evoenergy

Annual Planning Report 2021

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Approval

Date	Name	Position	Signature
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Acknowledgement of Country

Evoenergy acknowledges the Traditional Custodians of the Canberra region, the Ngunnawal people. We pay our respects to their Elders – past, present and emerging – and recognise their continuing connections and contributions to this region. We also acknowledge the First Peoples of the broader region in which our footprint extends.

Disclaimer

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

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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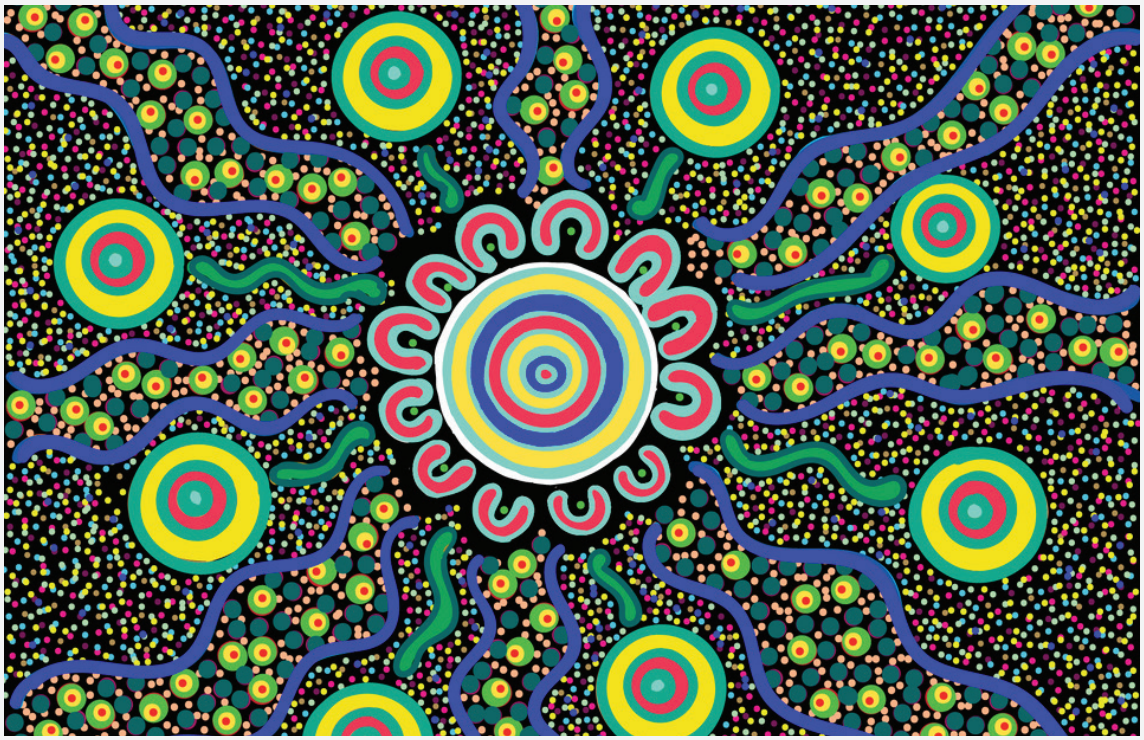
Review date

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 2022. 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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Foreword

This year has again been another busy year for Evoenergy with another increase in the number of Canberrans connected to the electricity network. We now have almost 205,000 people that rely on our electricity network to power their homes and businesses, and as our population grows and our urban landscape expands, we expect that number to continue to rise.

Each year our planning is centred around ensuring that the energy service we provide to the community is safe and reliable, while also integrating innovative energy solutions and operating as efficiently and sustainably as possible. We apply these principles to our short-term planning, but more importantly, as we look to the future.

The ongoing increase in solar, batteries and electric vehicles connected to the network represents an evolution in the way we use energy, and consumers have a growing desire to take more control of their energy generation and consumption. When we consider changing consumer energy preferences and our goal to reach the ACT Government's legislated target of achieving net zero emissions by 2045, it's fair to say we are in the midst of an energy revolution.

To achieve net zero emissions while providing energy to customers that is safe, reliable and affordable, is a complex challenge encompassing major strategic, technical, social and operational considerations, and we want to ensure Canberrans are at the centre of the decisions we make that shape our planning.

In addition to our annual planning, every five years we develop a longer-term plan for how we will operate and invest in the network and how the cost of this flows on to energy bills. We are currently preparing a plan for 2024–29 and an important part of the planning process is engaging with the community to ensure that our priorities for the period reflect the needs and preferences of Canberrans. If you're interested in getting involved in our planning to have your say, visit www.engagewithenergy.com.au.

Next year will be another important year in our journey toward reducing our emissions, and we'll be prioritising our focus on addressing existing and emerging network constraints, and working with key stakeholders to facilitate investment in non-network solutions such as batteries to alleviate high demand.

We have a long-standing commitment to serve the local community and we're looking forward to working with energy consumers and our stakeholders to achieve the best possible network solutions in the coming year.

Peter Billing
Evoenergy General Manager

Introducing Evoenergy

Evoenergy owns and operates electricity and gas networks and 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 (NEL), National Electricity Rules (NER), Utilities Act 2000, Utilities Technical Regulations Act, industry codes, technical codes, and regulations. The NER require Evoenergy to undertake annual planning review and prepare the Annual Planning Report. Our "poles and wires" network is supplied predominantly by power imported from interstate. There is an increasing amount of power generation embedded within Evoenergy's network with 45,196 kVA of inverters added last year. Evoenergy's primary focus is on the provision of a safe, reliable, and quality electricity supply in a cautious and efficient manner. We are asset management certified for compliance with ISO 50001 Asset Management Standard. Safety and risk management are key considerations of our business decisions. Whenever practicable, risk management is integrated with investment decisions and considers the life cycle of assets and least cost solutions.

Purpose of this report

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

The report also addresses network capacity limitations, asset renewal, power quality and reliability in relation to 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

In recent years the electricity industry has been changing at an unprecedented pace with increased uptake in Distributed Energy Resources (DER) driven by improvements in affordability, advances in technology and the rise of customer desire for energy independence. Within the Evoenergy jurisdiction the ACT Government has a strong focus on their climate change strategy, with a legislated target for net zero emissions by 2045. Aligning with this, the federal government as well as private sector have been accelerating and crystallising strategies around net zero emissions targets. These are key drivers for Evoenergy's strategy as we work towards these goals using a set of innovation and optimisation initiatives while operating within our regulatory and legislative requirements.

A key component of the Evoenergy strategy is

> **"A sustainable business, energising our evolving community".**

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

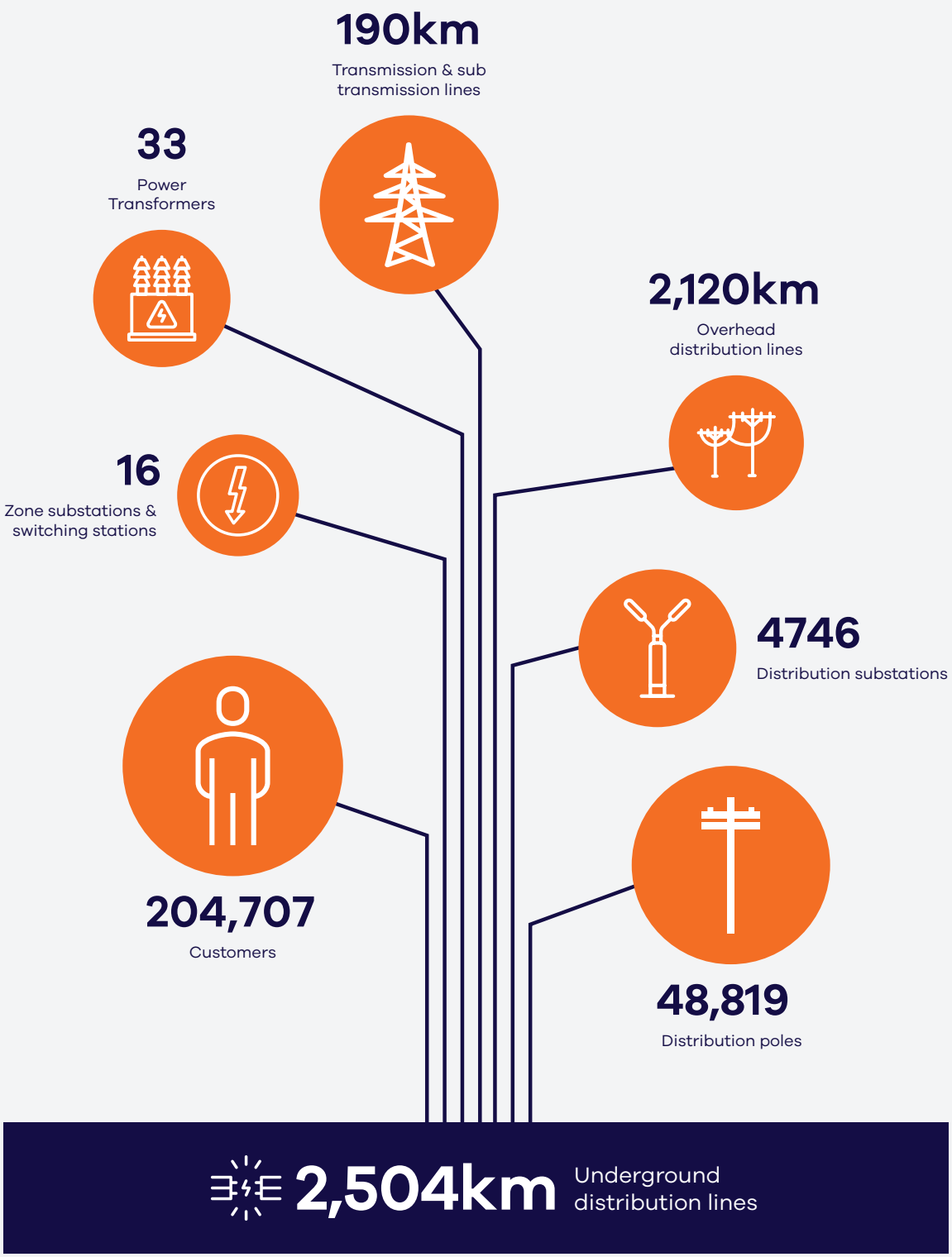
Evoenergy also aims to diversify our energy system through integration of non-network solutions, minimise the carbon and environmental footprint of our network operations and build network resilience to the changing climate. It is also important to understand the implications of, and road map to, a zero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

COVID-19 Operations

While the pandemic was an ever-looming threat throughout 2021 for most of the year Evoenergy was able to continue business operations with only minor restrictions and precautions.

When the first case in a second wave of COVID-19 was identified in Canberra in mid-August 2021, Evoenergy enacted immediate operational changes to keep our staff and community safe while ensuring we could continue to supply safe and reliable electricity to our customers. All staff who could be working from home were asked to do so and field operations moved into separated "bubble" style teams to minimise crossover between staff. As the COVID-19 situation evolves and ACT restrictions begin to change Evoenergy will continue to adapt while ensuring safety and reliability are prioritised.

Evoenergy snapshot



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.

POWERED BY **SAFETY**

System level demand

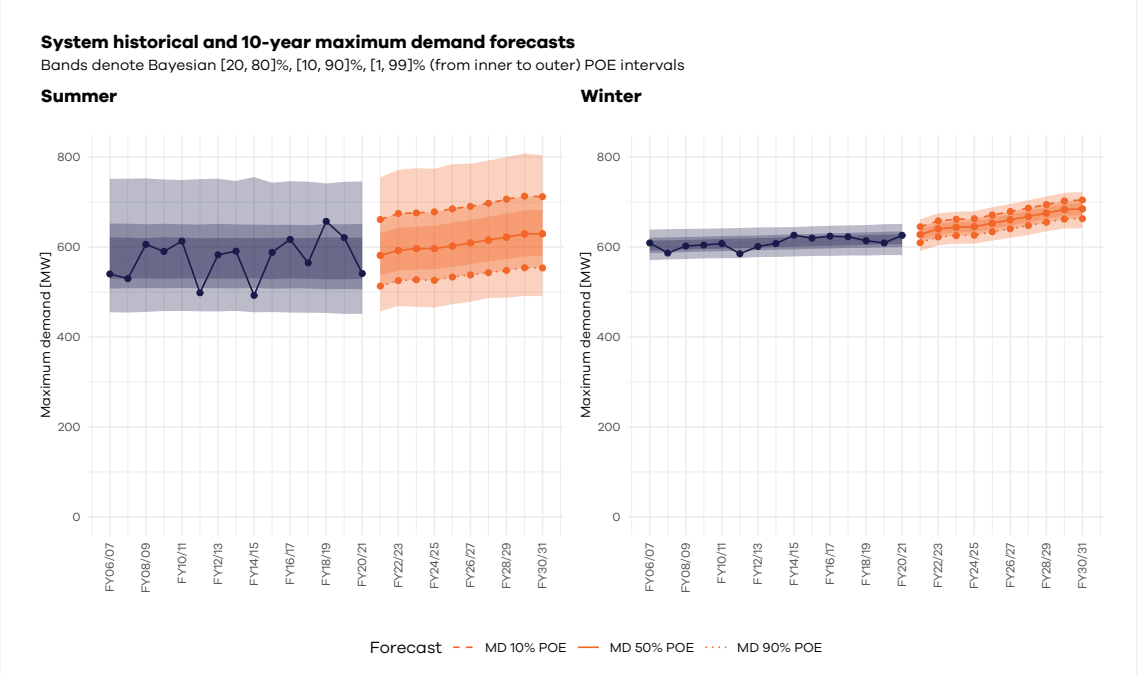
In 2021 the arrival of La Niña led to a mild summer season and a harsher winter season. This was reflected in the demand as we saw a decrease in summer demand with a peak of 509 MW and a small increase in Winter Demand to 626 MW. We are expecting a significant increase in winter demand for the next reporting period due to a very cold July and August 2021.

