gas generator installed at Mugga Lane waste transfer station (4 MW) and another at Belconnen waste transfer station (3 MW), a co-gen plant (1.2 MW) at the Harman defence facility and a co-gen plant (1.4 MW) at the Canberra airport.

There is approximately 108 MW of installed domestic rooftop photo-voltaic (PV) generation capacity consisting of around 25500 installations as at 30 June 2019. This represents approximately 20% of single residential dwellings. These are distributed all over the ACT. Their impact on zone substation summer peak demand is a reduction that ranges from 0.2% - 3.0% depending on the level of penetration in the area. Their impact on zone substation winter peak demand is negligible. Several residential developments mandated use of PV generation, resulting in 100% penetration.

To date there are approximately 1000 domestic battery systems connected beyond-the-meter and no battery storage systems connected directly to the Evoenergy distribution network .However, large systems are actively being considered.

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 that rooftop solar PV generation be installed on all detached dwellings. This low voltage inverter based generation contribute 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 customers 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.

Appendix F – provides further information on power quality issues associated with embedded generation.

**Figure 37.** Distribution of domestic rooftop solar PV installations throughout the ACT.

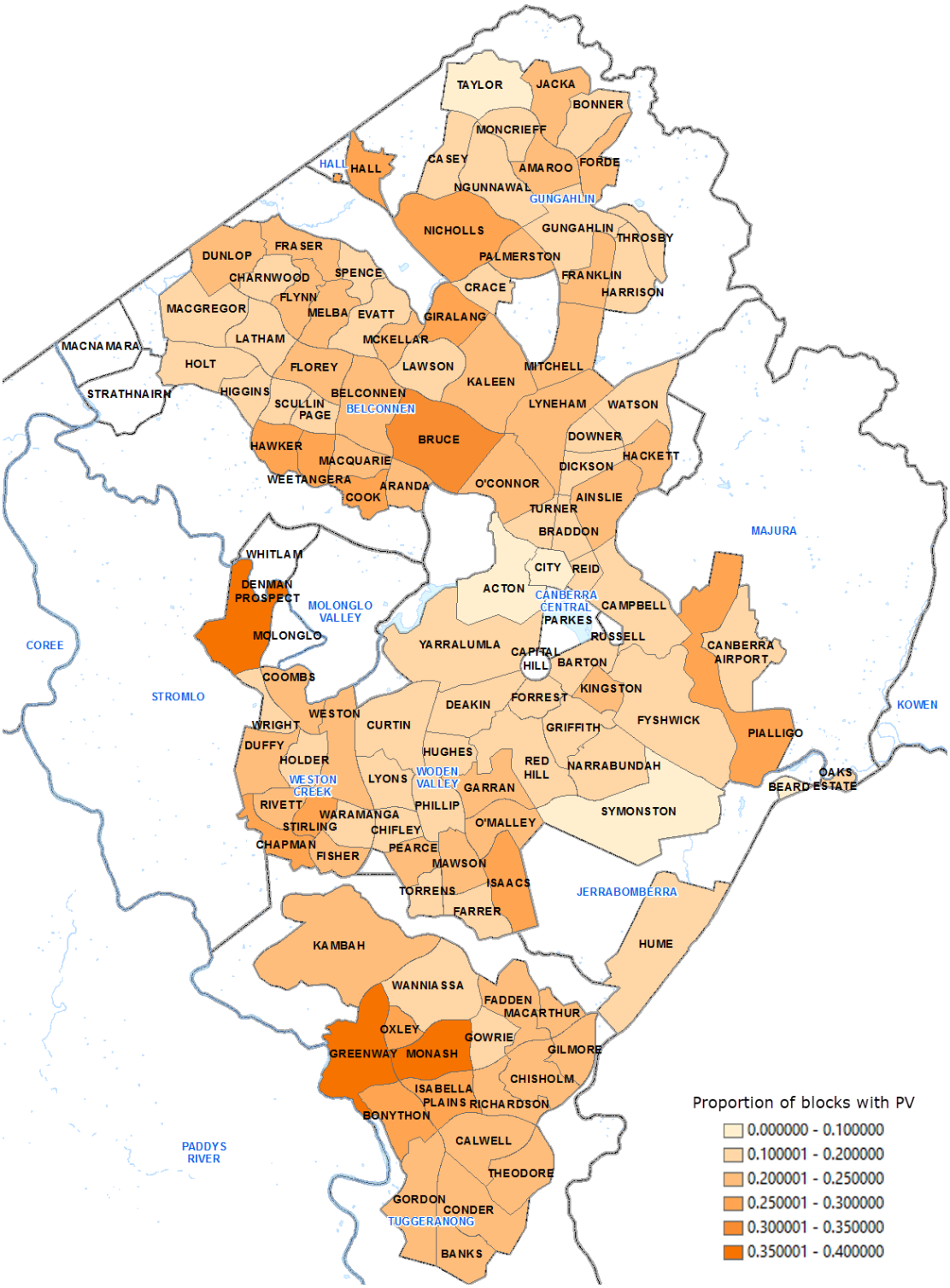


**Table 20.** Small scale rooftop solar PV generation installations by feeder.

| Zone Substation / Feeder | No. of Sites | Installed Capacity (W) |
|---|---|---|
| **BELCONNEN** | **2,106** | **8,222,763** |
| **Baldwin-Joy Cummins** | 293 | 1,053,815 |
| **Battye** | 4 | 28,300 |
| **Benjamin-Laurie** | 270 | 939,415 |
| **Cameron South** | 27 | 76,480 |
| **Chuculba** | 188 | 717,610 |
| **Eardley** | 54 | 183,978 |
| **Haydon** | 120 | 519,970 |
| **Maribyrnong** | 41 | 279,300 |
| **Mcguiness-Bellbird** | 183 | 793,679 |
| **Meacham-Bean** | 339 | 1,360,664 |
| **Shannon** | 235 | 825,000 |
| **Swinden-Lampard** | 59 | 266,299 |
| **William Slim** | 293 | 1,178,253 |
| **CITY EAST** | **1,671** | **8,167,779** |
| **Braddon** | 1 | 12,000 |
| **Chisholm** | 110 | 413,534 |
| **Constitution** | 9 | 111,000 |
| **Cowper** | 88 | 347,125 |
| **Duffy** | 161 | 678,129 |
| **Ebden** | 271 | 948,705 |
| **Electricity House** | 5 | 85,000 |
| **Fairbairn** | 5 | 24,500 |
| **Ferdinand** | 149 | 609,276 |
| **Haig** | 20 | 78,610 |
| **Ijong** | 14 | 74,600 |
| **Mackenzie** | 351 | 2,848,969 |
| **Masson** | 5 | 29,400 |
| **Northbourne** | 7 | 44,000 |
| **Quick** | 19 | 99,660 |
| **Stott** | 237 | 850,166 |
| **Wakefield** | 121 | 523,395 |
| **Wolseley** | 98 | 389,710 |
| **CIVIC** | **1,144** | **4,522,870** |
| **Belconnen Way North** | 163 | 653,715 |

| Zone Substation / Feeder | No. of Sites | Installed Capacity (W) |
|---|---|---|
| **Belconnen Way South** | 252 | 934,144 |
| **Black Mtn** | 167 | 651,946 |
| **Dryandra** | 236 | 842,830 |
| **Hobart Long** | 2 | 15,000 |
| **Hobart Short** | 7 | 140,000 |
| **McCaughey** | 19 | 99,800 |
| **Miller** | 265 | 1,067,485 |
| **Nicholson** | 33 | 117,950 |
| **EAST LAKE** | **58** | **962,439** |
| **Dairy North** | 9 | 50,939 |
| **Dairy South** | 19 | 448,200 |
| **Isa** | 20 | 327,400 |
| **Lyell** | 10 | 135,900 |
| **FYSHWICK** | **108** | **1,061,650** |
| **Abattoir** | 17 | 103,650 |
| **Airport** | 4 | 100,000 |
| **Barrier** | 24 | 243,200 |
| **Domayne** | 6 | 90,200 |
| **Gladstone** | 6 | 47,500 |
| **Tennant** | 39 | 331,400 |
| **Whyalla-Pialligo** | 12 | 145,700 |
| **GILMORE** | **1,310** | **5,785,664** |
| **Alderson** | 28 | 684,200 |
| **Beggs** | 108 | 418,155 |
| **Edmond** | 184 | 668,755 |
| **Falkiner** | 147 | 593,162 |
| **Findlayson** | 153 | 590,575 |
| **Jackie Howe** | 186 | 684,750 |
| **May Maxwell** | 156 | 560,744 |
| **Monaro** | 1 | 3,000 |
| **Penton** | 56 | 202,655 |
| **Rossman** | 154 | 616,039 |
| **Tralee** | 15 | 251,100 |
| **Willoughby** | 122 | 512,529 |
| **GOLD CREEK** | **3,818** | **16,001,962** |
| **Anthony Rolfe** | 112 | 841,710 |
| **Barrington** | 379 | 1,588,566 |

| Zone Substation / Feeder | No. of Sites | Installed Capacity (W) |
|---|---|---|
| **Birrigai** | 236 | 991,903 |
| **Ferguson** | 413 | 1,415,878 |
| **Gribble** | 75 | 346,585 |
| **Gungahlin** | 80 | 633,190 |
| **Hamer** | 291 | 1,080,787 |
| **Lander** | 321 | 1,189,233 |
| **Lexcen** | 258 | 1,039,907 |
| **Ling-Hughes** | 224 | 800,344 |
| **Magenta-Boulevard North** | 145 | 1,031,340 |
| **Nona** | 226 | 817,245 |
| **Riley** | 119 | 471,524 |
| **Saunders** | 277 | 1,095,183 |
| **Wanganeen-Bunburung** | 158 | 674,023 |
| **Wellington-Gurrang** | 177 | 772,636 |
| **West** | 327 | 1,211,908 |
| **LATHAM** | **4,046** | **15,385,922** |
| **Bowley** | 278 | 1,038,324 |
| **Conley** | 146 | 557,001 |
| **Copland** | 152 | 499,813 |
| **Elkington** | 213 | 831,930 |
| **Fielder** | 58 | 383,385 |
| **Florey** | 355 | 1,222,040 |
| **Homann** | 197 | 855,255 |
| **Latham** | 183 | 722,875 |
| **Lhotsky** | 493 | 1,739,312 |
| **Low Molonglo East** | 43 | 142,800 |
| **Low Molonglo West** | 42 | 165,278 |
| **Macrossan** | 204 | 699,855 |
| **Markell** | 248 | 1,020,725 |
| **Melba** | 176 | 699,861 |
| **O-Loghlen** | 235 | 894,890 |
| **Paterick** | 116 | 559,749 |
| **Powers** | 129 | 452,759 |
| **Zone Substation / Feeder** | **No. of Sites** | **Installed Capacity (W)** |
| **Seal** | 193 | 710,229 |
| **Tillyard** | 187 | 660,273 |

| Zone Substation / Feeder | No. of Sites | Installed Capacity (W) |
|---|---|---|
| **Verbrugghen** | 140 | 556,684 |
| **Weir** | 258 | 972,884 |
| **TELOPEA PARK** | **1,051** | **5,098,406** |
| **Blackall** | 4 | 80,000 |
| **Cunningham** | 236 | 960,420 |
| **Empire** | 156 | 614,694 |
| **Forster** | 65 | 358,055 |
| **Giles** | 25 | 105,935 |
| **Jardine** | 2 | 16,000 |
| **KF1** | 44 | 337,999 |
| **King Edward + Belmore** | 42 | 256,840 |
| **Kurrajong** | 1 | 3,300 |
| **Monash** | 10 | 44,300 |
| **NSW Cres** | 18 | 140,645 |
| **Ovens** | 15 | 68,955 |
| **Power House** | 73 | 294,880 |
| **Queen Victoria Terrace** | 4 | 80,000 |
| **Riverside** | 1 | 2,300 |
| **Strzelecki** | 91 | 378,924 |
| **Sturt** | 106 | 495,490 |
| **Telopea Park East** | 10 | 89,100 |
| **Throsby** | 148 | 770,569 |
| **THEODORE** | **2,032** | **7,619,256** |
| **Banyule** | 191 | 637,814 |
| **Callister** | 361 | 1,352,877 |
| **Chippindall** | 239 | 926,894 |
| **Eaglemont** | 326 | 1,291,928 |
| **Fairley** | 206 | 808,385 |
| **Lawrence Wackett** | 222 | 768,884 |
| **Lethbridge** | 185 | 765,090 |
| **Morison** | 201 | 695,084 |
| **Templestowe** | 101 | 372,300 |
| **WANNIASSA** | **4,058** | **15,032,559** |
| **Ashley** | 144 | 522,330 |
| **Athllon** | 207 | 706,458 |
| **Bissenberger-Hawkesbury** | 450 | 1,679,703 |
| **Brookman** | 168 | 710,840 |

| Zone Substation / Feeder | No. of Sites | Installed Capacity (W) |
|---|---|---|
| **Conolly** | 157 | 556,580 |
| **Fincham** | 3 | 23,240 |
| **Gaunson** | 126 | 494,819 |
| **Gouger** | 117 | 456,785 |
| **Grimshaw** | 523 | 1,398,641 |
| **Hawker-Pridham** | 231 | 896,350 |
| **Hemmings** | 129 | 500,253 |
| **Lambrigg** | 109 | 457,782 |
| **Langdon** | 220 | 991,417 |
| **Longmore** | 225 | 815,048 |
| **Mannheim** | 149 | 585,287 |
| **Marconi** | 194 | 688,194 |
| **Matthews** | 209 | 749,980 |
| **Muresk** | 255 | 1,016,923 |
| **Pitman-Rowland** | 8 | 73,100 |
| **Reid** | 231 | 878,748 |
| **Sainsbury** | 97 | 399,133 |
| **Sternberg** | 2 | 32,600 |
| **Symers** | 104 | 398,348 |
| **WODEN** | **3,692** | **14,973,350** |
| **Bunbury** | 289 | 1,183,844 |
| **Carruthers** | 184 | 752,769 |
| **Cooleman** | 117 | 432,996 |
| **Corinna** | 3 | 30,000 |
| **Cotter 11kV** | 302 | 1,318,493 |
| **Curtin North** | 188 | 695,020 |
| **Daplyn** | 187 | 639,767 |
| **Deakin No 1** | 117 | 483,464 |
| **Deakin No 2** | 68 | 279,535 |
| **Devonport** | 45 | 180,604 |
| **Easty** | 8 | 125,999 |
| **Follingsby** | 258 | 1,088,778 |
| **Hilder** | 252 | 1,086,724 |
| **King** | 16 | 231,015 |
| **Launceston** | 3 | 82,800 |
| **Lyons West** | 322 | 971,969 |
| **McInnes** | 174 | 642,272 |

| Zone Substation / Feeder | No. of Sites | Installed Capacity (W) |
|---|---|---|
| **Phillip North** | 5 | 29,500 |
| **Phillip South** | 1 | 3,300 |
| **Streeton** | 484 | 1,895,043 |
| **Theodore** | 162 | 766,128 |
| **Tidbinbilla 22kV** | 3 | 40,400 |
| **Weston East** | 188 | 660,343 |
| **Wilson** | 235 | 935,627 |
| **Yarralumla** | 81 | 416,960 |

#### 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 currently one operating bio-gas and one gas fuelled generator site connected to the Evoenergy network

The bio-gas generator is located at Mugga Lane Waste Transfer Station. This 4 MVA generator is connected to Gilmore Zone Substation via a shared 11 kV feeder. There are two gas generators at Canberra Airport with a total generation capacity of 2.9 MVA. These are connected to Fyshwick Zone Substation via a shared 11 kV feeder.

## Appendix C – The regulatory framework and operating environment

Evoenergy operates under the National Electricity Rules (NER) which are managed and updated by the Australian Energy Market Commission (AEMC).

Evoenergy is a Registered Participant in the National Electricity Market (NEM). This is the Australian wholesale electricity market and the associated electricity transmission grid. The NEM is operated by the Australian Energy Market Operator (AEMO) which controls the wholesale generation, dispatch and transmission of electricity in Queensland, New South Wales, South Australia, Victoria, the ACT and Tasmania. The NEM is not is governed by a set of procedures that AEMO manages in line with the *National Electricity Law* (NEL) and the *National Electricity Rules*. The market uses sophisticated systems to send signals to generators instructing them how much energy to produce each five minutes so that production is matched to consumer requirements, spare capacity is kept ready for emergencies, and the current energy price can be calculated. NEM infrastructure comprises both state and private assets managed by many participants.

Evoenergy is subject to the NEL and NER which regulate the NEM. Evoenergy operates in the NEM as both a Transmission Network Service Provider (TNSP) and a Distribution Network Service Provider (DNSP). The *National Electricity Objective* (NEO), as stated in the 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."

This objective requires Registered NEM participants to balance the costs and risks associated with electricity supply.

In addition, there are local territory requirements that Evoenergy must comply including licence conditions and other jurisdictional. The ACT has a Technical Regulator whose 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 and Planning Directorate is the ACT Technical Regulator. The ACT's economic regulator is the Independent Competition and Regulatory Commission (ICRC).

Technical regulation ensures the safe and reliable delivery of energy to the ACT community. The Utilities (Technical Regulation) Act 2014 sets out technical requirements for energy utilities. The specifics of many requirements are set out in technical codes made under the Act.

### National Electricity Rules

The NER Chapter 5 describes the planning, design 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 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.

### Electricity Transmission Supply Code

The *Electricity Transmission Supply Code* sets out performance standards to be met by TransGrid's and Evoenergy's transmission networks in the ACT. Implications for meeting this code are described in Section 7.5.1 Second Point of Supply to the ACT project.

### Regulatory Investment Test

Section 5.16 of the NER describes the Regulatory Investment Test for Transmission (RIT-T) and Section 5.17 describes the Regulatory Investment Test for Distribution (RIT-D). These tests 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 objectively.

### Revenue Determination

Australian Energy Regulator is responsible for the economic regulation of transmission and distribution businesses in the National Electricity Market. National Electricity Law, National Electricity Rules and various guideline published by AER which are publicly available govern the process for revenue determinations.

The revenue Evoenergy is allowed to earn from providing transmission, distribution and connection services in the ACT is set by the AER every five years. Evoenergy prepares and submits a revenue proposal to the AER which forms basis for AER decision. The proposal covers network operating and investment requirements for the next period and a range of related matters. The current Revenue Determination was announced in April 2019 for the regulatory control period from 1 July 2019 to 30 June 2024. This revenue allowance determines how much Evoenergy is able to invest in capital projects and what it can spend on operational expenditure to maintain and operate the network in a secure and reliable state.

## 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 customers 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 consumer response without increasing costs. STPIS achieves this by rewarding network businesses that outperform their targets or by penalising network businesses that do not.

In the regulatory proposal to AER Evoenergy supported the application of the scheme to the next 2019-24 regulatory control period. Evoenergy proposed that annual incentives under STPIS are capped at 2.5% of Evoenergy revenue.

AER published a decision on Evoenergy's submission in April 2019. AER decided to apply STPIS to Evoenergy for the 2019-24 regulatory control period. 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 is a based on economic value of reliability to customers as approved by AER.

For full details of the STPIS refer to the *AER Electricity Distribution Network Service Providers - Service Target Performance Incentive Scheme Guideline v2.0 - 13 December 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:

- Reliability of Supply (unplanned SAIDI and SAIFI).
- 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 customer interruption (in customer minutes) divided by the total number of distribution customers (urban or rural). Unplanned SAIDI excludes momentary interruptions (one minute or less).

Unplanned SAIFI (System Average Interruption Frequency Index)

The total number of unplanned sustained customer interruptions divided by the total number of distribution customers (urban or rural). Unplanned SAIFI excludes momentary interruptions (one minute or less). 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 include the customer service performance measure based on the customer call 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.

Evoenergy's strategies to manage the CESS include:

1. Ensuring that the annual capex budget matches or is lower than the AER Approved Allowance for each regulatory year. This includes the annual reforecast budgets.
2. Ensuring that final actual capex in any regulatory year does not exceed budget and/or the AER Approved Allowance.
3. The development of internal capex benchmarking targets based on optimal industry performance.
4. Close co-ordination of the Asset Management Maintenance and Capital Programs with the Program of Works delivery to achieve a timely capex program.

Consumers generally benefit from improved efficiency through lower regulated prices. Under the CESS, a service provider retains 30 per cent of any underspend or overspend while consumers retain 70 per cent of underspend or overspend. This means that for a one dollar saving in capex, the service provider keeps 30 cents of the benefit while consumers keep 70 cents of the benefit. The management of capital expenditure by Evoenergy has to 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 translates to higher capital expenditure. For the overall capital expenditure to stay within the regulatory envelope a reduction to other capital programs must take place.

For full details of the CESS refer to the *AER Capital Expenditure Incentive Guideline for Electricity Network Service Providers, November 2013 (CESS Guidelines) available from the AER website.*

### Efficiency Benefit Sharing Scheme

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 operation expenditure through the sharing of efficiency gains and losses with customers. 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 the fiveyear regulatory period, efficiency gains or losses are shared approximately 30 per cent to the distributor and the remaining 70 per cent to customers.

With an EBSS in place, distributor businesses are provided with an incentive to spend efficiently. The EBSS scheme is relevant to the network investment decisions for several reasons. Firstly, different network solutions 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 customer incentive to install a network battery, the incentive amount would count as operating expenditure. Similarly, if we contract customers 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 the two schemes which provide incentives in relation to the application of demand side management and non-network solution. 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*. AER provides and 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 current version of the scheme was published by the AER in December 2017. 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 and the Peak Demand Reduction Strategy. Further information on DMIAM is provided in the *AER's Demand Management Inceptive Mechanism Guideline, December 2017 available form AER's website*.

**Demand Management Incentive Scheme**

During the current 2019-24 regulatory period Evoenergy participates also 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 a 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 regulator 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*. Available from the AER website.

## Appendix D – Evoenergy integrated asset management and planning

### Integrated planning strategies

Evoenergy investment decisions are integrated with risk management. In making decisions Evoenergy consider risks and benefits to consumers, environment and our business. Evoenergy's network development process is closely coordinated with management of the existing assets including asset condition. Security of supply, reliability, power quality and safety are key considerations.

Significant organisational changes and investments have been made to date which will allow Evoenergy to respond to the regulatory and commercial challenges, and to optimise network performance through improved alignment of planning, asset management and regulatory compliance. During last year Evoenergy re-aligned organisational structure and developed a new business strategy which reflects the rapidly changing business environment in alignment with ACT Government, energy policies and Energy Network Association transformation road map for network utilities.

### Asset Management Strategy

Evoenergy's Asset Management Strategy and asset management objectives are aligned with the business objectives, in a manner that:

- Optimises sustainably whole-of-life, whole-system cost over the long-term.
- Employs new and innovative solutions to cater for changing energy industry landscape, growth in distributed energy resources and network support needs.
- Considers non-network and demand side management solutions for each network limitation or constraint.
- Appropriately considers how Evoenergy will supply current and future demand via the management of the condition and performance of the asset base, ensuring that asset management plans are coordinated with network development plans.
- Ensures that asset renewals are based on risk assessment corresponding asset condition, criticality and risk of failure
- Promotes most cost-effective way through the efficient use and maintenance of existing assets and the prudent investment in new assets.
- Promotes safety of people and protection of property and the environment.
- Appropriately considers the necessary current and future Asset Management capabilities of the organisation, in terms of people, processes, systems, equipment and data to achieve the identified outputs and objectives.

The Asset Management Strategy has been updated since the previous publication with ~~a~~ reference to risk management within the network asset context.

### Integration of asset management and risk management

Evoenergy's provision of distribution network services inherently involves risk.

These risks include:

- Risks to the community and workforce:
    - Electrical safety risks
    - Workplace safety risks
    - Bushfire and other environmental risks
- Risks to customers' quality of supply including:

- Power quality
- Reliability

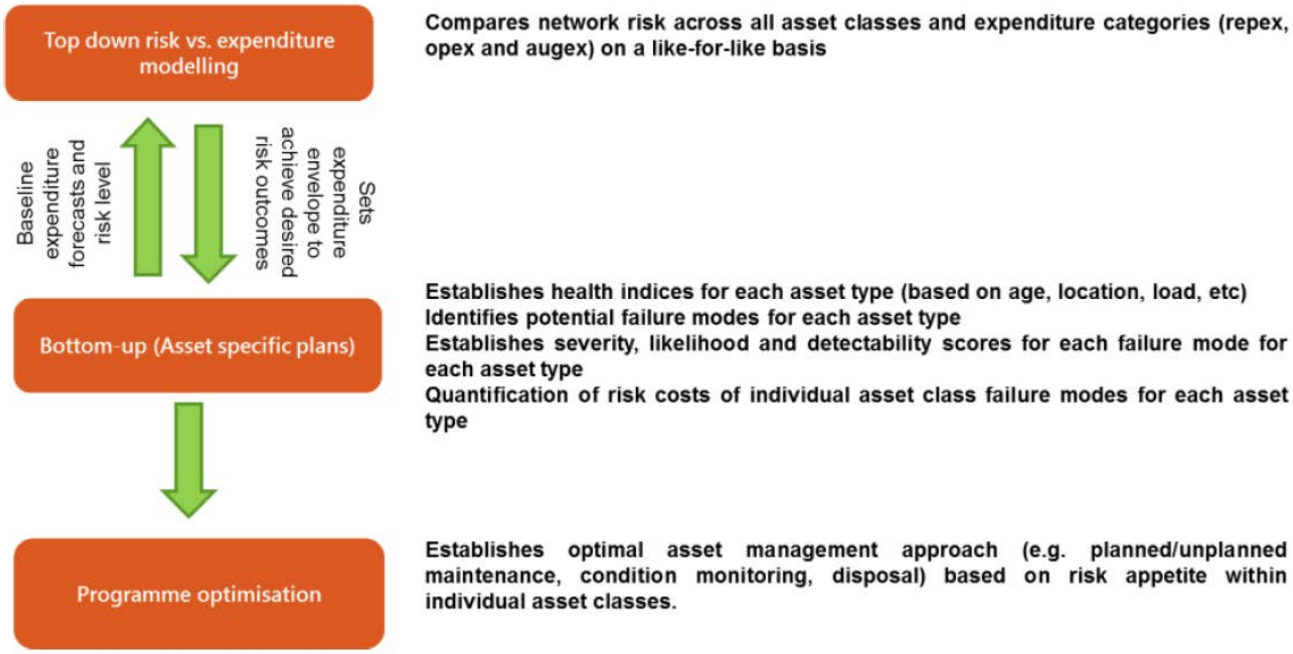
Evoenergy seeks to minimise risks via the following activities:

- Replacement of ageing, defective, failed and otherwise high risk assets in a way which optimises asset life cycle costs
- Monitoring of assets to detect and/or predict defects or failure.
- Inspection of assets to detect ageing, defective, failed and otherwise high risk assets.
- Routine and non-routine maintenance to rectify ageing, defective, failed and otherwise high risk assets.
- Provision of sufficient capacity to meet demand and demand growth and cater for the credible network contingencies.
- Provision of operational technology, information technology systems supporting the asset management activities
- Workforce management including capability, competence and training.

Evoenergy sets expenditure across these activities to achieve a level of quantified residual risk that is acceptable to its customers and the community to meet relevant regulatory and license requirements.

As shown in Figure 38 Evoenergy achieves this via a top-down and bottom-up approach to risk in management of network assets.