In 2021 forecast peak demand for network-delivered energy shows the growth in peak summer demand is expected to increase by approximately 8% over the next ten years. The increase in peak winter demand over the next ten years is expected to be approximately 9%. This significant increase is made up of a low organic growth component as well as an expected increase due to large data centre growth in the region.

A key feature of peak demand has been the relative volatility of peak summer demand over the last ten years culminating in the highest recorded peak in 2019 of 657 MW. 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 is forecast to increase, reflecting the impact of organic growth on heating loads during the winter period.

These trends are illustrated in the following historical and 10 year maximum demand forecast 2021.

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 (and energy at risk) which determines when network capacity should be augmented to underpin the security and reliability of supply. Chapter 5 and Appendix E provide more information on demand forecast methodology and outcomes for the system and distribution substations.

The net zero transition and shift in energy sources

The ACT is leading the way in Australia with a legislated goal to achieve net zero greenhouse gas (GHG) emissions by 2045 and this means the way electricity is generated, stored, and used is changing too. Evoenergy is committed to working towards a sustainable, net zero emissions (NZE) future for the ACT. Our goal is a responsible transition to NZE by 2045, taking into consideration the long-term practicalities, costs, benefits, and impact prior to determining the best pathways to take over the next 25 years. Transitioning to NZE ensures the long-term sustainability of our energy system and meets community expectations around the need for action against climate change, factoring in the societal, environmental, and economic costs and benefits of a sustainable, net zero future.

Evoenergy has undertaken detailed modelling to understand the potential impact of a range of future net zero pathways to 2045 for the Evoenergy energy networks in the ACT. This dynamic, strategic tool will enable future planning to prudently prepare and incrementally progress a customer centric, net zero transition roadmap centred on safety, reliability, security and affordability. Evoenergy and the ACT Government are working together to better understand the potential net zero transition pathways as we work towards a net zero future.

Evoenergy anticipates further load growth will be driven by emissions reduction across transport and the natural gas network which together are the biggest emitters accounting for 62% and 22%, respectively.

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

Localised constraints

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

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

Molonglo Valley demand constraints

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

Gold Creek demand constraints

The maximum demand in the Gungahlin District is forecast to continue to increase over the next ten years with continual growth in greenfield areas as well as high density residential and commercial developments. There is currently insufficient redundant capacity at Gold Creek Zone Substation for short but increasing periods of time and minimal coincident opportunity to transfer load to neighbouring zone substations. Evoenergy is currently considering two viable network options for this constraint, a third transformer at Gold Creek Zone Substation and a new zone substation located in the commercial suburb of Mitchell as well as the opportunity to utilise non-network options. Evoenergy is currently in the planning stages for a RIT-D process to be completed in the first half of 2022.

Overview of constraints

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	Reference
Dickson - Dooring St	Feeder	Capacity	No	4.1	Dec-19	Jun-20	Feb-22	$3.8m	7.6.3
Braddon – Donaldson St	Feeder	Capacity	No	3.9	Jun-22	Dec-22	Jun-24	$2.5m	7.8.3
Molonglo Valley	Zone Substation & Feeders	Capacity	Yes	24.3	Mar-20	Jun-20	Jun-22	$13.7m	7.6.1 & 7.6.2
Strathnairn	Feeder	Capacity	No	2.4	Jun-22	Dec-22	Jun-23	$2.4m	7.8.1
Pialligo	Feeder	Capacity	No	8.5	Dec-21	Mar-22	Dec-22	$4.8m	7.8.4
Belconnen Town Centre	Feeder	Capacity	No	4.1	Dec-22	Mar-23	Dec-23	$1.3m	7.8.2
Fyshwick	Feeder	Capacity	No	31	Jun-21	Dec-21	Jun-23	$5.5m	7.6.5
Mitchell / Gold Creek	Zone Substation	Capacity/ Voltage	Yes	32	Dec-21	Jun-22	Jun-24	$6.2m	7.6.4
North Canberra	Transmission	Voltage	No	-	Jun-22	Dec-22	Jun-24	TBC	7.6.4
Kingston	Feeder	Capacity	No	2024-29 period					7.6.3
Lyneham	Feeder	Capacity	No	2024-29 period					7.9.4
Phillip	Feeder	Capacity	No	2024-29 period					7.9.5
Strathnairn	Zone Substation	Capacity	Yes	2024-29 period					7.9.2

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

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

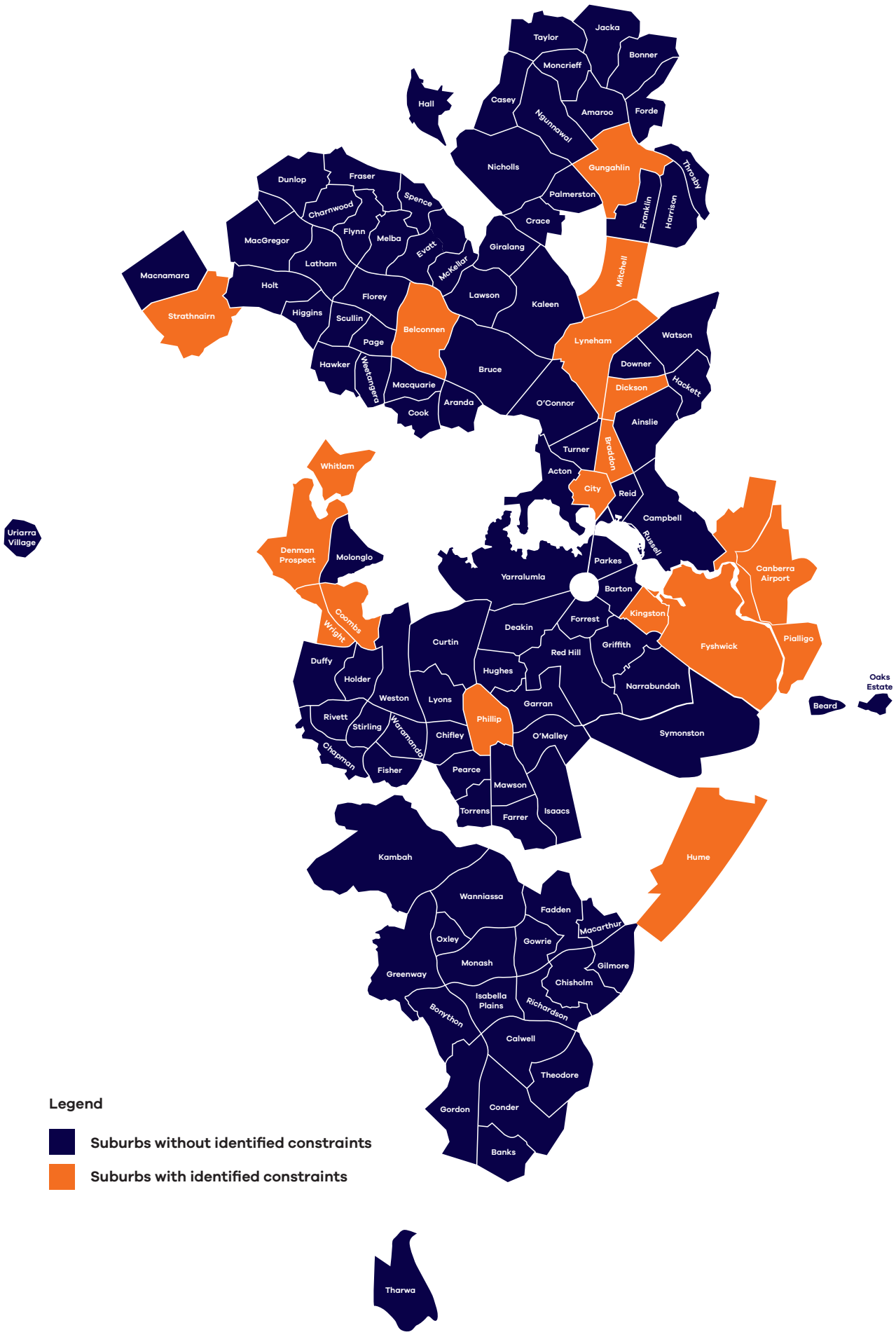
In addition to these localised capacity constraints, the make-up of electricity demand is changing in the ACT; specifically around customers driving localised growth in electricity demand, where electricity is sourced, and the impact that is having on network utilisation and performance.

Electricity connections grew by 5,268 in the 2020/21 financial year with load growth driven by:

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

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

Figure 2. Overview – network limitations heat map



Network performance

Evoenergy continues to focus on the management of existing assets taking into account asset performance and risks relating to asset condition, age and criticality. Our annual planning review process identified a need for several major asset retirements over the current regulatory period (2021 – 2024). Chapter 6 summarises the major asset retirements identified during the regulatory review including timing and costs. In addition to these major asset retirements, Evoenergy runs a number of grouped programs for smaller assets including distribution poles, substations or switchgear. These programs are further discussed in Chapter 6.

Table 2. Identified retirements of major assets

Area	Network Element	Primary Driver	RIT-D	Estimated Cost ($ million)	Consult	Decision	Date Required
Woden Zone Substation	132 kV Circuit Breaker	Asset condition & performance	No	$0.35m	N/A	Mar 2020 complete	Jun 2021 complete
Fyshwick Zone Substation	66 kV Assets	Asset condition & performance	No	$2.1m	Jun 2021	Dec 2021	Jun 2024
Latham Zone Substation	Substation Switchboard	Asset condition & performance	No	$3.1m	Dec 2022	Jun 2023	Jun 2024
Wanniassa	Distribution Line Underground Cable	Asset condition & performance	No	$4.3m	Dec 2022	Jun 2023	Jun 2024
Zone Substation	Provisional Power Transformer[1]	Asset condition & performance	No	$2.7m	Mar 2021 complete	Jun 2021 complete	Jun 2022

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 impacting large numbers of customers.

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.

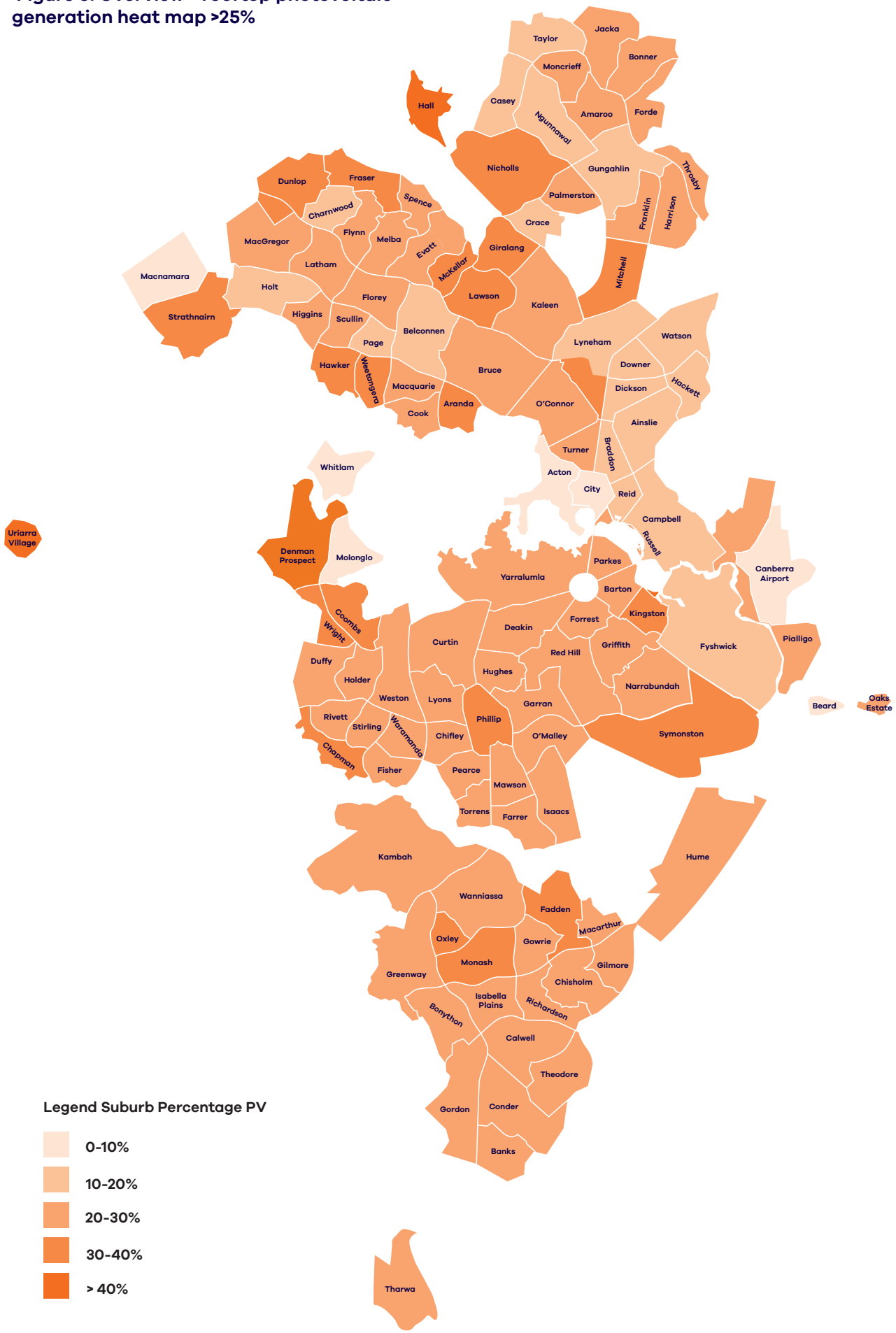
43 MW of large-scale solar generation is currently embedded in the ACT network. There is continued strong growth in rooftop photovoltaic generation with around a quarter of all residential dwellings in the ACT now with photovoltaic installations. Over the 2020/21 financial year rooftop photovoltaic generation increased by close to 45.5 MW, which was the highest annual increase on record, with total embedded generation capacity now approximately 250 MW.