**Figure 38.** Top down and bottom up approaches to risk assessment




The bottom-up approach requires asset managers, via asset specific plans to identify the activities required to maintain acceptable levels of risk across individual asset groups and the associated level of expenditure. The bottom-up approach is sufficiently detailed

to enable consideration of risk at the asset level but has the potential to result in over-expenditure at the aggregate level, whereby the same risk outcome is targeted by multiple activities.

To mitigate potential over-expenditure due to the bottom-up expenditure forecast, Evoenergy applies a top-down approach to risk management. The top-down approach considers how expenditure can be optimised across asset categories and expenditure categories to achieve the desired level of risk at least cost.

Evoenergy considers the results of both the top-down and bottom-up expenditure forecasts and determines a final expenditure envelope. The final expenditure envelope reflects the expenditure envelopes set via the top-down approach tempered by the technical and practical realities of individual asset needs as determined via the bottom-up approach.

**Risk based maintenance philosophy**

Evoenergy's Asset Management Strategy and Asset Management Objectives are directed at maintaining assets according to the principles of Risk Centred Maintenance (RCM). The governing factor in RCM analysis is the impact of a functional failure at the equipment level, and tasks are directed at a limited number of significant items - those whose failure might have safety, environmental or economic consequences. The continual assessment of assets follows the "Plan–Do–Check–Act" based approach.

**Certification of Asset Management System to *ISO 55001*:**

*ISO 55001* states the specification 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.

In July 2017 the JAS-ANZ accredited auditor Bureau Veritas assessed Evoenergy's Asset Management System in a Stage 1 audit and deemed it to meet the requirements the next stage (Stage 2) for *ISO 55001* certification. Evoenergy successfully completed the Stage 2 audit by Bureau Veritas in November 2017 and attained certification with the International Standards Organisation standard for Asset Management *ISO 55001* on 11 January 2018.

BUREAU VERITAS
Certification

Certification

Awarded to

**ACTEWAGL**

**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 2021**

*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:* **AU002633-1** *Date:* **11 January 2018**

Andrew Mortimore
General Manager - Bureau Veritas Certification

Managing office: Bureau Veritas Pty Ltd, 3/455 Williamstown Road, Port Melbourne, Victoria, 3207

Issuing office: Bureau Veritas Pty Ltd, 3/455 Williamstown Road, Port Melbourne, Victoria, 3207

JAS-ANZ

Annual audits are undertaken on our Asset Management System in order to retain our certification to *ISO 55001*. The most recent audit was undertaken during November 2018.

Certification to *ISO 55001* ensures Evoenergy has the visibility, capability and control to satisfy increasing customer and Regulator expectations.

### Existing assets

Electricity transmission and distribution networks are constructed of a range of asset types that have specific maintenance, refurbishment and replacement life cycles.

Primary assets, those with the purpose of transmitting and distributing energy, such as poles, conductors, switchgear and transformers, generally have an asset standard design life of around 30 – 60 years depending on the asset type.

Secondary assets, those with the purpose of measuring, monitoring, controlling, communicating and providing protection for primary assets, generally have an asset standard design life of around 10 – 20 years.

Evoenergy has prepared Asset Specific Plans (ASPs) for each class of asset, and from these plans has developed maintenance programs for each asset for its life cycle, including condition monitoring, periodic maintenance, renewal and leading to its ultimate replacement (refer Chapter 6).

Before replacing an asset such as a distribution substation, Evoenergy reviews its network plan for that location. In some cases, load growth (or reduction) may deem it more appropriate to replace with a larger or smaller distribution substation or decommission the asset rather than simply a like-for-like replacement. In this way Evoenergy integrates its planning to coordinate asset management spending with network development spending to provide the most appropriate and cost effective solutions.

Assets are replaced as the result of a condition and risk assessment, i.e. an asset is not just replaced because it has reached its 'retirement age'. It is replaced because its forecast risk exceeds its replacement plus net present value costs.

Evoenergy's network comprises long-life assets. It is essential that we invest in growth, replacement and maintenance works to ensure we continue to deliver a highly reliable and safe network for our customers and the community.

Evoenergy has made prudent investments to maintain supply quality and reliability, reduce safety and environmental risk, ensuring the most cost-effective asset management strategy is adopted.

The Evoenergy network includes approximately 52,000 poles, the majority of which are timber and subject to gradual rotting and subsequent loss of strength. Poles are inspected and assessed against reliability maintenance criteria (RCM) on a rotating annual program. Should maintenance methods such as installation of pole nails be deemed to no longer be effective, a pole will be listed for replacement as part of the annual replacement program. Low voltage poles are replaced with two-part fibreglass poles in locations that are difficult to access (typically urban residential property back yards), while high voltage and transmission poles are generally replaced with pre-stressed spun concrete poles.

### Network Development Strategy

Evoenergy's network development strategy incorporates providing adequate supply to existing and new customers with prudent investment decision making, whilst applying risk management principles to achieve an appropriate balance between supply adequacy, security, reliability and safety at the lowest cost to our customers.

Evoenergy incorporates long term strategic planning with short term planning to ensure appropriate network developments meet the long term needs of our customers.

The nature of the transmission and distribution industry is changing rapidly with the emergence of new technologies (refer to Chapter 9) and the development of the network must be done so as to cater for these 'non-traditional' factors.

As assets near the end of their economic lives and require replacement, we consider whether a straight like-for-like replacement is the best solution or whether the network can be reconfigured in a way to minimise the costs of asset renewals.

Evoenergy plans and develops its transmission and distribution networks in an integrated way, for example the best way to resolve a transmission constraint could be to implement a distribution solution.

For all major investment projects we investigate non-network options and seek alternative proposals from external third parties.

**Overview of network probabilistic planning**

The planning and development process for both transmission and distribution networks, is carried out in accordance with the National Electricity Rules (NER) Chapter 5 Part B Network Planning and Expansion. Planning for the transmission network is carried out in accordance with the NER Section 5.12 Transmission annual planning process and for the distribution network in accordance with the NER Section 5.13 Distribution annual planning process.

The primary objective of planning is to ensure that customers are able to receive reliable, safe and quality supply of electricity now and into the future. Evoenergy's planning standards are set to ensure that peak demand can be met with an appropriate level of backup should a credible contingency event occur. A credible contingency event is the loss of a single network element that occurs sufficiently frequently, and has such consequences, as to justify the NSP to take prudent precautions to mitigate. This is commonly referred to as an N-1 event. This reflects the implications of network service failures, noting that communities and businesses have a low tolerance to electricity supply interruptions.

Evoenergy is using deterministic n-1 criteria to identify existing and emerging limitations. However once a constraint is identified, risk based assessment is applied. As far as practicable a probabilistic risk assessment methodology to be applied to assess risk corresponding to various alternative solutions. For most capacity constraints the bulk of this risk is related to the possible interruptions of electricity supply and the calculated value of unserved energy. On the cost side, as far as practicable, Evoenergy accounts for the life of cost of the solution.

The probabilistic planning approach includes:

- Assessment of likelihood of failure of network elements.
- Assessment of consequence in the event of failure. This includes assessing the probability and quantity of unserved energy resulting from an unplanned outage of a network element. The value of unserved energy is calculated using the Value of Customer Reliability as reviewed and approved from time to time by the Australian Energy Market Operator and Australian Energy Regulator.
- Consideration of back-up capacity via load transfers between inter-tied feeders or between adjacent zone substations.
- A sensitivity analysis for key parameters such as load growth, cost and non-network demand management.
- A determination of economic timing for network augmentation and the net present value of options based on demand forecasts.

Some projects (particularly those relating to safety or compliance) may not lend themselves to a structure risk assessment ( for example if the project is designed to

address safety or compliance needs), For those project san assessment of alternatives can be based on the Net Present Cost (NPC) rather than Net Present Value (NPV).

For greenfield residential estate developments probabilistic planning may result in a staged approach to provision of supply capacity, e.g. use of mobile substation at Stage 1, construction of single transformer zone substation at Stage 2, and installation of second zone substation transformer at Stage 2. Installation of distribution feeders is similarly staged. Timing is determined by the load growth of the area being supplied and an increasing risk of supply interruptions (value of unserved energy)

The early identification, consultation and monitoring of emerging network limitations and prospective network developments is aimed at providing proponents of non-network solutions adequate time to prepare proposals.

Evoenergy's planning approach to addressing load growth or network constraint issues, is to use probabilistic analysis techniques coupled with fully exploring non-network solutions such as demand-side management, before investing in network augmentation. This approach takes into account the combination of demand forecasts, asset ratings and asset failure rates to identify the severity of constraints and the required timing of solutions.

Customers will offer demand response capabilities when the reward for demand response is greater than the value they place on that supply. This can include accepting some degree of direct load control or capacity limitation. Deterministic planning criteria, strictly applied, do not facilitate NSPs offering this type of optimisation decision to customers, as it focuses entirely on the level of reliability and security of supply, not the value of that supply to customers. A probabilistic planning framework therefore offers a different range of opportunities for demand management.

Evoenergy runs a load flow model of the network using a computer software program known as ADMS (Advanced Distribution Management System). This system is linked to our Supervisory Control and Data Acquisition (SCADA) system and obtains and analyses data such as the status of network assets (e.g. positions of circuit breakers), current flows and voltage levels throughout the network, in real time. This system is used to identify issues such as power flow constraints or voltage level issues on the network, and is used to model what-if scenarios such as the effect of a new load or generation connection. Using this tool, Evoenergy is able to identify existing and emerging constraints that form the basis of our asset management and network development plans.

Evoenergy's planning process is an annual process and covers a minimum forward planning period of ten years. The process commences with a comprehensive analysis of all indicators and trends to forecast the future load on the network. A detailed analysis of the network is then carried out to identify performance and capability shortcomings, i.e. constraints.

Evoenergy uses a two hour emergency cyclic rating for all its zone substation power transformers. Evoenergy has adopted the use of two hour emergency ratings and normal cyclic ratings, and uses the ADMS system to regularly record and reassess the cyclic loading capability of zone substation equipment, based on equipment manufacturer's recommendations and relevant Australian and international standards. Evoenergy maintains a high level of zone substation power transformer utilisation by using the two hour emergency cyclic rating, and effective load balancing between zone substations wherever possible. Load balancing is an integral initial solution to network augmentation planning.

Chapter 7 describes the outcomes of our annual planning process. If the augmentation or replacement cost of a proposal exceeds $6 million, we undertake a Regulatory Investment Test in line with the requirements of the NER (section 5.16 for transmission RIT-T and section 5.17 for distribution RIT-D). The purpose of the Regulatory Investment Test is to identify the credible option that maximises the present value of net economic benefit to all those who produce, consume and transport electricity in the market. A preferred option may have a negative net economic benefit (that is, a net economic cost) where the identified need is for reliability corrective action.

Evoenergy ensures the following prior to committing to any large investment:

- Investments are cost effective and consider whole-of-life costs associated with a new asset.
- Timing of the new investment is defined to meet the requirement of the need when it reaches the point that the need cannot otherwise be met.
- Appropriate investment procedures are followed, including business case and Board approval, and execution of the RIT-T or RIT-D if required.
- Works are timed to ensure smooth capital and replacement cash flows, and availability of resources.

Works are coordinated as required with other utilities and/or network service providers, and to meet customer needs.

## 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 and a high level explanation of the forecasting model
- Bulk supply points demand forecast tables
- Zone substation demand forecast tables and charts

### Demand forecast – key definitions and formulas

**Maximum demand** is the highest level of instantaneous demand for electricity averaged over a 30-minute period, and is estimated for summer and winter seasons. Maximum demand projections include load supplied by the network, network losses, and auxiliary loads.

**Probability of Exceedance (POE)** is a generalised approach to electricity demand forecasting. Probability of Exceedance is the probability, as a percentage, that the maximum demand level will be met or exceeded (eg due to ambient temperature) in a particular period of time. Due to the high proportion of residential load in the ACT, maximum demand is highly dependent on weather conditions. Thus, there is substantial uncertainty inherent in maximum demand forecasts. Evoenergy prepares maximum demand forecasts with 10%, 50% and 90% POE's:

- A 10% POE maximum demand projection is expected to be exceeded, on average, one year in 10.
- A 50% POE maximum demand projection is expected to be exceeded, on average, five years in 10 (or one year in two).
- A 90% POE maximum demand projection is expected to be exceeded, on average, nine years in 10.

The 50% POE maximum demand forecast is used for planning purposes.

**Diversity factor** is the ratio of the sum of the individual non-coincident maximum demands of the parts of a system to the maximum demand of the whole system under consideration. Diversity factor is generally ≥ 1.

$$\textit{Diversity Factor} = \frac{\textit{Sum of non} - \textit{coincident maximum demands of parts of system}}{\textit{Maximum demand of whole system}}$$

**Load factor** is defined as the average load divided by the peak load in a specified time period such as annually, quarterly or monthly. Load factor is generally ≤ 1. Evoenergy encourages its customers to improve their load factor, ie spread their load more evenly over the time period required.

$$\textit{Load Factor} = \frac{\textit{Average demand in a given time period}}{\textit{Maximum demand in the same given time period}}$$

The **power factor** of an AC electrical power system is defined as the ratio of the real power (MW) used to do work to the apparent power (MVA) supplied to the circuit. Power factor is generally > 0 and ≤ 1. Evoenergy sets minimum target levels for power factor

throughout the network and at customer connection points. Higher power factor allows the existing network to deliver more useful energy, ie real power.

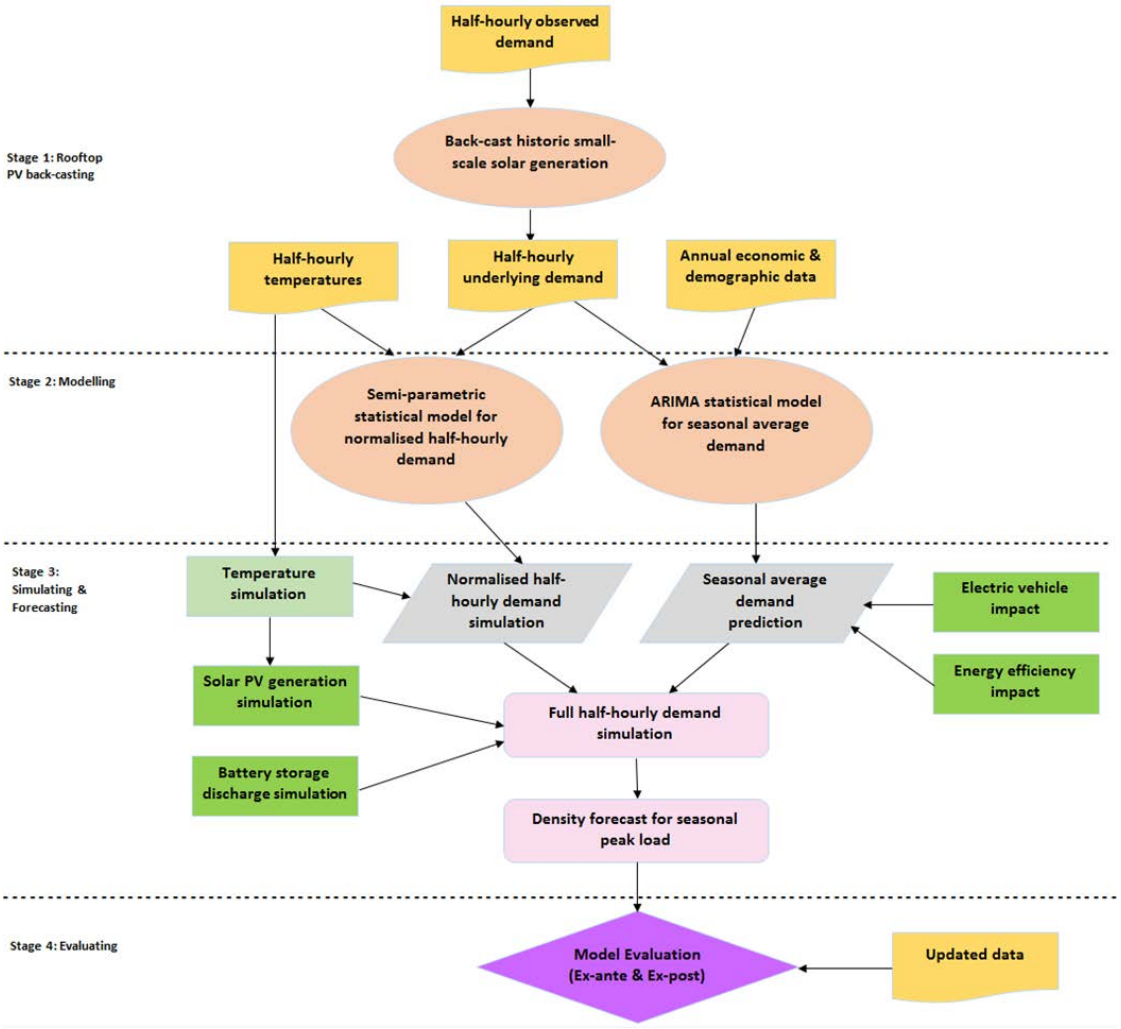
$$Power\ Factor = \frac{MW}{MVA}$$

Evoenergy has adopted and implemented AEMO's maximum demand forecast methodology which uses the Monash Electricity Forecasting Model (MEFM) which is based on the paper by Hyndman and Fan (2010)[13]. For more technical details about this methodology, the Monash Electricity Forecasting Model Technical Report is available at AEMO's website. Figure 39 illustrates the Integrated MEFM load forecasting process.

### Forecasting model

The diagram below provides an overview of key characteristics of the Monash model used by Evoenergy in the preparation of forecasts.

**Figure 39.** Block diagram of the Integrated Monash Electricity Forecasting Model.




[13] R. J. Hyndman and S. Fan (2010) "Density Forecasting for Long-term Peak Electricity Demand", IEEE Trans. Power Systems, 25(2), 1142–1153. http://robjhyndman.com/papers/peak-electricity-demand/

Key features of the integrated MEFM load forecasting methodology are:

- Integrated MEFM has four sub-models:
    1. Half-hourly model (HH model);
    2. Seasonal average demand model (annual model);
    3. Solar PV model (PV model); and
    4. Battery storage discharge model.
- Adjusted half-hourly demand where each year of demand is normalised by seasonal average demand is an input to the HH model.
- Annual model considers seasonal average demand against all possible economic and demographic drivers including energy efficiency variables.
- Forecasts calculated from the annual model are adjusted based on electric vehicle uptake impact on average energy consumption.
- Forecasts calculated from half-hourly and PV generation models are based on ambient temperature simulations.
- For the HH model, temperature and calendar variables are selected through a cross-validation procedure based on mean squared error (MSE).
- The coincident maximum demand contribution of block loads to the total maximum demand of bulk supply points and zone substations are calculated using diversity factors.
- The final demand forecast simulation = (HH model forecast × Annual model forecast) - Solar PV simulation forecast –Battery storage discharge simulation forecast.

**Bulk supply points demand forecasts**

Tables below show the results for the summer and winter demand forecast for bulk supply point at Canberra Substation, Williamsdale Substation and Queanbeyan Substation.

## Canberra bulk supply point demand forecast

**Table 21.** Summer (S) and Winter (W) maximum demand forecast table (MW)

| Year | POE90 (S) | POE50 (S) | POE10 (S) | POE90 (W) | POE50 (W) | POE10 (W) |
|---|---|---|---|---|---|---|
| **2020** | 341 | 386 | 438 | 424 | 443 | 466 |
| **2021** | 343 | 388 | 435 | 423 | 441 | 461 |
| **2022** | 341 | 388 | 437 | 420 | 438 | 458 |
| **2023** | 338 | 386 | 443 | 418 | 436 | 458 |
| **2024** | 342 | 390 | 441 | 417 | 434 | 454 |
| **2025** | 345 | 395 | 442 | 415 | 433 | 453 |
| **2026** | 350 | 394 | 442 | 416 | 434 | 454 |
| **2027** | 350 | 395 | 446 | 415 | 434 | 453 |
| **2028** | 352 | 400 | 457 | 416 | 434 | 452 |
| **2029** | 354 | 399 | 455 | 417 | 435 | 456 |

**Table 22.** Summer (S) and Winter (W) minimum demand forecast table (MW)

| Year | POE90 (S) | POE50 (S) | POE10 (S) | POE90 (W) | POE50 (W) | POE10 (W) |
|---|---|---|---|---|---|---|
| **2020** | 65 | 78 | 90 | 122 | 136 | 146 |
| **2021** | 57 | 72 | 85 | 115 | 128 | 140 |
| **2022** | 46 | 65 | 79 | 103 | 118 | 132 |
| **2023** | 38 | 56 | 71 | 93 | 106 | 121 |
| **2024** | 27 | 46 | 61 | 78 | 94 | 108 |
| **2025** | 14 | 34 | 51 | 66 | 82 | 98 |
| **2026** | 3 | 23 | 38 | 55 | 71 | 86 |
| **2027** | -5 | 14 | 29 | 47 | 64 | 81 |
| **2028** | -12 | 8 | 25 | 42 | 60 | 75 |
| **2029** | -17 | 2 | 21 | 35 | 53 | 69 |

## Queanbeyan bulk supply point demand forecast

**Table 23.** Summer (S) and Winter (W) maximum demand forecast table (MW)

| Year | POE90 (S) | POE50 (S) | POE10 (S) | POE90 (W) | POE50 (W) | POE10 (W) |
|---|---|---|---|---|---|---|
| **2020** | 24 | 27 | 31 | 22 | 23 | 25 |
| **2021** | 24 | 27 | 30 | 22 | 23 | 24 |
| **2022** | 24 | 27 | 31 | 22 | 23 | 24 |
| **2023** | 24 | 27 | 31 | 22 | 23 | 24 |
| **2024** | 24 | 27 | 31 | 22 | 23 | 24 |
| **2025** | 24 | 28 | 31 | 22 | 23 | 24 |
| **2026** | 24 | 28 | 31 | 22 | 23 | 24 |
| **2027** | 24 | 28 | 31 | 22 | 23 | 24 |
| **2028** | 25 | 28 | 32 | 22 | 23 | 24 |
| **2029** | 25 | 28 | 32 | 22 | 23 | 24 |

**Table 24.** Summer (S) and Winter (W) minimum demand forecast table (MW)

| Year | POE90 (S) | POE50 (S) | POE10 (S) | POE90 (W) | POE50 (W) | POE10 (W) |
|---|---|---|---|---|---|---|
| **2020** | 7 | 9 | 10 | 11 | 12 | 13 |
| **2021** | 6 | 8 | 9 | 10 | 11 | 12 |
| **2022** | 5 | 7 | 9 | 9 | 10 | 12 |
| **2023** | 4 | 6 | 8 | 8 | 9 | 11 |
| **2024** | 3 | 5 | 7 | 7 | 8 | 10 |
| **2025** | 1 | 4 | 6 | 6 | 7 | 9 |
| **2026** | 0 | 2 | 4 | 5 | 6 | 8 |
| **2027** | -1 | 2 | 3 | 4 | 6 | 7 |
| **2028** | -1 | 1 | 3 | 4 | 5 | 7 |
| **2029** | -2 | 0 | 2 | 3 | 5 | 6 |

## Williamsdale bulk supply point demand forecast

**Table 25.** Summer (S) and Winter (W) maximum demand forecast table (MW)

| Year | POE90 (S) | POE50 (S) | POE10 (S) | POE90 (W) | POE50 (W) | POE10 (W) |
|---|---|---|---|---|---|---|
| **2020** | 163 | 184 | 209 | 196 | 205 | 216 |
| **2021** | 164 | 185 | 208 | 196 | 204 | 213 |
| **2022** | 163 | 185 | 209 | 195 | 203 | 212 |
| **2023** | 161 | 184 | 212 | 193 | 202 | 212 |
| **2024** | 163 | 186 | 210 | 193 | 201 | 210 |
| **2025** | 164 | 188 | 211 | 192 | 200 | 210 |
| **2026** | 167 | 188 | 211 | 193 | 201 | 210 |
| **2027** | 167 | 189 | 213 | 192 | 201 | 210 |
| **2028** | 168 | 191 | 218 | 193 | 201 | 209 |
| **2029** | 169 | 190 | 217 | 193 | 201 | 211 |

**Table 26.** Summer (S) and Winter (W) minmum demand forecast table (MW)

| Year | POE90 (S) | POE50 (S) | POE10 (S) | POE90 (W) | POE50 (W) | POE10 (W) |
|---|---|---|---|---|---|---|
| **2020** | 21 | 26 | 30 | 35 | 39 | 42 |
| **2021** | 19 | 24 | 28 | 33 | 37 | 41 |
| **2022** | 15 | 21 | 26 | 30 | 34 | 38 |
| **2023** | 13 | 19 | 23 | 27 | 31 | 35 |
| **2024** | 9 | 15 | 20 | 23 | 27 | 31 |
| **2025** | 4 | 11 | 17 | 19 | 24 | 28 |
| **2026** | 1 | 7 | 13 | 16 | 20 | 25 |
| **2027** | -2 | 5 | 10 | 14 | 18 | 23 |
| **2028** | -4 | 3 | 8 | 12 | 17 | 22 |
| **2029** | -6 | 1 | 7 | 10 | 15 | 20 |

## Zone substations limitation tables

The table below show the summer and winter demand (MVA) forecast for the zone substation and comparison with the two hour and continuous emergency rating of the substations. 10POE and 50POE are included in the tables. The identified limitations over the 10 year period are highlighted in the red font.

**Table 27.** Zone substation - summer forecast demand (MVA) summary

| ZSS | Continuous Rating | Emergency 2-hr Rating | POE | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Belconnen** | 55 | 76 | 50 | 56 | 55 | 55 | 54 | 53 | 53 | 52 | 52 | 52 | 51 |
| | | | 10 | 62 | 61 | 61 | 60 | 59 | 59 | 58 | 57 | 57 | 57 |
| **City East** | 95 | 95 | 50 | 70 | 70 | 70 | 69 | 68 | 68 | 68 | 68 | 68 | 67 |
| | | | 10 | 76 | 75 | 75 | 75 | 74 | 73 | 74 | 73 | 73 | 73 |
| **Civic** | 110 | 114 | 50 | 64 | 63 | 61 | 61 | 60 | 60 | 60 | 61 | 60 | 59 |
| | | | 10 | 68 | 67 | 66 | 66 | 64 | 64 | 64 | 65 | 64 | 64 |
| **East Lake** | 43 | 54 | 50 | 17 | 17 | 17 | 16 | 17 | 16 | 16 | 16 | 15 | 15 |
| | | | 10 | 19 | 19 | 19 | 18 | 18 | 18 | 18 | 17 | 17 | 17 |
| **Fyshwick** | 28 | 28 | 50 | 31 | 32 | 32 | 32 | 31 | 30 | 30 | 30 | 30 | 29 |
| | | | 10 | 33 | 34 | 33 | 33 | 33 | 33 | 32 | 32 | 32 | 32 |
| **Gilmore** | 45 | 62 | 50 | 40 | 50 | 50 | 51 | 51 | 53 | 53 | 53 | 54 | 55 |
| | | | 10 | 42 | 52 | 54 | 54 | 54 | 55 | 56 | 56 | 57 | 59 |
| **Gold Creek** | 57 | 76 | 50 | 68 | 71 | 74 | **77** | **79** | **82** | **86** | **88** | **91** | **95** |
| | | | 10 | **76** | **80** | **84** | **88** | **89** | **94** | **98** | **102** | **103** | **110** |
| **Latham** | 95 | 95 | 50 | 53 | 53 | 52 | 54 | 53 | 50 | 52 | 52 | 54 | 52 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 57 | 57 | 58 | 59 | 59 | 61 | 58 | 60 | 60 | 62 |
| **Telopea Park** | 100 | 114 | 50 | 85 | 83 | 83 | 83 | 81 | 80 | 81 | 80 | 80 | 79 |
| | | | 10 | 94 | 92 | 90 | 89 | 90 | 89 | 86 | 88 | 88 | 86 |
| **Tennent** | 15 | 15 | 50 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | | 10 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Theodore** | 45 | 62 | 50 | 24 | 23 | 24 | 24 | 23 | 24 | 23 | 24 | 23 | 23 |
| | | | 10 | 28 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 28 | 27 |
| **Wanniassa** | 95 | 95 | 50 | 69 | 67 | 66 | 66 | 65 | 63 | 64 | 64 | 63 | 63 |
| | | | 10 | 75 | 74 | 75 | 73 | 73 | 72 | 70 | 70 | 69 | 69 |
| **Woden** | 95 | 95 | 50 | 77 | 80 | 83 | 82 | 81 | 79 | 80 | 80 | 80 | 80 |
| | | | 10 | 84 | 87 | 90 | 89 | 89 | 89 | 87 | 89 | 89 | 89 |