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

Figure 3 provides a heat map of the percentage of solar photovoltaic penetration per suburb.

[1] Not specifically a retirement but major system spare to provide contingency for unplanned zone transformer retirement.

Figure 3. Overview - rooftop photovoltaic generation heat map >25%



Gold Creek voltage constraints

In addition to the demand constraint, an emerging need has been identified at Gold Creek Zone substation to manage voltage regulation on the high voltage distribution network supplied from that zone substation. There is excessive leading reactive power being generated within the high voltage (HV) system in the Gold Creek Zone area which cannot be managed by the current zone transformer tap changing arrangement. Evoenergy is currently assessing options including:

1. Install two 11 kV fixed reactance shunt reactors
2. Install two 11 kV variable reactance shunt reactors
3. Seek non-network solution to manage reactive power such as network or community scale batteries, systemic reactive set point control of PV inverters or residential batteries.

The quality of supply constraints at this site also interact with the demand constraints and are being assessed for potential solutions wholistically.

Working with stakeholders on solutions

Solutions to constraints will fall into one of two categories—solutions over $6 million which are required to go through the regulatory investment test (RIT) process and solutions under $6 million which are not required to go through the RIT process. Depending on the solution, this may be a regulatory investment test for distribution (RIT-D) or a regulatory investment test for transmission (RIT-T).

Solutions that are required go through the RIT process will be analysed to determine if there may be a preferred non-network solution to the constraint. The findings of this analysis are published in a non-network options report which is publicly available on the Evoenergy website and communicated to our Demand Management Register[2] participants.

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

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

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

Grid Connected Battery Systems

2021 saw the very first customer-initiated grid connected battery energy storage system (BESS) in the ACT. This was a privately owned system installed in the suburb of Holt, owned by the Elvin Group which will operate in the National Electricity Market (NEM). Evoenergy successfully commissioned the BESS unit in 2021 and is awaiting final approval from the jurisdictional technical regulator for operating in the ACT.

Additionally, further systems have been planned in Greenfield suburbs of the ACT such as Jacka, proposed by the Suburban Land Agency (SLA)[3].

This is in addition to the Evoenergy's own successful tenderer who will be installing a BESS unit as a result of the RIT-D for the Molonglo load centre. Further details are in section 7.6.1.

Evoenergy is also working closely with local energy policy directorates and other stakeholders to understand the impact of the ACT Governments' commitment towards investment in BESS units up to 250 MW supported by $100 million of this funding. This could have substantial impact for the electricity operations in the ACT and Evoenergy is keen to understand how to leverage these systems to provide additional value to the customers in the ACT.

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

[3] https://www.tenders.act.gov.au/tender/view?id=234943

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[4] is an integral part of our approach as an 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, network tariff 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 also consulted on policy options.

Evoenergy firmly believes in 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 our Stakeholder Engagement Strategy. For specific consultation matters additional plans or programs may be developed.

An updated Evoenergy Stakeholder Engagement Strategy[5] was published earlier this year. The Strategy guides our activities to enhance relationships with consumers and the interest groups that represent them. Evoenergy has a long-standing commitment to the local community that we serve, as we strive to operate with our consumers' long term interests at heart. Building on our commitment to providing excellent customer service, this Strategy focuses on ways to better understand consumers' needs and preferences, and develop proactive initiatives to more effectively engage with them into the future. We understand engagement is about two-way communication and providing an opportunity for us to listen more carefully to our stakeholders.

The Stakeholder Engagement Strategy together with the Demand Side Management Engagement Strategy are key reference documents governing engagement with our stakeholders.

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

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

[5] Available here: https://www.evoenergy.com.au/consumer-engagement-program

Figure 4. Four paths of engagement

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

Path 1:

Participate in a **broad based program** as a consumer or solution provider. Broad based program incentivise consumers to reduce electricity demand.

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

Path 2:

Participate in a targeted program. Targeted programs aim to address network limitations in a particular area in the network (e.g. specific location or suburb).

Review the network limitations in the annual planning report.

Path 3:

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

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

Path 4:

Provide a suggestion or comment. Receive correspondence on specific matters relating to network development.

To provide comment, register for a workshop or receive correspondence.

1.1 Engagement in broad-based demand management programs

As part of our planning processes and commitment to proactive engagement with our customers, 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 have commenced to trial specific sectors and consumer demographics within the ACT. 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 network tariffs which incentivise consumers to shift their demand to periods when the network typically has excess capacity. Innovative and highly cost reflective network tariffs are being trialled and extensive consumer engagement programs are being implemented in preparation for the upcoming 2024-29 regulatory period.

Consumer benefits

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

How to participate

If you would like to participate in a broad-based program including a pilot or a trial, 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 constraint, 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 a targeted initiative

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 the type of constraint, location of constraint, level of constraint and its timing. As part of the network development process Evoenergy must resolve identified limitations either though network or non-network solution. The information is updated as new data becomes available.

Targeted solutions to constraints

Targeted programs focus on a reduction of demand in specific areas or pockets of the network where limitations were identified or the provision of other services such as voltage regulation, "solar soak" services or provision of contingency. The majority of limitations identified by Evoenergy in the 2021 planning review relate to the distribution line (feeder) capacity constraints, however there are also voltage and contingency constraints emerging.

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

Consumer benefits

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

If a consumer proposes a viable alternative which defers or eliminates a need for network investment, Evoenergy is likely to be interested in sharing the cost of investment. Under 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[6]. You can also provide a suggestion or request information or updates on any program.

Evoenergy investigates identified network limitations and periodically updates data (e.g. load information) relating to the limitations.

As part of the investigations, depending on the screening assessment of options, Evoenergy may issue an RFP to submit non-network solutions.

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

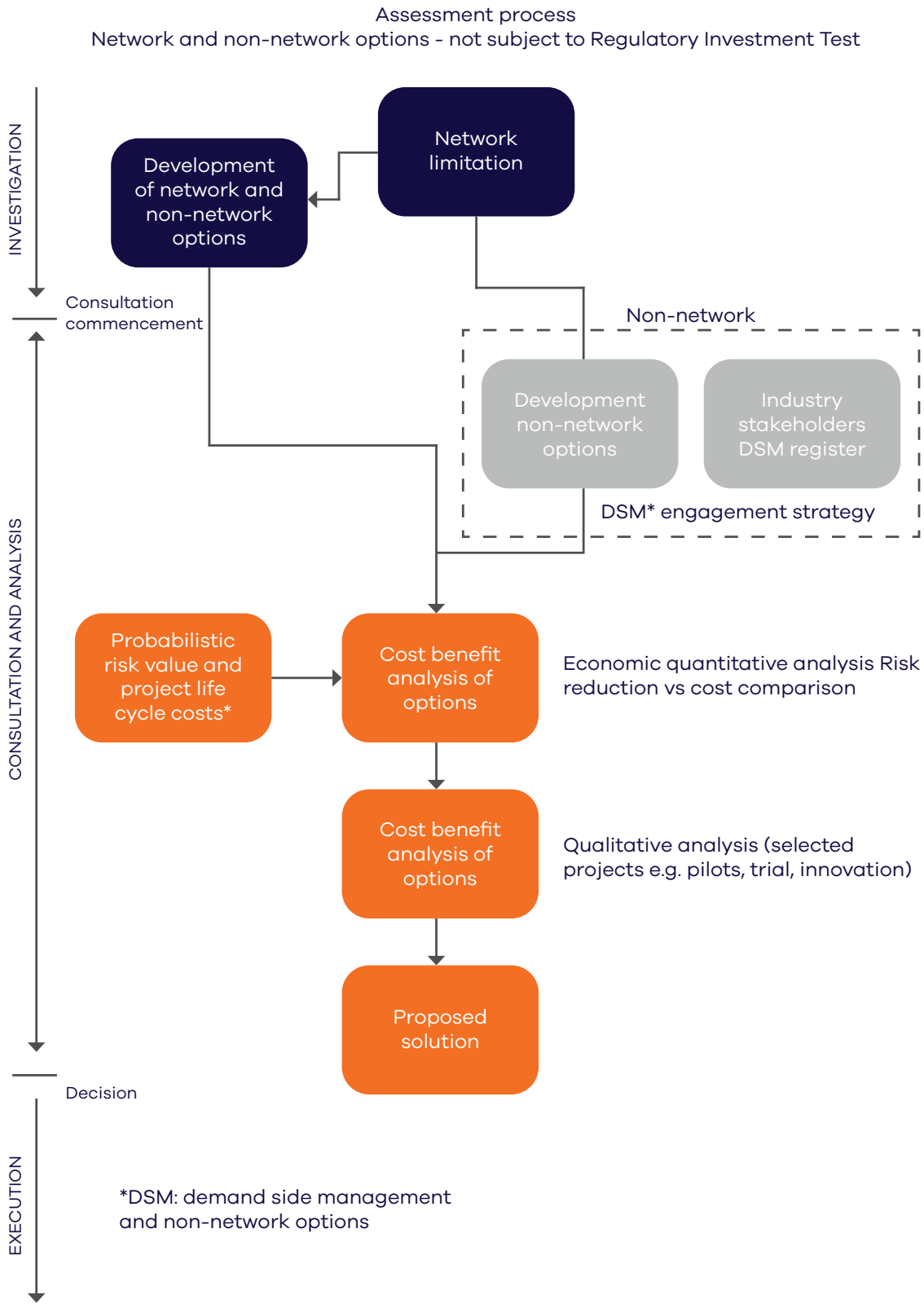
Our RFP will explain the network limitation, the timeline for resolution and possible solutions. The RFP will indicate what investment, capital contribution or incentive we are prepared to provide to external parties to resolve the issue.

Distribution and Transmission projects above $6 million are subject to mandatory Regulatory Investments Test[7] (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.

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

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

Figure 5. 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.

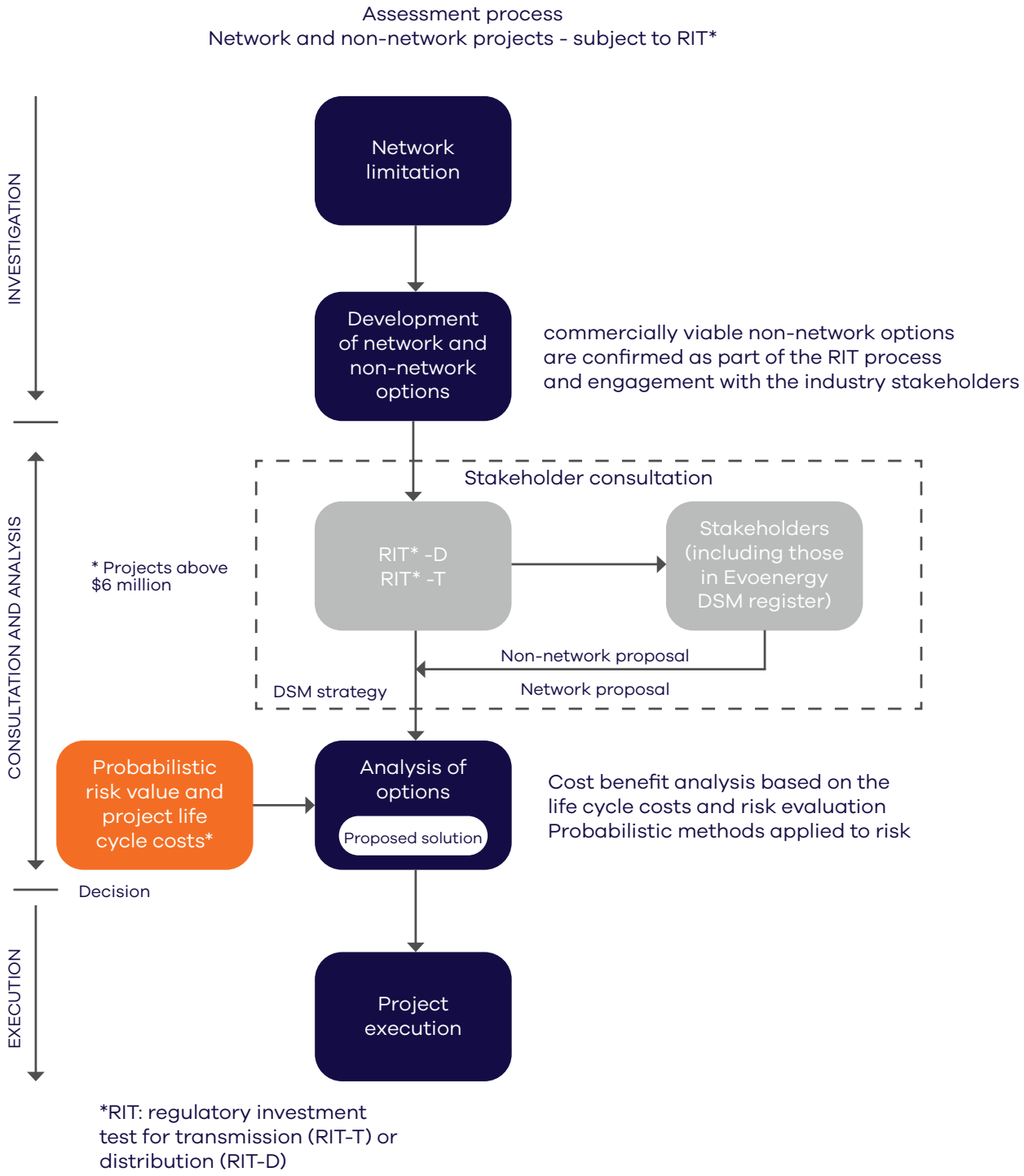
RIT Transmission (RIT-T) is conducted for transmission projects according to the process set out in AER's Application Guidelines. RIT for distribution projects (RIT-D) is conducted according to the process set out in AER's Application Guidelines for Regulatory investment test for distribution. For eligible 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.