**Table 28.** Zone substations - winter demand forecast summary and capacity constraints

| ZSS | Continuous Rating | Emergency 2-hr Rating | POE | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Belconnen** | 55 | 76 | 50 | 57 | 57 | 57 | 55 | 56 | 55 | 54 | 54 | 54 | 54 |
| | | | 10 | 59 | 60 | 59 | 58 | 58 | 57 | 57 | 57 | 57 | 56 |
| **City East** | 112 | 114 | 50 | 67 | 66 | 66 | 66 | 65 | 63 | 63 | 62 | 62 | 61 |
| | | | 10 | 69 | 69 | 68 | 68 | 67 | 66 | 66 | 65 | 64 | 64 |
| **Civic** | 110 | 143 | 50 | 57 | 57 | 55 | 54 | 54 | 54 | 52 | 52 | 53 | 53 |
| | | | 10 | 58 | 58 | 57 | 56 | 56 | 55 | 54 | 54 | 54 | 54 |
| **East Lake** | 43 | 54 | 50 | 18 | 17 | 17 | 17 | 16 | 16 | 16 | 16 | 16 | 16 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 18 | 18 | 18 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| **Fyshwick** | 28 | 28 | 50 | 24 | 25 | 24 | 24 | 23 | 23 | 23 | 23 | 23 | 22 |
| | | | 10 | 25 | 26 | 25 | 25 | 25 | 25 | 24 | 24 | 24 | 24 |
| **Gilmore** | 45 | 69 | 50 | 51 | 52 | 52 | 51 | 52 | 53 | 52 | 53 | 54 | 53 |
| | | | 10 | 53 | 53 | 53 | 53 | 53 | 54 | 54 | 55 | 54 | 55 |
| **Gold Creek** | 57 | 84 | 50 | 73 | 77 | 80 | 82 | **85** | **88** | **89** | **93** | **98** | **100** |
| | | | 10 | 78 | 82 | **84** | **87** | **89** | **92** | **94** | **98** | **101** | **103** |
| **Latham** | 100 | 114 | 50 | 64 | 66 | 67 | 65 | 66 | 66 | 67 | 68 | 68 | 68 |
| | | | 10 | 68 | 70 | 70 | 68 | 69 | 68 | 69 | 70 | 72 | 72 |
| **Telopea Park** | 100 | 114 | 50 | 77 | 76 | 75 | 75 | 74 | 73 | 72 | 72 | 72 | 71 |
| | | | 10 | 79 | 78 | 79 | 77 | 76 | 76 | 74 | 74 | 75 | 75 |
| **Tennent** | 15 | 15 | 50 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | | 10 | 2 | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 2 | 2 |
| **Theodore** | 45 | 69 | 50 | 26 | 26 | 25 | 25 | 25 | 24 | 24 | 23 | 23 | 22 |
| | | | 10 | 28 | 27 | 27 | 27 | 26 | 25 | 25 | 24 | 24 | 23 |
| **Wanniassa** | 100 | 114 | 50 | 72 | 70 | 69 | 69 | 69 | 69 | 68 | 68 | 67 | 67 |
| | | | 10 | 74 | 73 | 73 | 73 | 72 | 72 | 72 | 72 | 72 | 71 |
| **Woden** | 100 | 114 | 50 | 80 | 80 | 81 | 82 | 82 | 82 | 82 | 81 | 81 | 81 |
| | | | 10 | 84 | 84 | 84 | 85 | 85 | 85 | 84 | 85 | 85 | 85 |