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

Stakeholders who would like to participate in the process or be notified of future regulatory investment test can register their interest on the Evoenergy website[8].

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

Figure 6. Process overview – projects subject to Regulatory Investment Test



1.4 General feedback and suggestions

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

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

Chapter 2: About Evoenergy

This chapter 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.

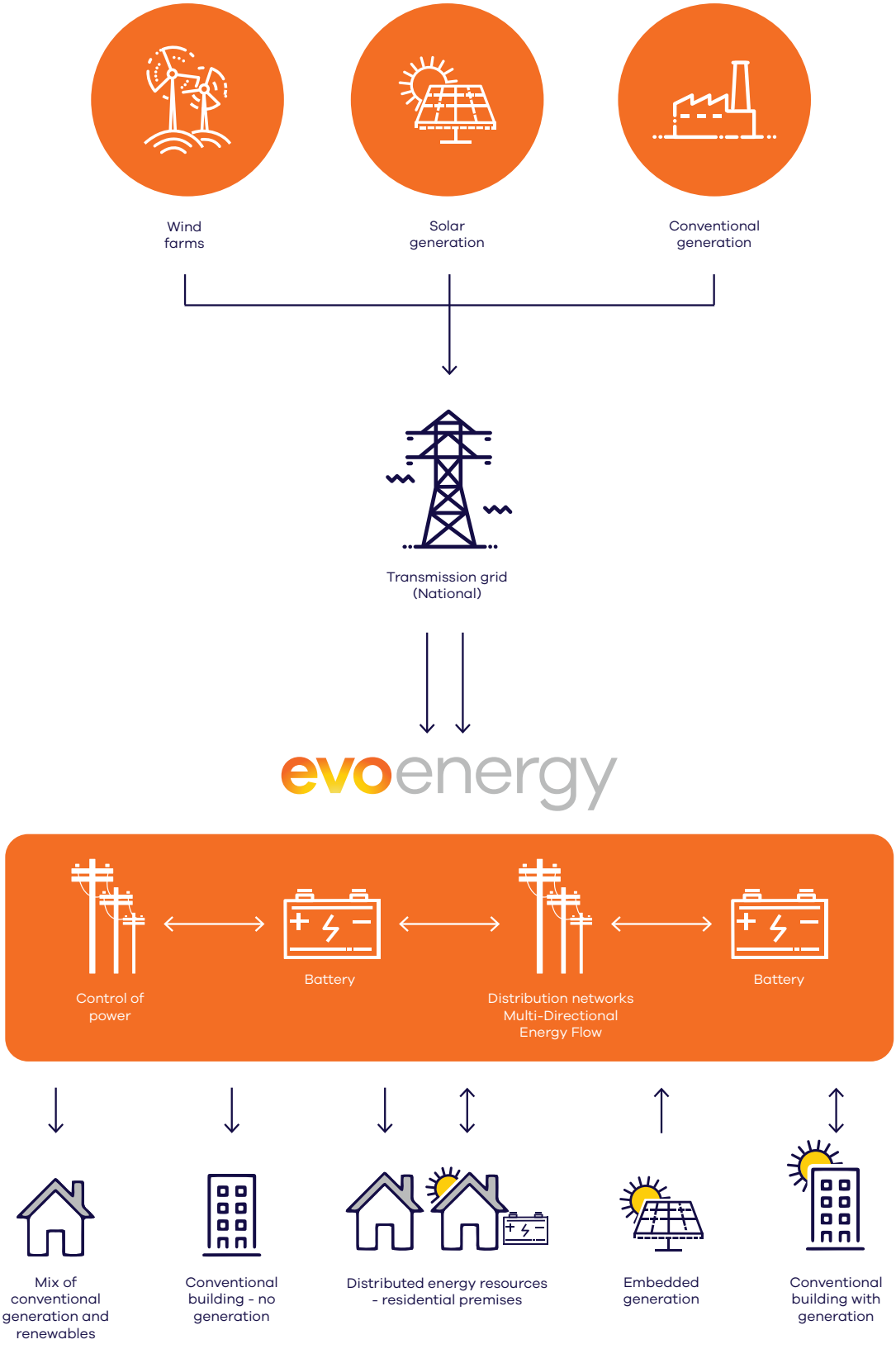
2.1 Introduction

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, distributed energy resources as the energy landscape shifts toward a net zero emissions future.

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

Figure 7. Evoenergy within the energy delivery chain



2.2 Evoenergy's physical environment

Evoenergy provides electricity and gas services over an area of 2,358 square kilometres to 212,500 electricity consumers as of 30 June 2021, within the ACT. It also supplies electricity to around 90 consumers in New South Wales.

Evoenergy owns and operates the electricity network which includes 208 kilometres of transmission lines, sixteen 132 kV/11 kV zone substations and switching stations, around 4750 distribution substations and over 4600 km of distribution lines. More detailed statistical information on the network asset numbers is provided in Table 20.

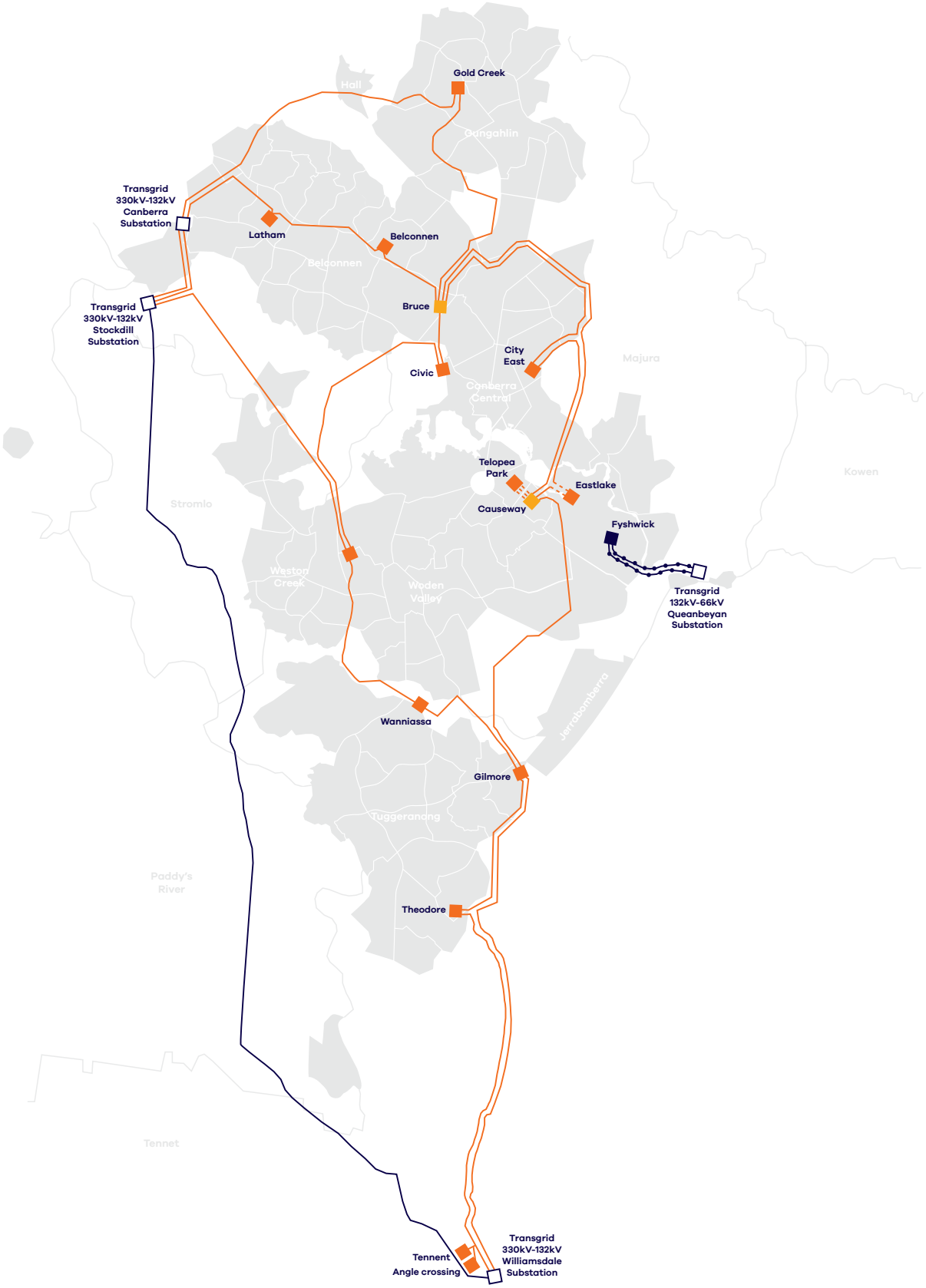
Figure 8 and Figure 9 below show the overview of the main components of the existing Evoenergy's transmission network including bulk supply points, zone substations and interconnecting lines.

Figure 8 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. The vast majority of low voltage distribution poles are located in residential backyards which is a unique feature of Evoenergy's network. Many sections of the network are heavily vegetated.

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

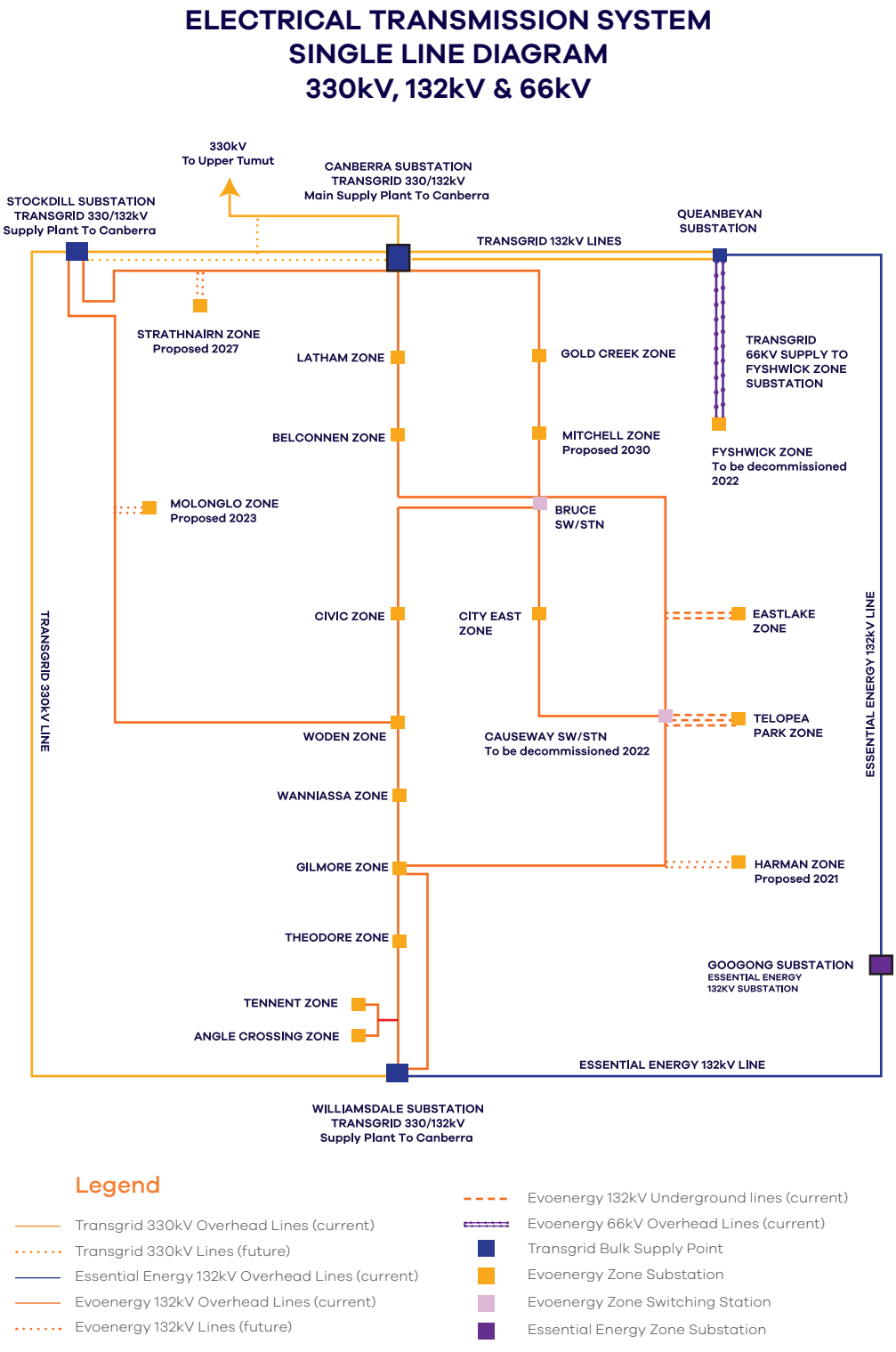
Figure 8. Evoenergy's transmission network – geographic representation

Details current as at December 2021.



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

Figure 9. Evoenergy's existing and future 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.

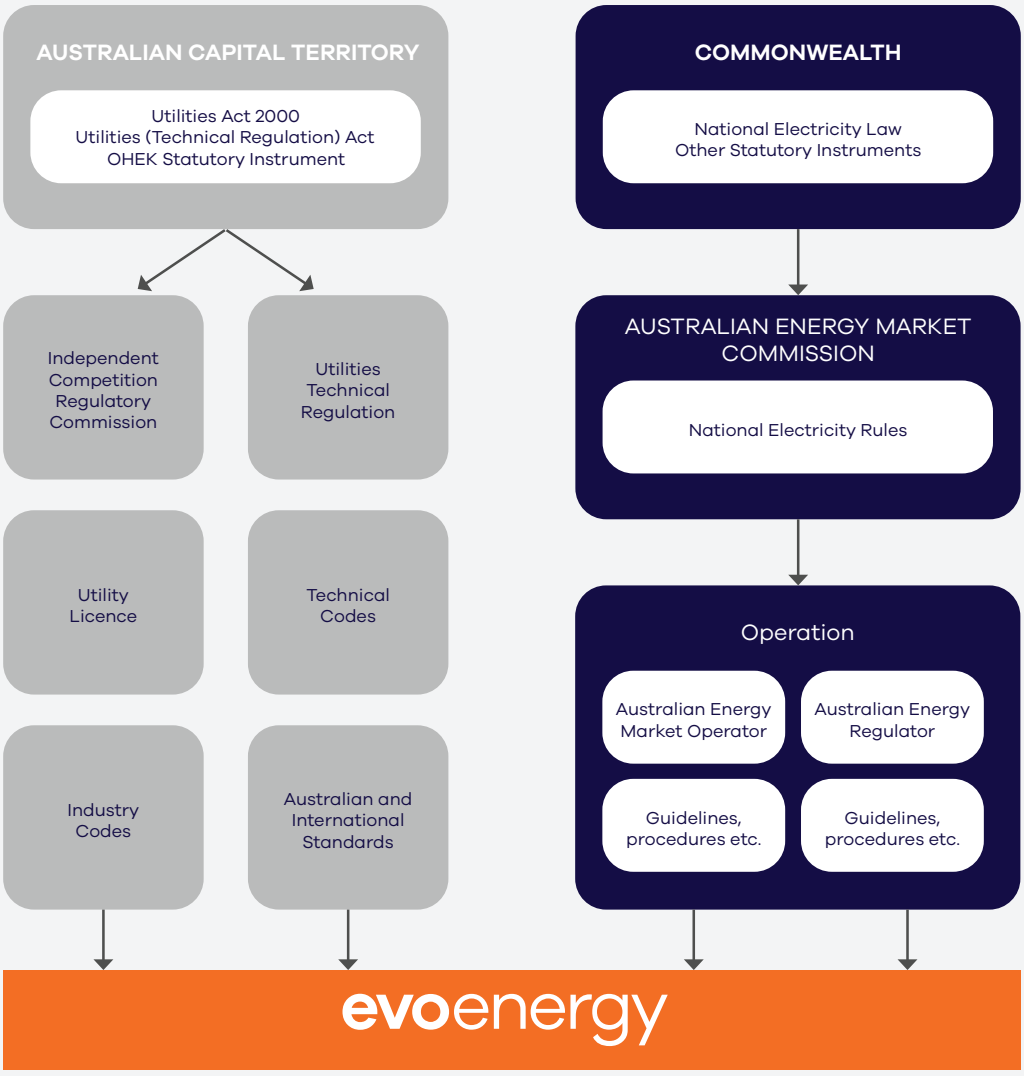
The way we plan our network is consistent with a range of obligations and regulatory instruments which support the National Electricity Objective (NEO):

"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. Therefore a consideration of technical and operational outcomes goes hand in hand with the economic and consumer interest when we make network investment decisions.

Figure 10 provides an overview of 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 10. Utility regulation framework – main elements



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

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

2.4 Factors impacting future network development

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

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

The ACT is leading the way with a goal to achieve net zero emissions by 2045 and this means the way energy is generated, stored, and used is changing too. The energy industry is entering a period of rapid change, with emerging technology and innovation in the way we generate, capture and store energy, as well as a focus on a future that's cleaner and more sustainable, with energy that's efficient, flexible, and responsive.

In 2021 Evoenergy launched its new Sustainability Strategy which aims to leverage Evoenergy's achievements to-date and make a systematic and step-change improvement in sustainability performance and management. The strategy scope includes Evoenergy's operations based at the Greenway depot and the asset management and operation of its electricity network. The goals of the strategy are to achieve net-zero greenhouse gas emissions by 2045, become resilient and adaptive to climate change and have responsible supply chain and resource management.

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

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

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

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

Government policies and long term context

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 front of the meter and behind the meter generation.

Across the ACT network, 43 MW of large-scale solar generation is currently embedded and there is around 30 MW of new solar generation under consideration. The strong growth in rooftop photovoltaic generation continued last year. Around a quarter of residential dwellings in the ACT have rooftop solar (photovoltaic) installations. The installed capacity of residential installations has increased by just over 46% the 2020/21 financial year. At the same time the average size of installation has increased from 2.5 kVA in 2010 to around 5.6 kVA for the new installations in 2019. This growth has had an increasing impact on the network, particularly in relation to voltage regulation in areas where the penetration of photovoltaic is high. Figure 3 in the executive summary shows geographic areas of high PV penetration.

ACT energy policies point to the continuation of this trend. The government policy includes the 100% renewable energy target was reached in 2020 and which has been extended in perpetuity into the future. The 2019 government renewable auctions mandated provision of network batteries a part of the offer. Perpetual 100% renewable target means, that the future increases in the energy consumption will have to be matched by additional renewable generation. The rapid uptake of the distributed generation in the Australian Capital Territory is expected to continue. Consequently, Evoenergy predicts an increase in power quality challenges and electricity demand due to decarbonisation, gas substitution and electric vehicles.

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The ACT Government energy policy includes Zero Emissions Framework with 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. Development conditions specified by the government for several recently developed residential estates exclude gas reticulation.

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. Energy consumers are embracing new technologies and increasingly taking control of their own energy generation, storage and usage. Power flows are becoming two-way, based on generation and demand patterns, and Evoenergy is evolving from a traditional Distribution Network Service Provider (DNSP) to a Distributed System Operator (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 11 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 further encouraged in the near future. Production of bio-gas from waste vegetation material is forecast to increase over the next few years. The extent that consumers generate and store energy both for their own use and export, will have a major impact on the topology and dynamic control of the distribution network.

[9] https://electricvehiclecouncil.com.au/wp-content/uploads/2021/08/EVC-State-of-EVs-2021-sm.pdf

The ACT has the highest rate of EV sales of any state (83 EVs per 10,000 new car sales) . Evoenergy is keen to create an electricity network that is fit for purpose for this new driver of energy demand stemming from the electrification of transport in the ACT including transition of public transport and commercial fleets to zero emission fleets. To this end, Evoenergy is keen to facilitate and innovate with local government, businesses, third parties and the general community on the various processes, requirements, and options for efficient transition for the electric vehicle uptake. Evoenergy is working collaboratively with all levels of the ACT Government on the various initiatives and strategies in the decarbonisation effort in this space and has already seen a significant uptake of enquiries and connection applications for private and public charging infrastructure.

The ACT Government have launched the Sustainable Household scheme where Canberrans can apply for an interest free loan from $2,000 to $15,000 to buy energy-efficient products.

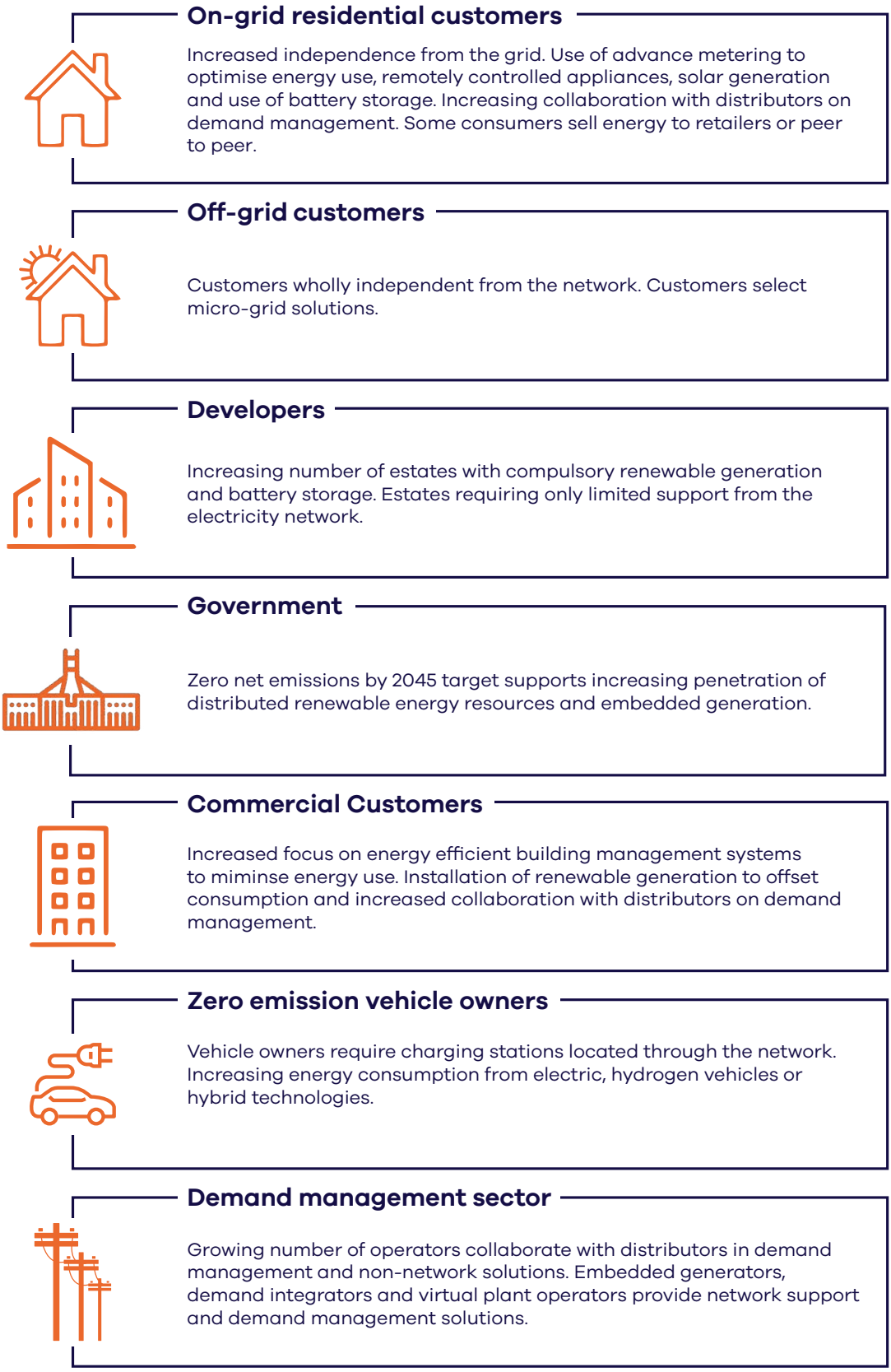
These include:

- rooftop solar panels
- household battery storage systems
- electric heating and cooling systems
- hot water heat pumps (HWHP)
- electric stove tops
- electric vehicles (available in a future phase of the scheme)
- electric vehicle charging infrastructure
- installation costs for these products.

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

[9] https://electricvehiclecouncil.com.au/wp-content/uploads/2021/08/EVC-State-of-EVs-2021-sm.pdf

Figure 11. 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 (details available in Chapter 5). No new major security concerns have been identified at the system level to be addressed by Evoenergy. Evoenergy liaises with TransGrid to manage transmission voltage regulation constraints at zone substations at the time of low network load which coincided with high PV generation during the day or low consumption at night.

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.

Factors impacting reliability

The reliability of the supply is measured though a number and duration of electricity supply interruptions experienced by network consumers (details available in Chapter 4). 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[10] and our intent is to maintain reliability performance within the existing regulatory targets. Our work program is oriented towards maintenance of reliability levels and targeting improvements in specific areas of concerns, including the worst performing feeders and worst served customers. For more details on network reliability performance refer to Chapter 4.

[10] AER 2020 Electricity distribution network service providers Annual Benchmarking Report – November 2020 (2021 version not yet available) - https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/annual-benchmarking-reports-2020

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 consumers connected to the electricity network. Power quality can be measured and expressed through a range of parameters including voltage levels, voltage and current harmonics, voltage stability and power factors. Departures form the standard may have adverse impact on consumer equipment. Consumer 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 assessing the hosting capacity of the network as the levels of PV increase.

In network locations with high concentration 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 may increase voltage levels beyond the normal operating limits. High voltages 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 require ongoing management are set to increase in line with the growing penetration of distributed generation.