## Zone substation demand forecast charts

**Figure 40.** Belconnen Substation 10-year summer and winter demand forecast chart

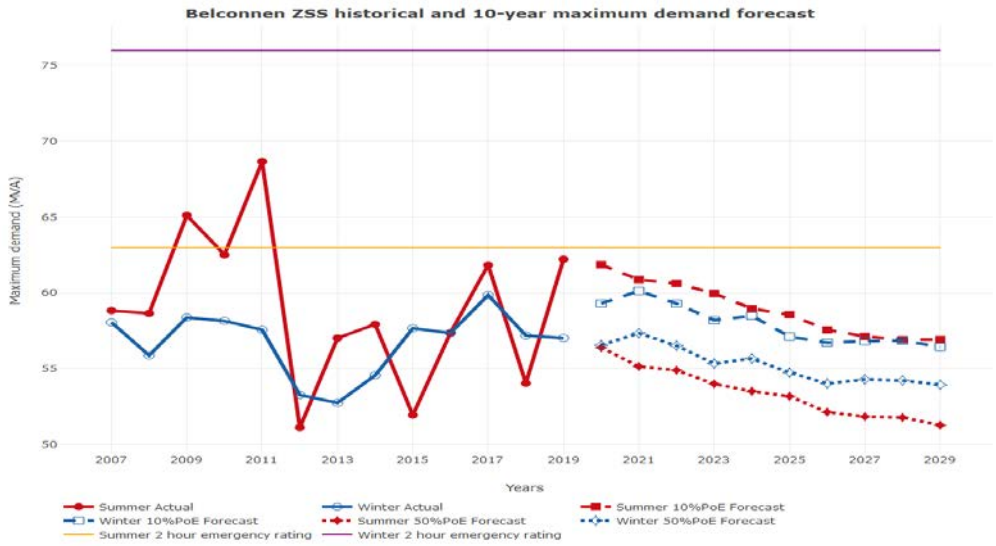



**Figure 41.** City East Substation 10-year summer and winter demand forecast chart

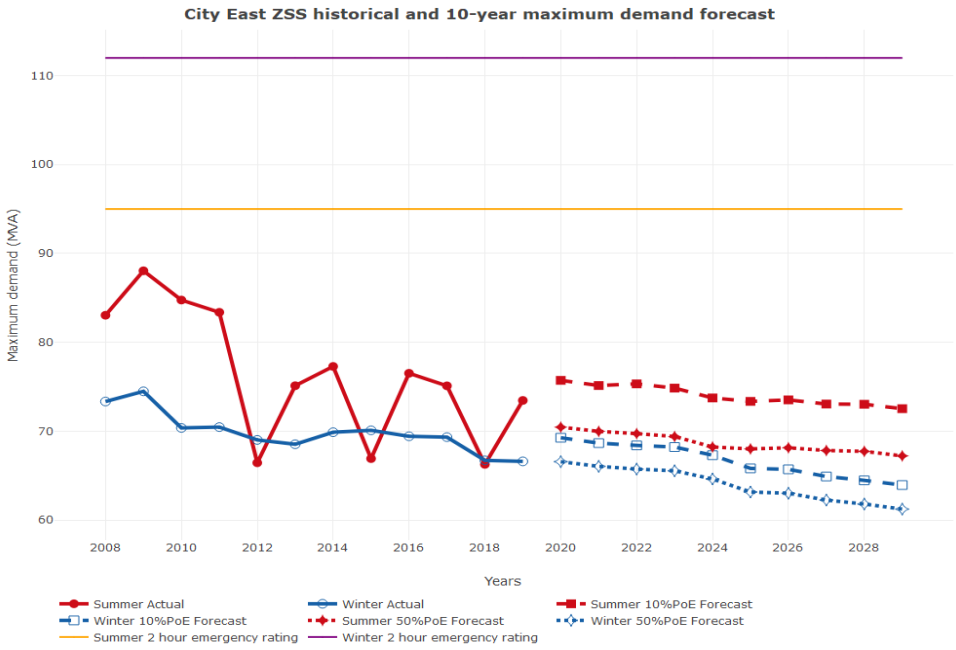


**Figure 42.** Civic Substation 10-year summer and winter demand forecast chart

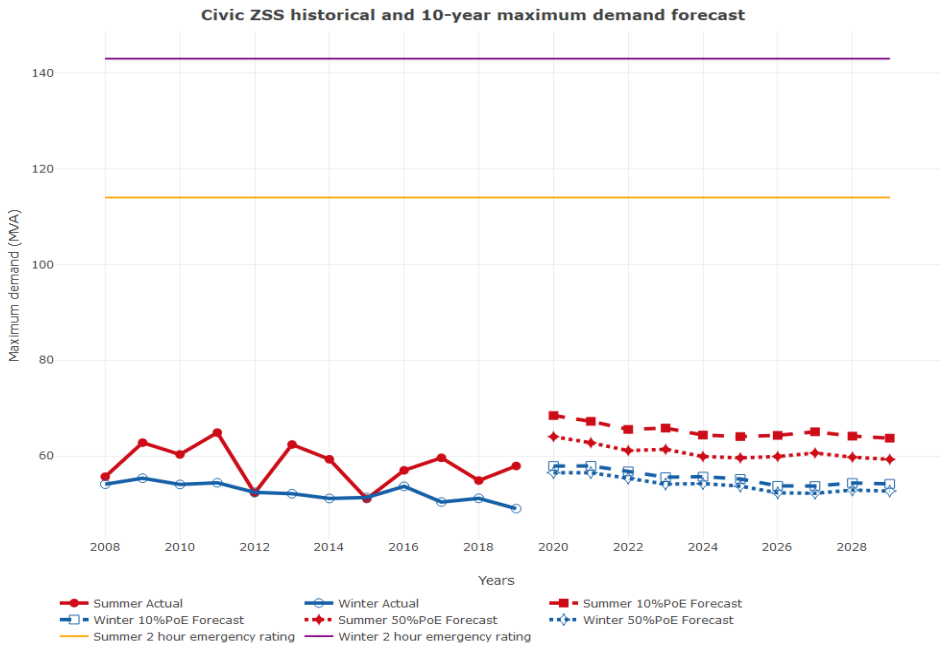



**Figure 43.** East Lake Substation 10-year summer and winter demand forecast chart

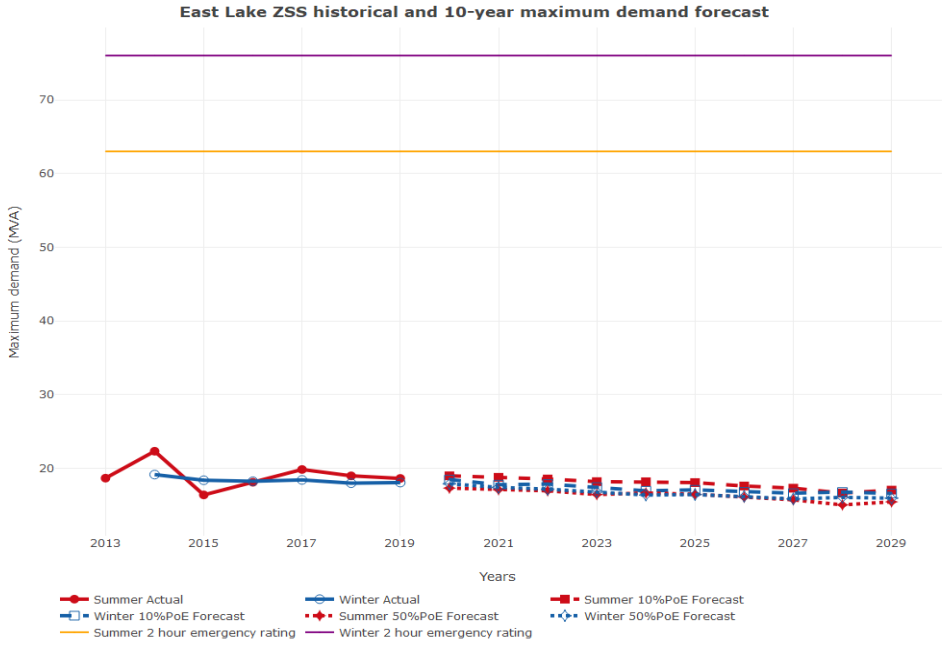


**Figure 44.** Fyshwick Substation 10-year summer and winter demand forecast chart

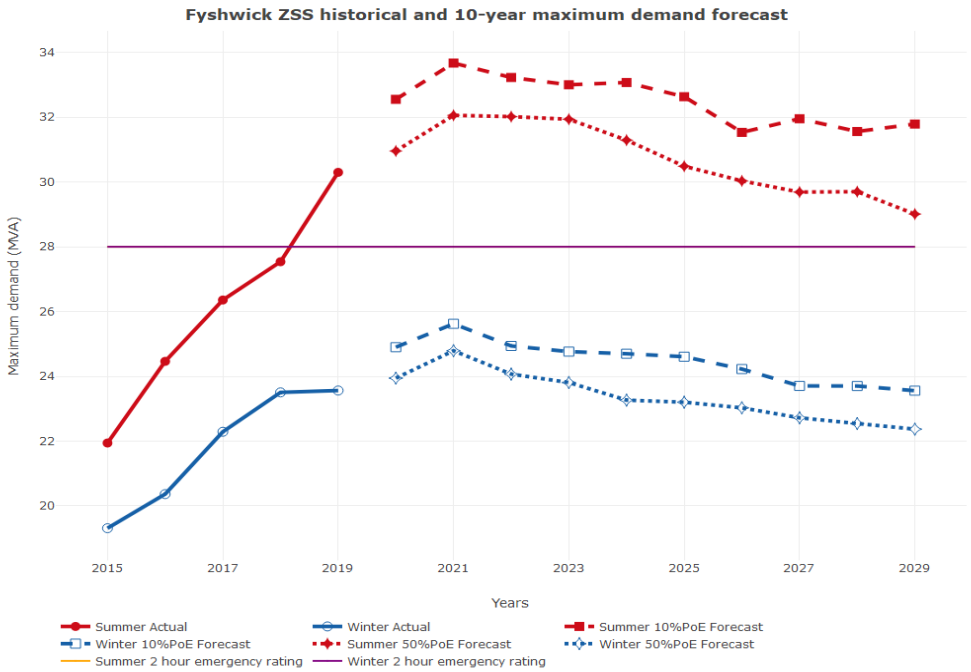



**Figure 45.** Gilmore Substation 10-year summer and winter demand forecast chart

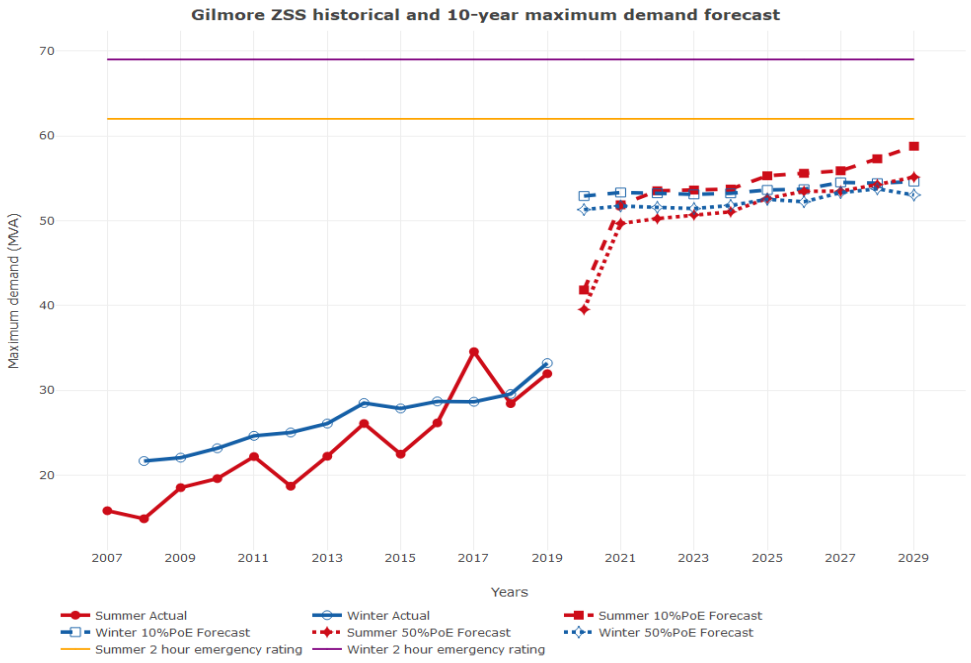


**Figure 46.** Gold Creek Substation 10-year summer and winter demand forecast chart

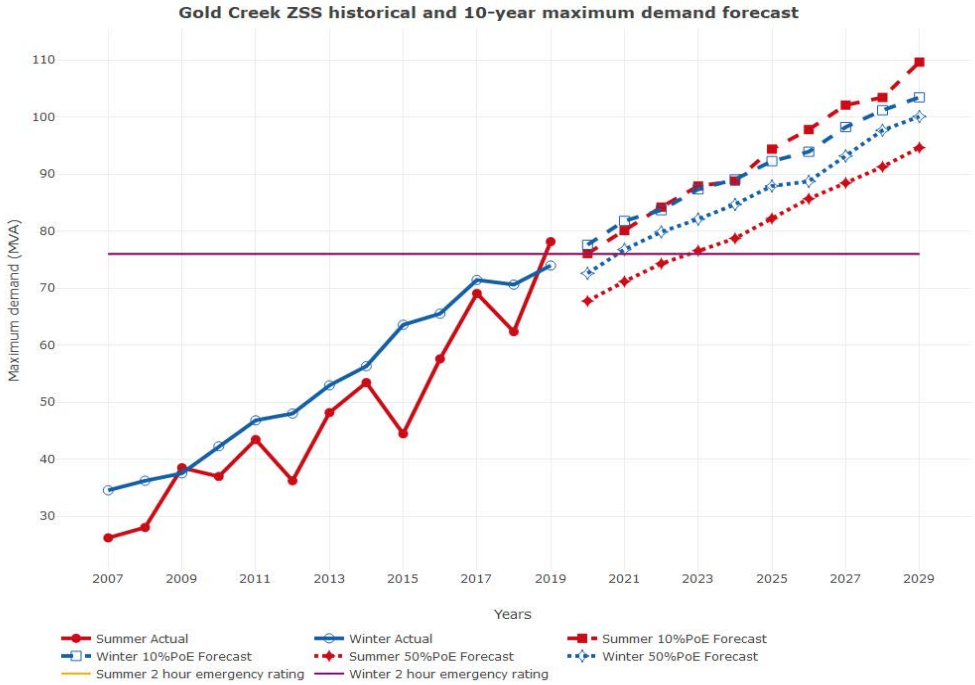



**Figure 47.** Latham Substation 10-year summer and winter demand forecast chart

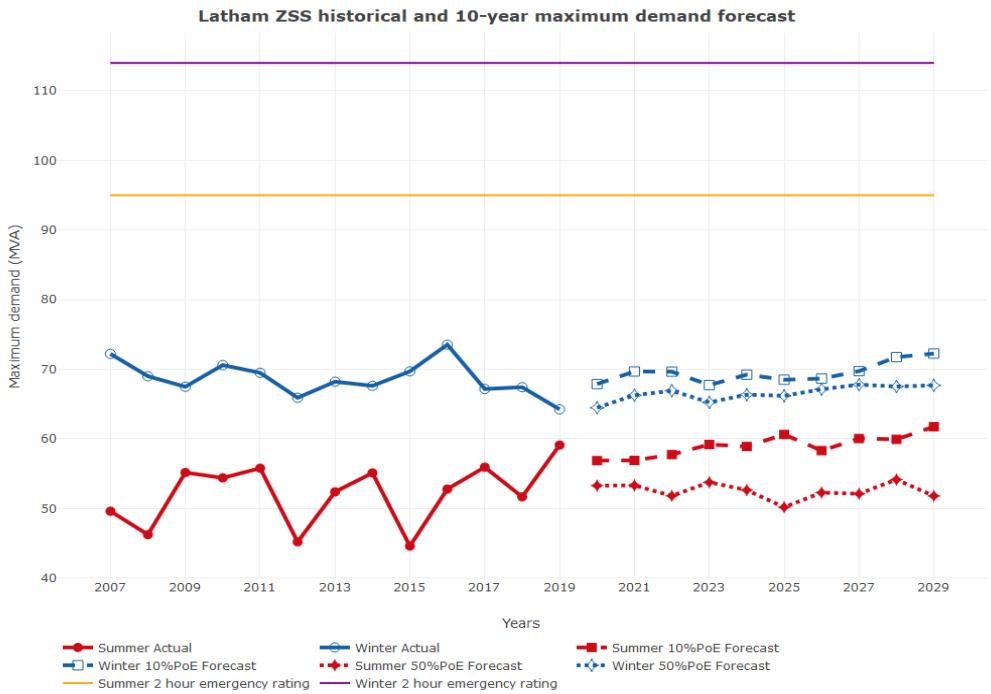


**Figure 48.** Telopea Park Substation 10-year summer and winter demand forecast chart

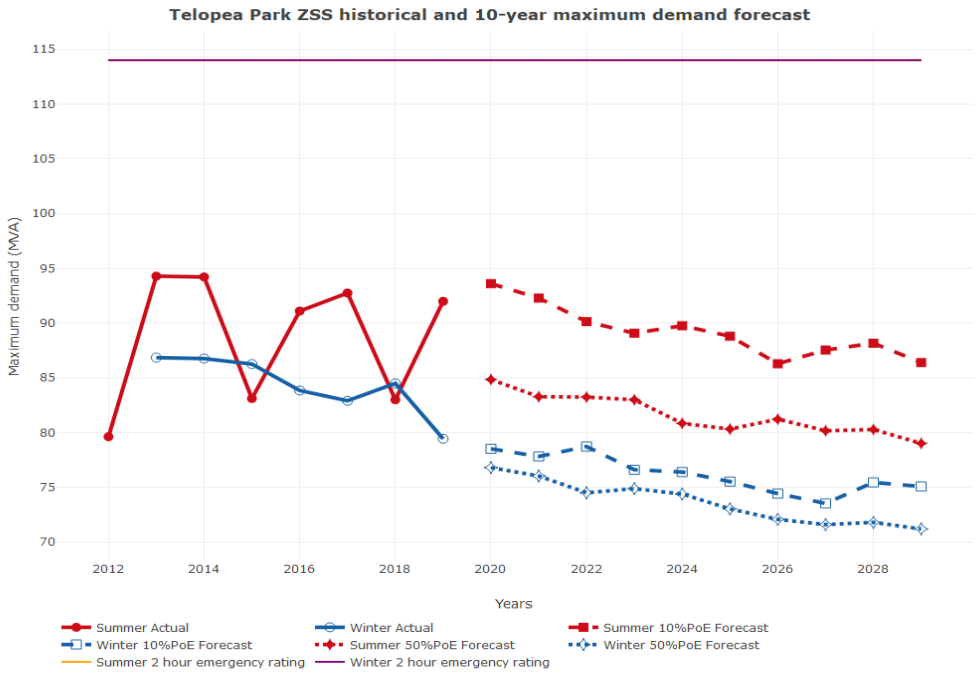



**Figure 49.** Tennent Substation 10-year summer and winter demand forecast chart

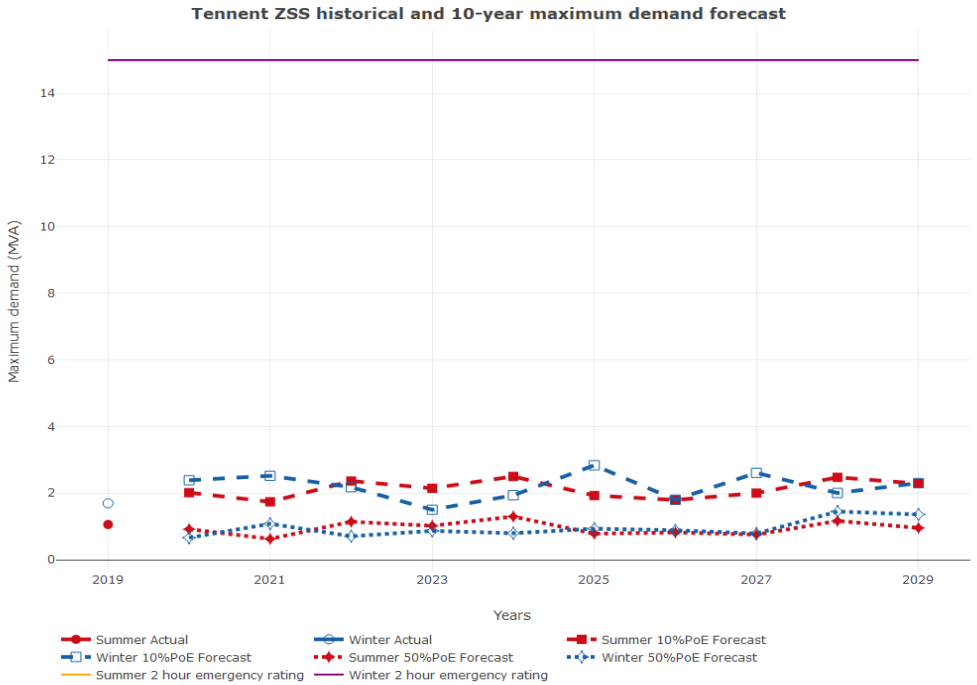


**Figure 50.** Theodore Substation 10-year summer and winter demand forecast chart

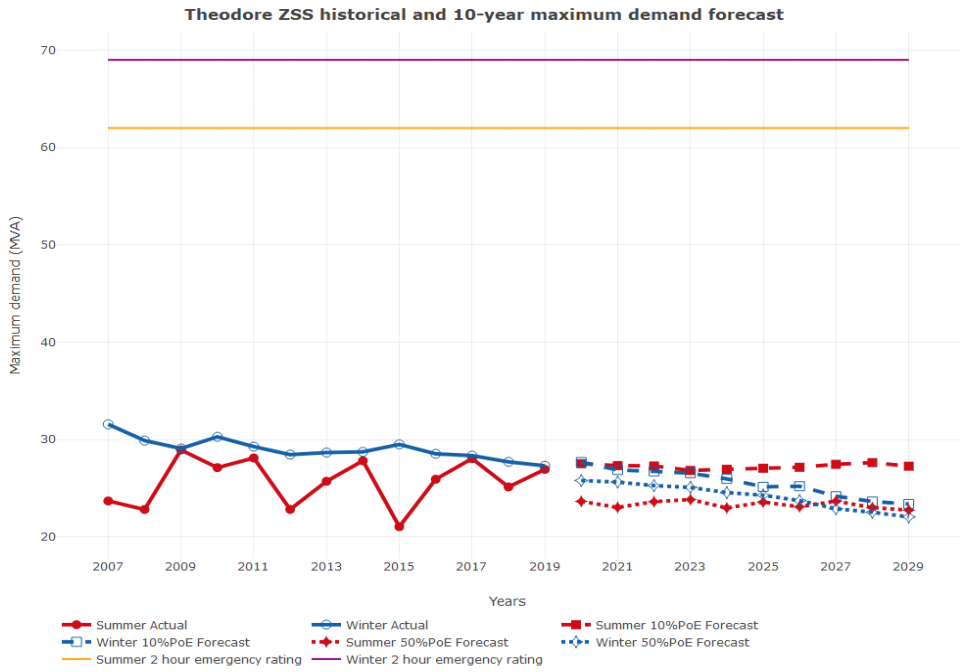



**Figure 51.** Wanniassa Substation 10-year summer and winter demand forecast chart

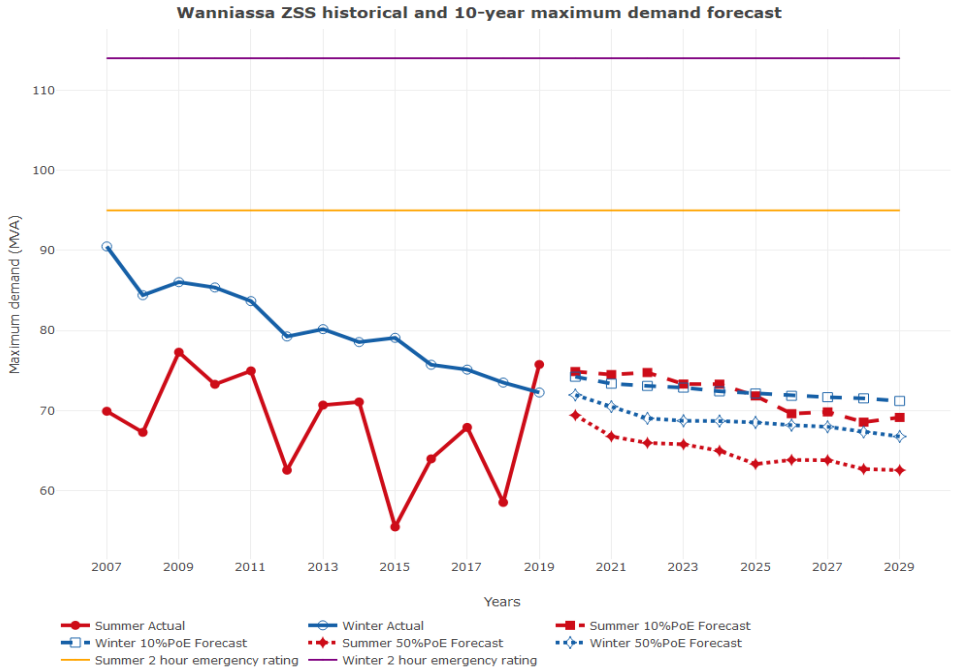
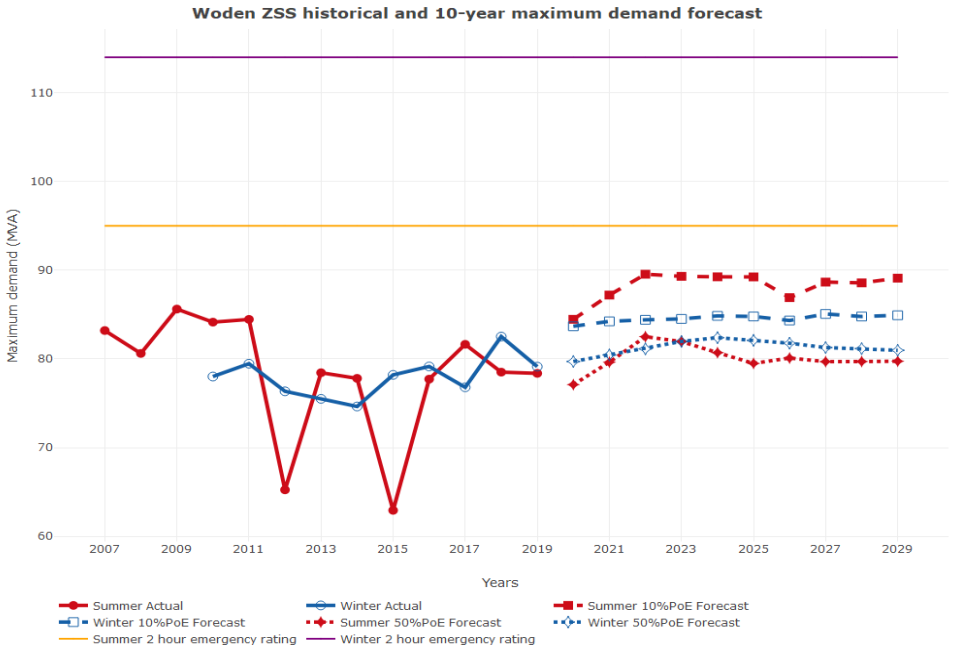


**Figure 52.** Woden Substation 10-year summer and winter demand forecast chart



# Appendix F – Network reliability standards and performance

## Key definitions

- **SAIDI**: System Average Interruption Duration Index. The ratio of total customer minutes interrupted to total customers served. This is a performance measure of network reliability, indicating the total minutes, on average, that customers are without electricity during the relevant period.
- **SAIFI**: System Average Interruption Frequency Index. The ratio of total customer interruptions to total customers served. This is a performance measure of network reliability, indicating the average number of occasions each customer is interrupted during the relevant period.
- **CAIDI**: Customer Average Interruption Duration Index. The ratio of total customer time interrupted to total customer interruptions. Measured in minutes and indicates the average duration an affected customer is without power. CAIDI = SAIDI/SAIFI.

Network reliability standards set by the Australian Energy Regulator and jurisdictional technical regulator are outlined in the following sections.

## Australian Energy Regulator Reliability Standards

The Australian Energy Regulator (AER) introduced a Service Target Performance Incentive Scheme (STPIS) for network reliability on 1 July 2015 for Evoenergy. The purpose of the STPIS is to provide an incentive to maintain existing supply reliability to customers, and to implement improvements to the extent to match customer's value on supply reliability. The scheme does this by offering financial inventive 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 allowance.

Network reliability STPIS targets are set by the AER for the five year regulatory control period. The reliability targets set by AER for the109-24 are shown in the last column in the table below.

**Table 29.** STPIS Reliability Performance Targets for Unplanned Outages:

| Year | 2019-24 |
|---|---|
| **Unplanned SAIDI I**[14] | |
| Urban | 32.524 |
| Short Rural | 35.056 |
| Whole Network (weighted average) | 33.366 |
| **Unplanned SAIFI**[15] | |
| Urban | 0.565 |
| Short Rural | 0.591 |
| Whole Network (weighted average) | 0.574 |

### Jurisdictional Regulator Reliability Standards

The ACT Utilities (Technical Regulation) Act. That Act requires Evoenergy to comply with all relevant industry and technical codes, any directions by the Independent Competition and Regulatory Commission (ICRC) or the ACT Technical Regulator. Relevant codes include the Consumer Protection Code, the Electricity Distribution Supply Standards Code and the Electricity Transmission Supply Code. The reliability targets specified in the Electricity Distribution Supply Standards Code are shown in Table 30. The ACT targets apply to planned and unplanned supply interruptions. Table 31 below includes full set of actual reliability performance figures for planned and unplanned outages.

**Table 30.** 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 |

[14] SAIDI-System Average Interruption Duration Index – refers to the a combined length of supply interruptions (minutes) which average customer experiences during the year

[15] 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 31 provides the historical reliability performance statistics for Evoenergy's network. The table includes SAIDI (minutes) and SAIFI figures for the rural network, urban network and the whole of the network from 2015 onwards. The planned and unplanned outages are set out against jurisdictional and STPIS reliability targets.

**Table 31.** Performance vs targets – planned and unplanned interruptions

| | 2015-17 | | | 2017-19 | | | 2019-24 |
|---|---|---|---|---|---|---|---|
| **Network Reliability Category** | **Target** | 2015-16 | 2016-17 | **Target** | 2017-18 | 2018-19 | **Target** |
| **SAIDI** | | | | | | | |
| **Whole Network Overall** | 91 (ICRC) | 74.01 | 83.74 | 91 (ICRC) | 88.49 | 92.53 | 91 (ICRC) |
| **Whole Network Planned** | - | 38.89 | 44.21 | - | 57.05 | 41.54 | - |
| **Whole Network Unplanned** | - | 35.12 | 39.53 | - | 31.44 | 34.94 | - |
| **Urban Unplanned** | 31.912 (AER) | 35.73 | 42.74 | 30.32 (AER) | 29.81 | 33.19 | 32.524 (AER) |
| **Short Rural Unplanned** | 49.32 (AER) | 30.25 | 39.11 | 46.86 (AER) | 34.11 | 36.58 | 35.056 (AER) |
| **SAIFI** | | | | | | | |
| **Whole Network Overall** | 1.2 (ICRC) | 0.86 | 0.902 | 1.2 (ICRC) | 0.7 | 0.95 | 1.2 (ICRC) |
| **Whole Network Planned** | - | 0.185 | 0.212 | - | 0.2 | 0.19 | - |
| **Whole Network Unplanned** | - | 0.675 | 0.69 | - | 0.49 | 0.63 | - |
| **Urban Unplanned** | 0.616 (AER) | 0.682 | 0.669 | 0.585 (AER) | 0.45 | 0.60 | 0.565 (AER) |
| **Short Rural Unplanned** | 0.942 (AER) | 0.616 | 0.852 | 0.895 (AER) | 0.56 | 0.60 | 0.591 (AER) |
| **CAIDI** | | | | | | | |
| **Whole Network Overall** | 74.6 (ICRC) | 86.06 | 92.84 | 74.6 (ICRC) | 126.41 | 96.92 | 74.6 (ICRC) |
| **Whole Network Planned** | - | 210.22 | 208.54 | - | 285.25 | 215.58 | - |
| **Whole Network Unplanned** | - | 52.03 | 57.29 | - | 64.16 | 55.09 | - |
| **Urban Unplanned** | - | 52.39 | 63.89 | - | 66.24 | 55.18 | - |
| **Short Rural Unplanned** | - | 49.11 | 45.90 | - | 60.91 | 60.92 | - |

### Reliability Strategy and Plan

Evoenergy reliability strategy is published on Evoenergy website. The current strategy for Evoenergy is to maintain the existing reliability performance and target improvement in the selected areas for the worst performing feeders and worst served customers. Evoenergy's network reliability strategy and plan considers the following tactics to manage our network reliability for customers.

## Prevention

### Minimise asset failures

When assets fail, it often results an unplanned outage for customers. Reducing the number of asset failures can reduce unplanned outages for customers and improve network reliability. An objective of Evoenergy's asset maintenance programs is to reduce asset failures through assets inspection, maintenance, refurbishment and replacement.

### Reduce outages caused by vegetation

Vegetation can cause 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. Evoenergy vegetation management strategy aims to reduce the number of outages caused by vegetation by inspecting and tree clearing around overhead power lines.

### Reduce third party damage

Damage to Evoenergy's network from the public or other organisations also causes unplanned outages for customers. Damage to our network is often caused by a 3rd party by hitting an underground cable while excavating, a crane coming in contact with overhead lines or a vehicle crashing into a network asset such as a substation. Evoenergy runs public awareness campaigns, offers electrical safety rules training and publishes its underground network assets on Dial Before You Dig (DBYD) to damage to our network caused by others.

### Decommission legacy assets

Removing assets from the network, remove points of failure. Part of Evoenergy's asset management strategy seeks opportunities to decommission legacy assets from the network when they are in need of replacement. This not only results in reduced replacement expenditure (avoided REPEX) but reduces potential failure points which may fail in the future causing an outage to customers and network unreliability.

### Design reliable networks

Probabilistic planning is a risk-based methodology that effectively manages network reliability. Often the dominant risk considered is a risk of supply interruptions. The value of the risk is expressed as the energy at risk or unserved energy. The value is derived from the probability of supply interruptions and the value of energy to customers.

### Dispatch Distributed Energy Resources (DER)

During peak demand, generation, transmission or distribution networks cannot always meet peak demand events. When these events occur, load shedding (disconnection of customers) may be required to maintain the stability and reliability of the national

electricity grid. Load shedding events are directed by AEMO for National Electricity Market (NEM) constrained events or Evoenergy for distribution network constraints.

Controlled dispatch of Distributed Energy Resources (DER) can reduce the likelihood of load shedding events by reducing demand during peak periods. By avoiding load shedding events, this reduces unplanned outages for customers and reduce the likelihood of AEMO directed or Evoenergy network constrained load shedding events during peak demand.

### Maximise availability for PV generators

The number of LV connected PV generators is increasing causing LV network voltage stability issues. These generators operate within a prescribed voltage standard and if the voltage drifts outside this range, the generator must disconnect from the network until the voltage is within range. Although the network is available for customers to consume electricity, their generator experiences an outage. Evoenergy's power quality strategy aims to maintain LV voltage regulation and thus maximise network availability for PV generators.

### Minimise the number of planned outages

Planned outages are required to provide safe access to maintain and install new capacity in the network. Evoenergy's asset management plans synergise maintenance tasks to reduce planned outages for customers. For example primary and secondary asset maintenance strategies are aligned so that one (1) planned outage is required to maintain as many assets in a single outage as practicable.

## Minimisation

### Auto-reclosers

Auto-reclosers are switchgear designed to isolate faults when they occur, then attempt to automatically restore supply automatically. Many overhead network faults are transient such are lighting or foreign objects (such as tree branches) cause a fault that must be isolated for the safety and reliability of the network. If the fault is transient, supply is restored to customers in less than 1 minute, if the fault is permanent such as a failed asset, the auto-recloser stops tyring to automatically restore supply until field crews are dispatched to repair the network.

Auto-reclosers provide fault discrimination that is used to reduce the number of customers affected when faults occur. If a fault occurs downstream of an auto-recloser, only customers connected downstream of the auto-recloser will experience an outage. Customers connected upstream of the auto-recloser don't experience an outage.

### Diversify network outage risk

Diversifying network outage risk refers to network design which limits the number of customers affected for any one (1) fault on the network. Evoenergys asset management planning does this by analysing feeder outage rates, optimising the number of customers connected to feeders, design and installation of network protective devices and network redundancy.