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

Chapter 3: Asset life cycle management

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

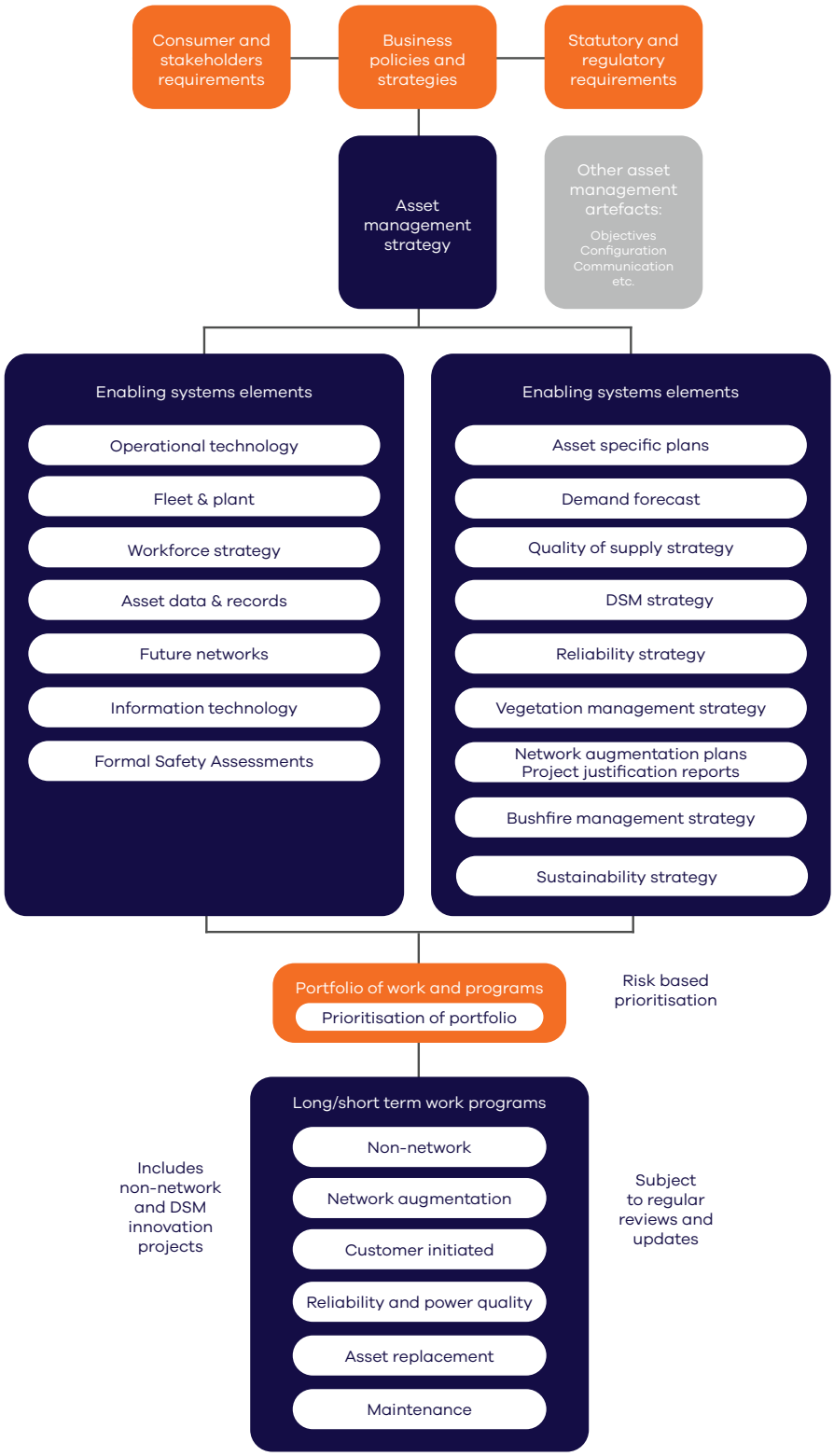
3.1 Asset management approach and components

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, asset health and criticality.
- Exploration of demand management and non-network solutions through engagement with the consumers and industry stakeholders.
- Application of rigorous probabilistic risk assessment methods to operational risk analysis and network investments.
- Application of Risk Centred Maintenance methodology to the development of asset maintenance programs in accordance with asset performance, health, and criticality.
- Optimising programs across asset categories by using a risk based top-down review to achieve the desired level of risk mitigation at least cost.

Figure 12 provides an overview of the main Asset Management and Network Planning artefacts relevant to the development of the network programs relating to asset augmentation, replacement and maintenance. The 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 12. Asset management and network planning – overview of key artefacts



3.2 Network planning methodology

Evoenergy applies its network planning process to address existing and emerging network limitations and performance issues. The primary objective of network planning is to ensure sufficient security, quality, and reliability of supply at the lowest possible cost. Evoenergy's network planning processes 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 methodology is used to identify parts of the network where demand may exceed supply capacity. The network is designed with a limited redundant capacity margin in the critical parts of the network to cater for credible contingency events. This deterministic methodology is usually referred to as the "n-1" criteria. 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 constraints 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 13 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.

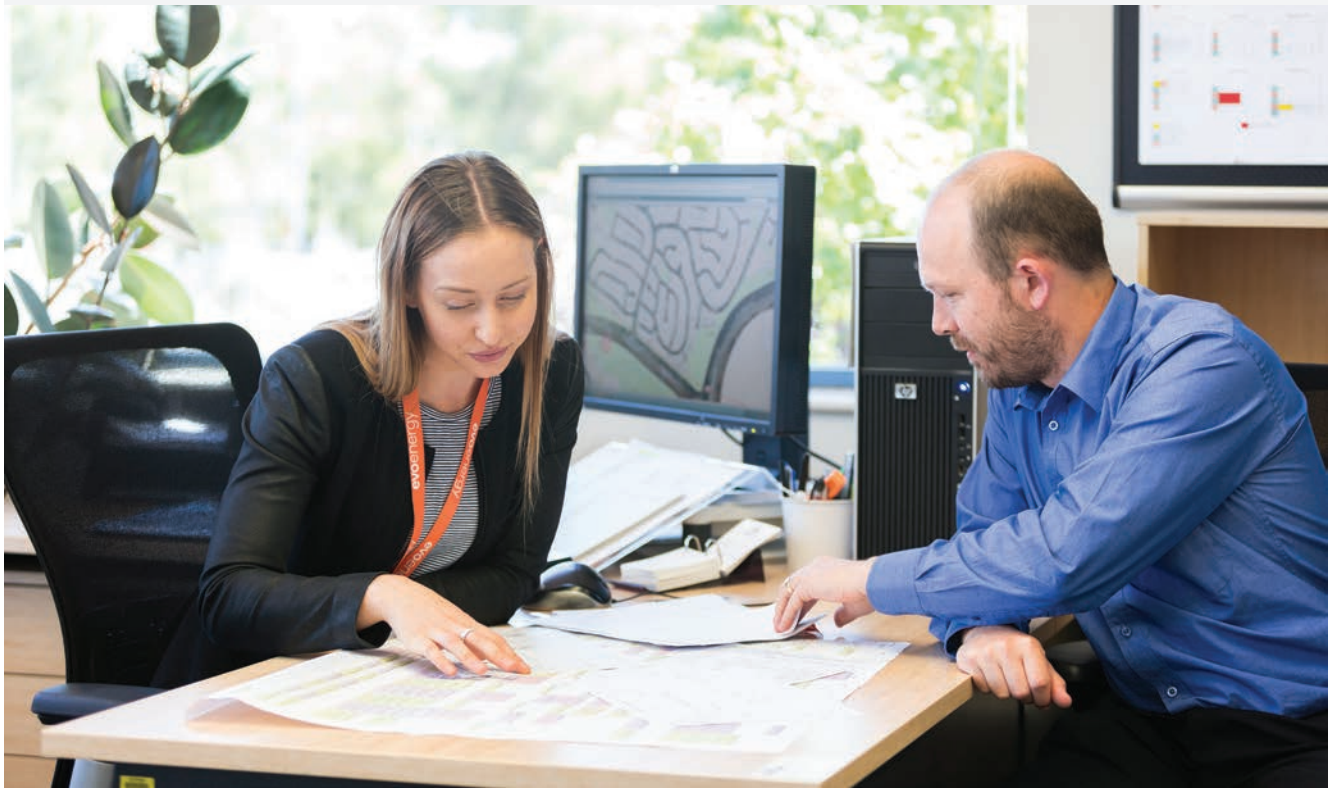
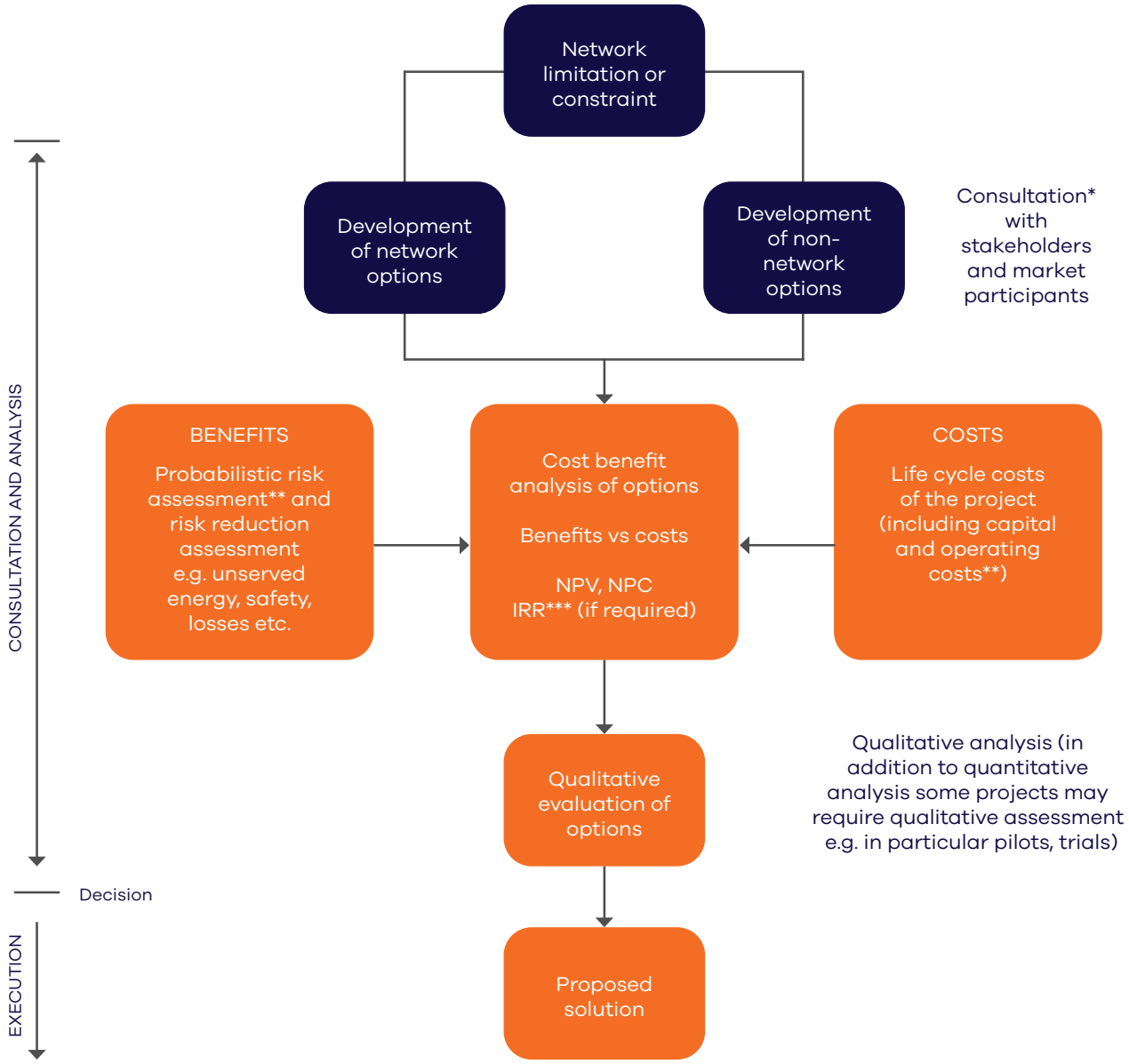


Figure 13. Overview – probabilistic risk-based investment decisions



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

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), known as the value of customer reliability, is published by the AER[11].

Apart from the risk of supply interruption, typical risk assessment may include safety, environmental and financial risks. The value of risk expressed in monetary terms allows for the comparison of the market benefits with the corresponding investment costs. Risk reduction in that comparison is considered as a benefit. Evoenergy developed improved asset management model which uses probabilistic risk methodology to asset renewal decisions. The model has been recently reviewed and employed within PowerPlan application to preparation of Asset Specific Plans. The approach is consistent with the AER's applications notes on asset replacement planning[12].

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.

3.4 Management of existing assets

Evoenergy's approach to the management of the existing assets aims to optimise investment over the life cycle of the assets. Asset retirement and renewal are closely coordinated and integrated with the network augmentation plans to exploit synergies and capture savings. The foundation of the asset management approach is operational risk assessment based on the analysis of asset condition, performance, and criticality. Asset criticality takes into account the operational function of the asset and consequences of failure. The analysis includes 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 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.