## Restoration

### Fault Location, Isolation & Service Restoration (FLISR)

Evoenergys strategic plan towards a smart and self-healing network utilises automated Fault Location, Isolation and Service Restoration (FLISR) for the safe and fast restoration of supply to customers. Automated FLISR is a collection of tools including switchgear with remote control and indication, and a centralised Advanced Distribution Management System (ADMS). Current fleet of switchgear with remote control and indication is currently being reviewed for compatibility with Evoenergys automated FLISR system.

### Remote network indication & control

Overhead and underground switchgear can be installed with remote indication and control. This enables Evoenergys 24 hour network control centre to respond quickly to faults by enabling faster identification and isolation of faulty sections of the network and quicker restoration supply to customers connected to healthy sections. This allows fast restoration of supply to some customers before crews are dispatched on-site. Crews are still dispatched to repair the network and restore supply to the remaining customers.

### Maintain asset availability to enable fast restoration

When assets fail and an outage occurs, supply is often restored to customers by isolating the failed section of network and restoring supply from an adjacent part of the network providing redundancy. These defects must be repaired in a timely manner and the network restored to its normal configuration. If these defects are not repaired, and another fault occurs in the same area, the time to restore supply to customer is likely to increase significantly as the adjacent network is defective and not available to restore supply.

Evoenergy’s asset management plans and network defects triage process seeks to identify network defects with high reliability risk to make repairs in a timely manner.

## Appendix G – Power quality standards and obligations

This appendix provides additional information in relation to power quality in addition to that provided in Chapter 4.

It provides the following information:

- An overview of the main standards, guidelines and other 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 network planning strategy 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 2344:2016 – 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 3000:2007 – Australian/New Zealand Wiring Rules.
- AS/NZS 7000:2016 – Overhead Line Design.
- TR IEC 61000.3.6:2012 – Electromagnetic compatibility (EMC) Limits – Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems.
- AS/NZS 61000 – Electromagnetic Compatibility (various sub-standards).
- AS/NZS 60038:2012 – 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 customers' 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 customer'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 customer's point of supply is measured to ensure the V1%, V99% and V50%, (phase-to-neutral and phase-to-phase).

**Table 32.** 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 |
| $V_{50\%}$ + | 244 Volts | 244 Volts |
| $V_{50\%}$ - | 225 Volts | 225 Volts |
| Utilisation Limit (+10% / -11%) | - | 424 Volts (Phase-to-Phase Maximum)<br>253 Volts (Phase-to-Neutral Maximum) |
| | - | 392 Volts (Phase-to-Phase Minimum)<br>204 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 per cent 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 customer-generated due to the following:

- Frequent starting of induction motors – mainly the direct on line starting of induction motors.
- Electric welders.
- Arc furnaces.

Evoenergy responds to a customer report of flicker by installing a mobile power quality analyser. Evoenergy advises the customer 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 61000.3.7:2012.

**Table 33.** 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 34.** 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 customers' premises (e.g. induction motor starting).

Dips caused by faults on adjacent feeders can propagate throughout the network, affecting customers' supply voltage on all feeders at the zone substation. Although only customers 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 35.** Voltage Dip Voltage Tolerances

| 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.

## Voltage Difference Neutral to Earth

Voltage differences between neutral and earth can present the risk of damage to electrical equipment at customers' 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 customers 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.

Target voltage difference between neutral and earth is < 10 V steady state (5 minute average) at the point of supply.

**Table 36.** Voltage Difference between Neutral to Earth Limits

| Voltage Difference Between Neutral To Earth |
|---|
| < 10 Volts<br>(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 through the use of ADMS calculations to ensure compliance.

Evoenergy's objective is to limit voltage unbalance to less than the compatibility levels for low voltage networks in AS/NZS 61000.2.2, and the indicative planning levels for medium and high voltage networks in TR IEC 61000.3.13.

**Table 37.** Compatibility Levels for Voltage Levels in LV and MV Systems

| MAXIMUM NEGATIVE SEQUENCE VOLTAGE (% OF NOMINAL VOLTAGE) |
|---|
| 2% |

1. Up to 3 % may occur in some areas where predominately single-phase loads are connected.
2. Compatibility levels are not defined for HV and EHV systems.

## Harmonics

Harmonics are usually customer-generated. Non-linear loads such as industrial equipment (e.g. arc welders), variable speed drives, uninterruptible power supplies, 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 customer 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. Evoenergy is currently investigating the use of the ADMS to identify areas of the network where harmonic levels are outside regulation limits and explore the potential of real-time harmonic monitoring at zone substations.

Customers must ensure that harmonic distortion caused by their equipment does not exceed the limits prescribed in Australian Standard AS/NZS 61000 parts 3.2, 3.4, 3.12 and TR IEC 61000.3.6.2012.

**Table 38.** 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 ≤ h ≤ 49 | 2.27x(17/h)-0.27 | 21 ≤ h ≤ 45 | 0.2 | 10 ≤ h ≤ 50 | 2.27x(17/h)-0.27 |

The corresponding compatibility level for the total harmonic distortion is: THD = 8% (LV) and 3% (HV).

**Power Quality Issues Associated with Embedded Generation**

## Voltage stability and regulation

Synchronous generators provide dynamic voltage support to the power system, particularly during and immediately following system faults. Synchronous generators provide considerable fault current to the network which helps maintain voltage stability during and immediately following network faults. Asynchronous generators provide much less fault current. This could lead to voltage instability during network faults. Most wind and large-scale PV generators in areas with poor voltage stability will struggle to remain connected to the network during network faults, and their power output may need to be restricted to manage this risk. Increasing rooftop PV could eventually cause high voltage issues on the distribution network so output from DC/AC inverters will need to be strictly adhered to.

The replacement of synchronous generation with asynchronous generation reduces the fault current and can lead to a “weak” system. This can cause the following issues:

- DC/AC inverters not remaining operational through network faults, tripping off and requiring resetting to reconnect their generation. This is commonly known as ‘fault ride-through’ capability.
- Inability to achieve steady-state stability during system normal.
- Protection schemes unable to distinguish between system normal load current and fault current leading to an inability to detect and clear faults on the system.
- Slow rate of recovery following network faults.

Solar PV generation both on a large scale (e.g. solar farm) and small scale (e.g. residential rooftop system) can be intermittent and difficult to forecast. Consecutive days of rain or cloud cover will significantly reduce PV output, so the network cannot rely on such generation and must be capable of operating without it.

Evoenergy's distribution network has been designed and constructed to allow for voltage drop from power flow through the high voltage network to the end of the low voltage network. With increasing connections of rooftop solar PV to the low voltage network, at times of low load and high generation, power flows in the reverse direction from the low voltage network to the high voltage network. This reverse power flow can cause voltage rise on the distribution network which has to be managed to keep voltage within regulatory limits, ie 230 V +10% / -6% at customer points of connection. High voltage may affect or damage connected appliances or electronic equipment.

High concentration of rooftop solar PV generation systems in one locality causes voltage variability at the local level, potentially degrading power supply and impacting the operation and lifespan of electrical appliances. To maintain low voltage levels within regulatory limits, Evoenergy is planning to trial the installation of distribution transformers equipped with on-line tap changers (OLTC). Such OLTC transformers are used widely in Europe in areas of concentrated rooftop PV.

## Frequency stability

Synchronous generators such as the Snowy Hydro scheme generators, produce power through directly connected alternating current machines, rotating at a speed synchronised to power system frequency. These generators produce inertia, which lessens the impact of changes in power system frequency following a disturbance such as loss of a generator or transmission line, resulting in a more stable system.

The inertia of the rotating plant of such generators can support system frequency following a system disturbance such as loss of a transmission line or large generator. Power systems with low inertia experience faster changes in system frequency following a disturbance, which could lead to system instability and under frequency load shedding.

Asynchronous generators such as wind turbines and solar PV generators are connected to the power system via power electronic inverters. These generators contribute little inertia to the system unless coupled with a fly-wheel or similar. When a network has little or no inertia, a fast change to system frequency could result from a fault (sudden loss of generator or transmission line) which could lead to under-frequency load shedding on the distribution network.

As the amount of non-scheduled embedded generation in the ACT increases, Evoenergy's network could become reliant on frequency controlled ancillary services (FCAS) provided by other regions to maintain frequency stability and the supply-demand balance. Frequency control services in future will need to be sourced increasingly from non-traditional sources such as battery storage systems, demand-based resources, and renewable generation.

## 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

Supervisory Control and Data Acquisition (SCADA) systems collect system status and analogue information from field devices. This data is used by Evoenergy's Advanced Distribution Management System (ADMS) and other operational systems to monitor and control the network. This data is also used for power systems analysis purposes to aid network planning and augmentation decision making. SCADA also provides asset condition monitoring information used for asset maintenance and informing replacement decisions.

Zone substation power transformers, switchgear and controllable distribution assets are critical elements of the electricity network and SCADA is important for safe and reliable operation.

Evoenergy's has deployed integrated SCADA and protection systems in recent years that use multifunction numerical devices in an interconnected communications network. Implementation costs have been reduced due to the development of reusable device templates and a reduction in the number of devices required as the result of installing multifunction protection relays and other devices. These systems are able to provide automated condition monitoring which is used to optimise asset maintenance.

New and replacement SCADA systems are implemented as follows:

- Remote Terminal Units (RTUs) use DNP3 protocol over IP for communications to the ADMS SCADA master station.
- Zone substation communications to the ADMS use the Evoenergy IP-MPLS optical fibre network. Critical distribution substation sites also use optical fibre communications where available.
- Communications for distribution substations, reclosers, switches and other field devices use the Evoenergy UHF Digital Radio Network, 3G/4G communications or mesh radio; depending on availability and best cost option for individual sites.
- The RTU operates as a data concentrator with monitoring and control performed in bay protection relays.

## Protection Systems

Evoenergy uses protection systems thought 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 general public and property.

Evoenergy has identified the need to replace a number of defective and poor performing protection relays that have reached the end of their economic life. Old electro-mechanical and static/electronic protection devices are being replaced with modern numerical relays.

As part of the secondary systems strategy, protection and SCADA replacements are proposed at Woden, City East and Wanniassa zone substations commencing in 2019.

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, Williamsdale and Queanbeyan. Voltage levels on the 132 kV bus at Canberra 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. In order 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). Line drop compensation is varied to manage high voltage caused by embedded generation connections along the feeder.

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 customer complaints where required. Evoenergy shall use the implementation of the ADMS and 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 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 12.2 kA. Evoenergy's 11 kV network is non-effectively earthed via the neutral earthing transformers at zone substations. This keeps the fault level generally 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 transmission 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 customers 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 a sufficient amount of 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:

- Inadequate sizing of the earth conductor relative to the maximum fault current.
- 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[16]. 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 inspects the earth connections on its system on a five-yearly program.

## Electrical earthing audit 2018

In 2018, the ACT Technical Regulator conducted and audit of electrical earthing practices within Evoenergy’s network. The audit identified some non -conformances and recommended several improvements.

[16] 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

In response, Evoenergy initiated a set of initiatives to address the identified deficiencies. Using risk assessment, Evoenergy developed and prioritised a program which addresses earthing design, construction and testing, work practises, testing and records management.

The actions taken include updated Evoenergy earthing design manual which is compliant with the relevant standards. In addition, Evoenergy is developing earthing construction and testing manual which is the intended to be the main reference for field personnel involved in construction and testing of earthing. The objective of the changes is to achieve the industry best practise and full compliance with the relevant standards.

The earthing test program for transmission assets, distribution assets and zone substations was prioritised in accordance with the risk profiles including asset type, age, condition and a likelihood of persons being exposed to earth potential rise. The Evoenergy's 2018-19 year testing program and beyond is conducted in accordance with the risk based priorities.

## Transmission Service Network Provider (TNSP) metering

Evoenergy has installed TNSP metering at all of 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 transmission 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).

## Customer metering - competition in metering

Evoenergy manages a fleet of approximately 195,000 revenue meters installed at customer premises. The main purposes of conventional meters is to measure a consumption of electricity.  The meters are being managed in accordance with Evoenergy's metering asset management plan. In 2017 a set of regulatory reforms under the Power of Choice banner expanded contestability to the installation of all customer metering. Under new rules the meter installation is subject to completion and can be provided by parties authorised by AEMO. 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 metering of energy consumption. The latest generation of meters include functionality which can provide additional information to customers on their energy consumption, assist with network operation and provide additional data in relation to power quality.

Evoenergy is exploring 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.

## 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 also 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)[17] which describes EMF's 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 customer'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).

[17] http://www.ena.asn.au/sites/default/files/emf_handbook_2016

## 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.

Customers 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 customer’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.

## System Losses

As electrical energy flows through the transmission and distribution networks, a portion is lost due to the electrical resistance and heating of network elements such as conductors 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 transport, to ensure adequate supply is available to meet prevailing demand and maintain the power system in balance. In practical terms, this means more electricity must be generated to allow for this loss during 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. 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 number of 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.

The asset life cycle cost assessment ensures that the capital cost is one of the factors in the assessment of transformer tenders. 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 taken into account 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 size cables result in different electrical losses, cables are usually sized according to capacity requirements. In most cases the differences in value of electrical losses is not sufficient to justify a selection cable.

## 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 section 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 customers. Evoenergy calculates distribution loss factors for both site specific customers (embedded generators with output greater than 10 MW and load customers with maximum demand greater than 10 MW) and average DLFs for non-site specific customers. High voltage distribution feeders and transmission lines are analysed using data from Evoenergy's Advanced Distribution Management System (ADMS).

The DLF calculation methodology can be found on Evoenergy's website[18], and Evoenergy's published DLFs can be found on AEMO's website[19].

[18] https://www.evoenergy.com.au/-/media/evoenergy/about-us/evoenergy-loss-factor-methodology.pdf

[19] https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Loss-factor-and-regional-boundaries/Distribution-loss-factors-for-the-2019-20-financial-year