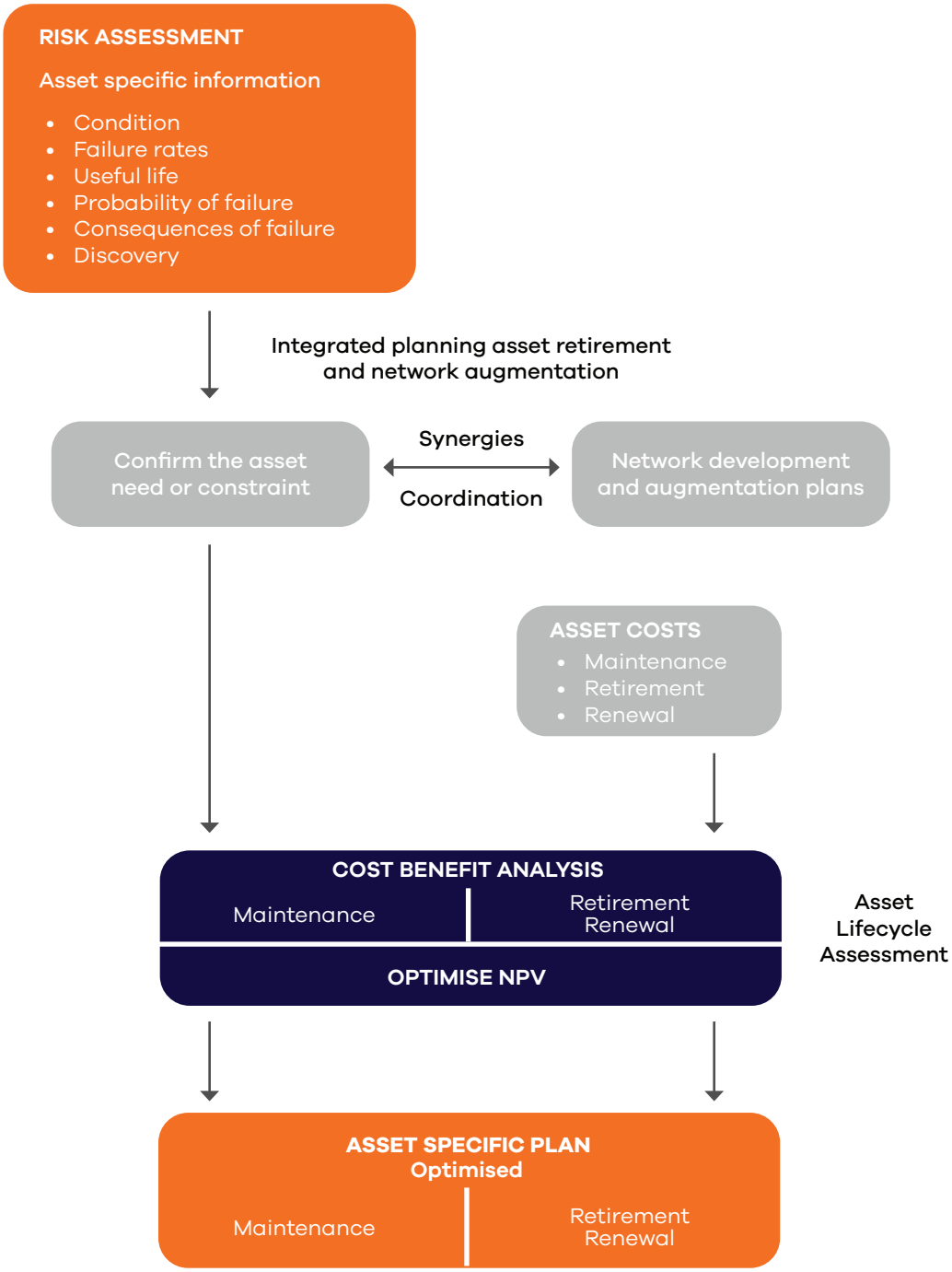
An additional step is to optimise the investment across asset classes. The top-down analysis across ASPs ensures that investment dollars are allocated to the assets where the overall benefits (e.g. risk reduction) are greatest.

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

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

[11] VCR values are sourced from: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability
[12] AER January 2019. Industry practice application note. Asset replacement planning.

Figure 14. Optimising asset retirement and renewal – an overview



3.5 Asset maintenance

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

The process of developing a risk centred maintenance program depends on selecting scheduled tasks that are both applicable and effective for a given asset. Risk assessment is integrated into the process. For some asset classes, the risk centred maintenance 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 planned maintenance program that is based at reliability characteristics of the equipment in the operating context (function and criticality) in which it is used.

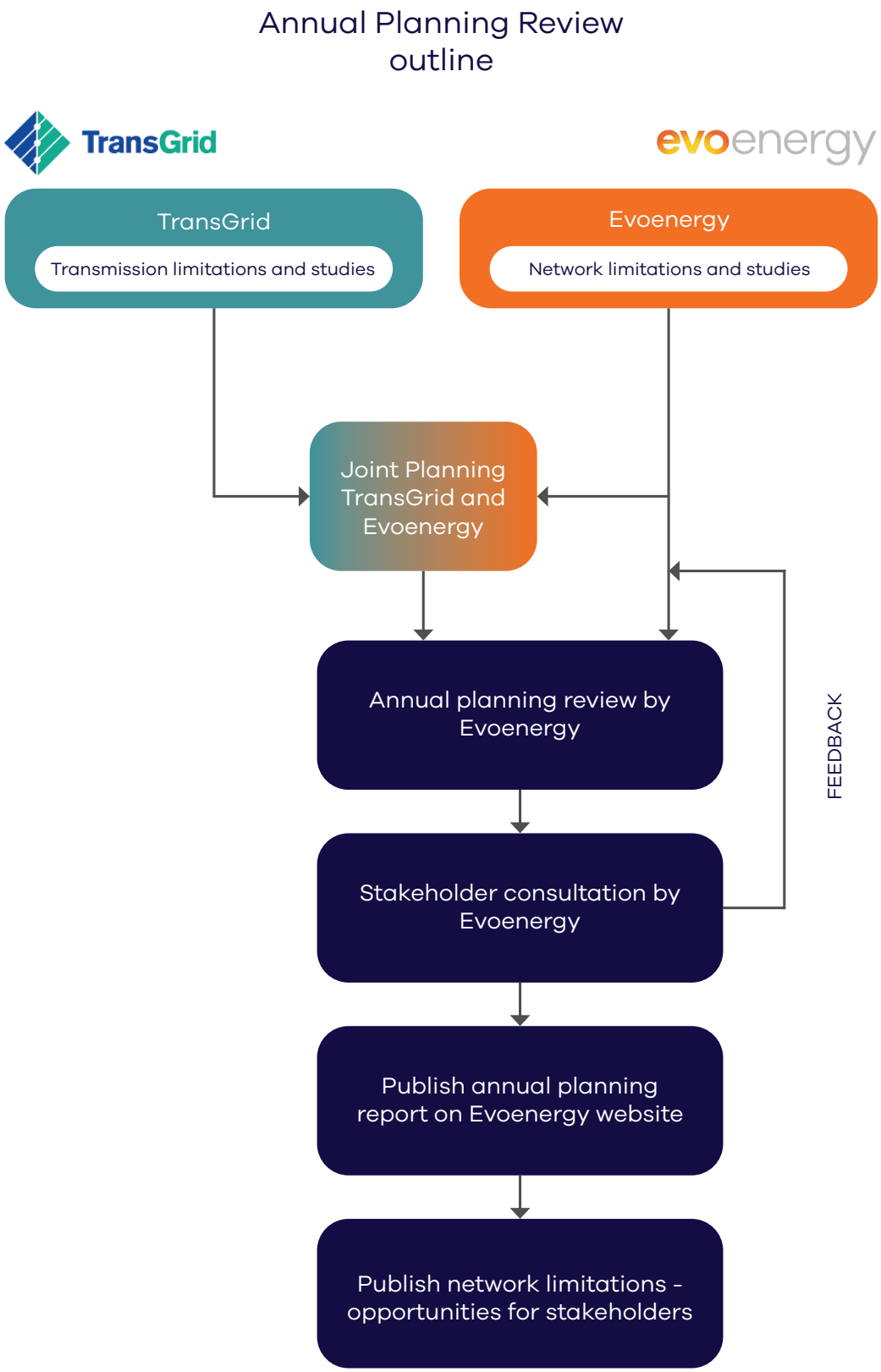
3.6 Annual planning report

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 15 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 15. Annual planning review – outline of the process



Chapter 4: Network performance

This chapter discusses network reliability and power quality performance. Network performance refers to the level of service Evoenergy provides to 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 16 and Figure 17.

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

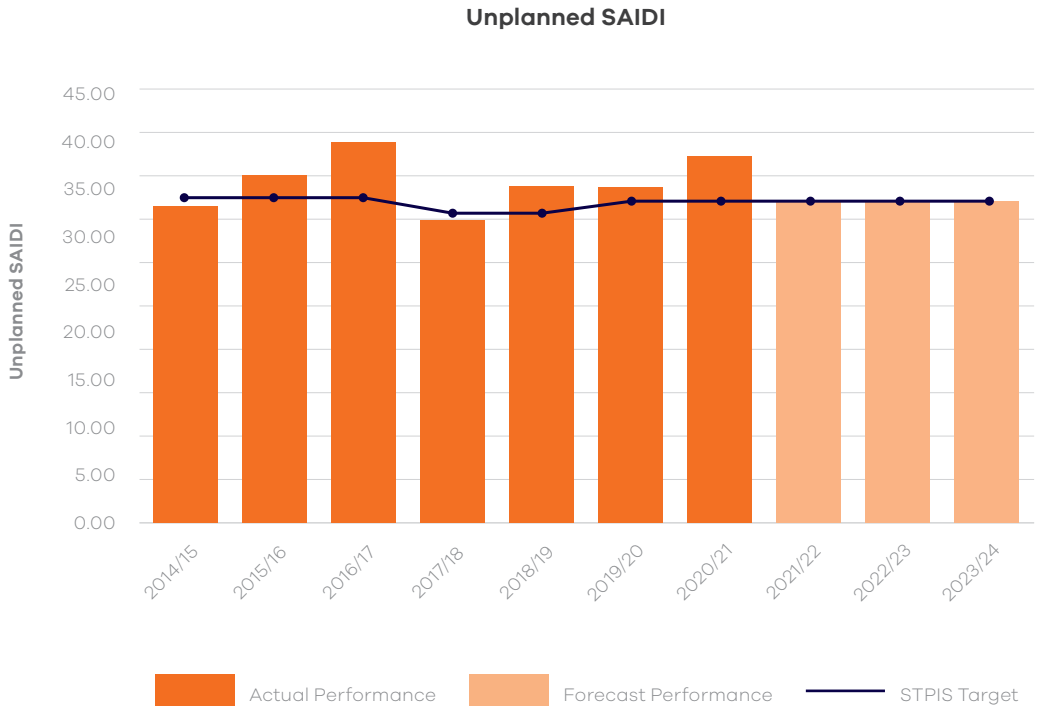
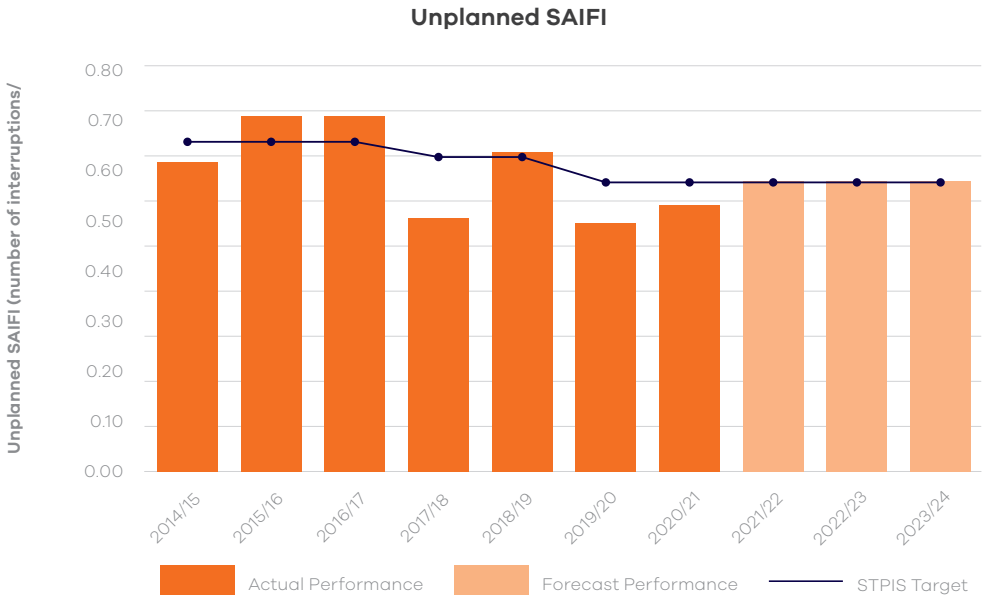


Figure 17. SAIFI- unplanned interruptions per customer (number of interruptions per customer per year)



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

Energy consumers value fast restoration when outages occur. This was expressed by consumers when Evoenergy consulted with consumers through our Energy Consumer Reference Council (ECRC), an independent forum providing representatives of the community with an opportunity to provide considered input into operations and long-term planning of Evoenergy. The feedback indicated the majority of energy consumers prefer faster restoration compared to fewer outages.

Evoenergy's average duration of unplanned outages per consumer (SAIDI) has slightly increased over the last 10 years in-line with increasing time to restore unplanned outages. Evoenergy's reliability strategy aims to address this trend.

Worst served customers and worst performing lines

Some consumers ('worst served customers') experience poorer performance compared to the network average. Evoenergy monitors planned and unplanned outages for all consumers and identifies consumers that experience reliability well below average.

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

Power quality

Our reliability strategy extends to minimising interruptions to consumer grid connected PV inverters. Power quality, specifically LV voltage regulation is affecting consumer grid connected PV inverters causing limits to those PV inverters. Whilst the challenge is experienced as a reliability concern by consumers, improvements are addressed through our power quality strategy.

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 below average and needs to be addressed through asset maintenance, network design or renewal measures. Furthermore, reliability of some assets such as older underground distribution cables is being closely monitored 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 network 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 economically feasible options to maintain or improve network performance for consumers. 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 2020/21 we took a number of steps to address reliability issues:

- Installed remote controlled automatic reclosers on one (1) overhead feeder to minimise consumers affected by faults and reduce supply restoration time to consumers on healthy sections.
- Installed fault passage indicators in new ground mount substations (padmount substations) to reduce outage restoration time.

4.1.3 Reliability – planning outcomes

Reliability strategy and tactics

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

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

- **Prevent** outages from occurring
- **Minimise** the number of consumers affected when faults occur and
- **Restore** supply to consumers quickly and safely.

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 consumers affected by faults and reduce the duration of outages for consumers on healthy sections. In 2021/22 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 2021/22 this program is planned on one (1) underground feeder.
- Utilise network augmentation opportunities to optimise network load and connected consumers 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 consumers when a fault occurs. This strategy further utilises 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 9 which discusses use of more advanced technologies.

4.2 Power quality

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

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

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

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

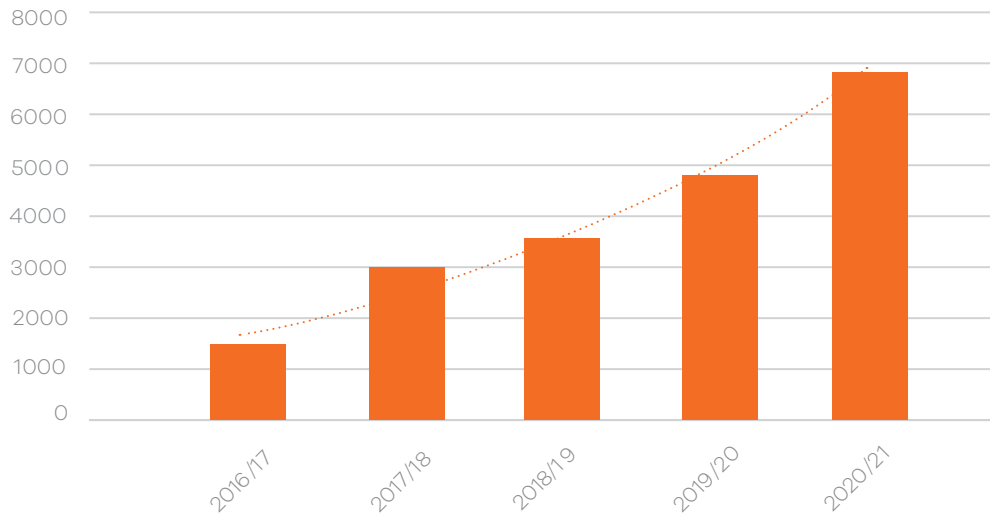
Appendix G provides more details on the power quality standards, obligations, and parameters.

4.2.1 Power quality – what are the main challenges?

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

Evoenergy is experiencing increasing voltage regulation challenges in the low voltage network. The majority of these challenges relate to increasing penetration of the distributed photovoltaic (PV) generation within Evoenergy network, particularly rooftop photovoltaics.

Number of rooftop PV systems connected each year



As a result, some parts of the low voltage network are increasingly subject to reversed power flows. The latest planning review confirmed that that voltage regulation is the most important power quality challenge that Evoenergy is currently facing. Evoenergy is experiencing increasing numbers of voltage regulation incidents particularly in locations where the penetration of the PV generation is high, or generation clusters exists. Evoenergy has determined that hosting capacity limits for PV generation will be increasingly challenged in the future in various network locations. Gold Creek Substation is one such area which requires special attention. Supply in Gold Creek requires effective coordination of voltage regulation at TransGrid's Canberra Substation, Evoenergy's Gold Creek Zone Substation and the distribution system to effectively manage voltage regulation problems (section 4.2.2).

In addition to the voltage regulation concerns Evoenergy is taking steps to resolve existing issues relating to voltage unbalance in some parts of the low voltage network. The methods to address voltage unbalance in a structured and systematic way are being explored by Evoenergy. The Power Quality Strategy is discussed in more detail in the section 4.2.3 below.

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. Neutral to earth voltage is being monitored by Evoenergy at times when reactive and pro-active measurements are conducted in the system with the use of the portable monitoring and measurement devices.

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

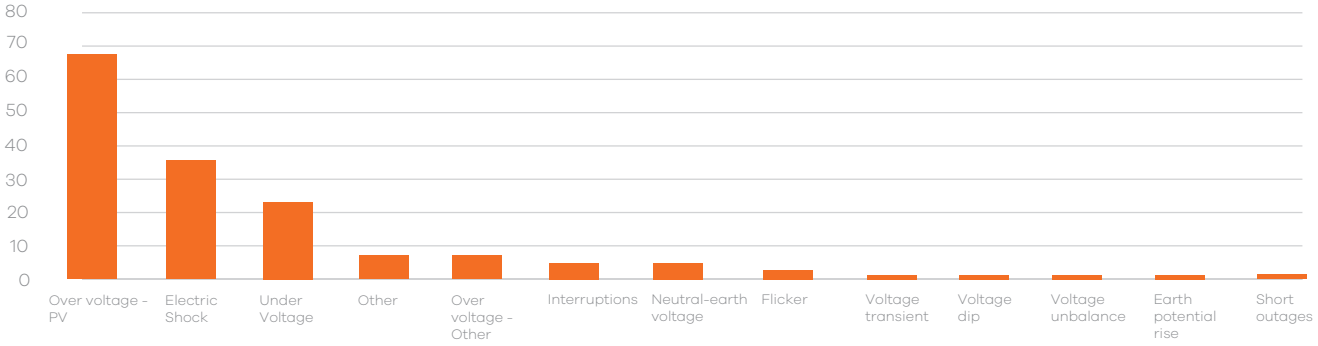
In 2020-21, Evoenergy conducted proactive power quality monitoring programs and investigated power quality issues.

A snapshot on types of power quality investigations carried out from 149 consumer requests:

In addition to reactive investigations, Evoenergy carried out the following proactive programs to manage power quality in the network:

- 100 randomly selected sites were tested, during the year, for voltage level, voltage unbalance, voltage fluctuations and harmonics; and
- 24 sites with solar installations, of capacity greater than 30kW and less than 1.5MW, were audited for voltage compliance.

Investigations carried out based on nature of requests received from customers



Gold Creek Zone Substation

An emerging need has been identified at Gold Creek Zone substation to manage voltage regulation on the high voltage distribution network supplied from that zone substation. The voltage on the high voltage network is regulated by zone substation power transformer on load tap changers to maintain a set point automatically adjusted as a function of the transmission voltage, the distribution system real power loading and the power angle of the load.

For long and regular periods of each late night/early morning and mid-afternoon periods on sunny days the zone substation power transformers operate at the tap range limit without further ability to regulate voltage. This is occurring mainly in spring, summer, and autumn and to a lesser extent on sunny days in winter.

There is excessive leading reactive power being generated within the high voltage (HV) system in the Gold Creek Zone area. The high voltage network supplied by Gold Creek Zone Substation is predominantly underground cables. The leading reactive power is mainly being caused by the capacitive effect of lightly loaded high voltage cables due to lower overnight load or solar power generation during daylight periods. During these periods, the HV voltage floats above the set-point due to lack of tapping range.

In October 2019 Evoenergy raised a project with TransGrid to assess and modify the transmission voltage setting at Canberra 330 kV Substation to provide greater headroom in voltage regulation at Gold Creek Zone. In April 2020 TransGrid lowered the transmission system voltage regulation set-point at the Canberra 330 kV Substation from 136 kV to regulate at nominal 132 kV. This change reduced the period of time where Gold Creek Zone substation has no further regulation headroom.

The zone substation power transformers leading up to April 2020 operated at the maximum end of the voltage regulation range greater than 50% of the day generally from midnight until 5:30 am and again from midday to 3:00pm.

After April 2020 the zone substation power transformer operation at the maximum end of the voltage regulation range has reduced to approximately 30% of the day for predominantly overnight periods.

With the expected growth of solar penetration and increased cables lengths to connect future residential development in the Gold Creek area it is re-forecast by spring 2023 that situation will return to pre-April 2020 conditions during the daytime periods.

Evoenergy is currently undertaking a detailed technical study of both the power quality issues at the Gold Creek Zone Substation as well as the interaction with capacity constraints in the area. This will lead into a likely RIT-D for the Zone Substation. As part of these investigations the solutions to both the quality of supply and capacity constraints will be addressed.

4.2.3 Power quality – planning outcomes

During the year, Evoenergy has reviewed and updated Power Quality Strategy which was subject to consultation with the technical regulator at the time of preparation of this Annual Planning Report. The new draft strategy sets out projects and initiatives designed to manage power quality issues including those identified during the review.

The main existing and new initiatives covered by the draft strategy confirm continuing focus on the management of Power Quality in general and voltage regulation. The suite of measures includes proactive monitoring, participation in national surveys and investigation of specific power quality issues. The main components are summarised below.

.

Proactive monitoring

The Power Quality Strategy includes a proactive monitoring program (compliant with AS 61000.4.30 – Testing and measurement techniques – Power quality measurement methods) covering 100 randomly selected sites and 24 mid-sized distributed photovoltaic installations.

Proactive monitoring measures also include installation of permanent power quality monitoring devices at selected distribution substations. To date monitoring devices have been strategically installed in distribution substations monitoring the LV network. Installation of these devices is planned to continue over the next three years up to the end of the current regulatory control period 2019-24. At the completion of this program, 20% of distribution substations will have LV monitoring capability.

In addition to the proactive monitoring methods above, the network is studied using the Advanced Distribution Management System (ADMS) to assess LV network performance, proactively highlighting poor performing areas of the network. These models can leverage data from LV distribution substation monitors and have the potential to include smart meter data in the future to further increase accuracy of the model.

Data Driven Distributed Energy Resources (DER) Management Pilot

This pilot project was completed in 2021 and explored capability of data analytics and multiple data sources to study voltage performance on a distribution feeder. The study leveraged GIS data including network topology, smart meter data and data from DERs to estimate voltage performance throughout LV networks on the distribution feeder.

Using a data analytics tool, data driven network models were constructed to analyse steady state LV network performance and evaluate options to improve performance. The study highlighted a number of poor performing LV networks and instances of non-compliance with LV steady state voltage standards.

Options to improve performance were also explored within the data analytics tool simulating their effectiveness. Options include, distribution transformer tap change and phase balancing load and generation which all showed opportunity to improve performance.

This pilot project;

- Identified solutions to improve LV steady stage voltage performance on the distribution feeder studied
- Provided insights and learnings to model LV networks identifying potentially poor performing networks and proactively implement power quality surveys and solutions to improve performance
- Discovered insights of DER behaviour

Smart Metering Data

Smart metering data was used in the Data Driven Distributed Energy Resources (DER) Management Pilot completed in 2021 and highlighted potential benefits in managing power quality in Evoenergy's network. As such integration of smart metering data into Evoenergy's "network visibility plan" and use in network planning and performance monitoring is of strategic importance under the Distribution System Operator (DSO) strategy.

Automatic Voltage Regulation

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

PQCA National Survey and Benchmarking

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

Network compliance is measured on the performance of 95% of sites analysed. Based on this criterion, the recent annual report indicated that Evoenergy network is compliant for all disturbances. Additionally, there was a positive trend in overall material improvement in Evoenergy voltage regulation performance with lower number of incidents outside the envelope.

According to this report, Evoenergy was the top performer amongst participating networks for voltage, unbalance and harmonics, with an overall level of non-compliance that is much better than the national average.

Power quality issues and complaints

Website upgrade

There is a strong correlation between increasing rooftop solar PV installation and the number of power quality complaints lodged with Evoenergy. Investigations into these complaints have revealed that only a small portion are associated with genuine complaint issues, suggesting that there is confusion in the community about when and how to lodge a complaint or enquiry. To address this confusion, we will amend our website to provide education on power quality issues and introduce a portal for lodging complaints and enquiries.

Investigation

Evoenergy investigates all instances of identified power quality issues and power quality complaints. At present, most issues result from the 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. To manage voltage regulation, Evoenergy has published requirements for the connection of embedded PV installations which include variable invertor power factor settings and curtailment of output depending on the voltage.

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

Power Quality Issues Associated with Embedded Generation

Distribution system voltage levels have been observed to experience large fluctuations in areas of the network where there is a high penetration of rooftop PV generation. Evoenergy is installing distribution transformers fitted with an on-load tap changer (OLTC) voltage regulation capability at several other suburbs with a high PV penetration. Full cost benefit assessment is applied for broader application of OLTC transformers in the Evoenergy network.

Another trial currently in progress is the Ginninderry Energy Pilot Project which aims to assess the real time implications/outcomes from an electricity-only neighbourhood with a very high penetration of solar PV systems and includes a trial of residential batteries. For more information on this project please see section 9.5.

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, advances in technology, economic factors, and consumer preferences. In the long term, the demand in Evoenergy will be also increasingly driven by the government energy policies such as ACT's zero emission 2045 target as well as incentives and mandates driving consumers to change from natural gas to electric appliances and preventing new connections to the natural gas network (e.g. in greenfields developed by the Suburban Land Agency). These targets would require carbon dioxide emitting energy sources for transportation and gas to be transferred or substituted by alternative energy sources such as electricity or green gas. The overall impact on the network is expected to be significant but varied from location to location depending on the structure of the existing load, consumption trends and distributed energy resources.

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

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

5.2 System demand

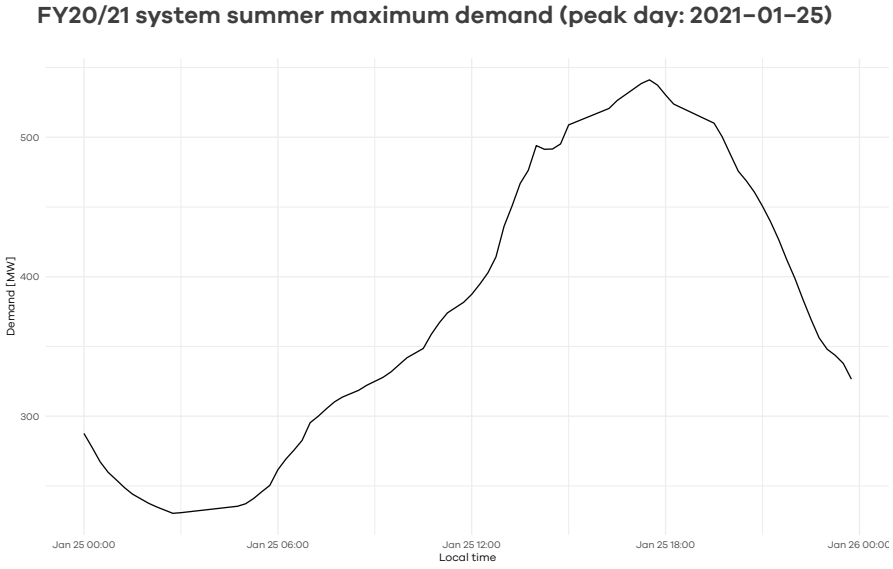
5.2.1 Historical demand

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

- Summer maximum demand is weather dependent. For example, summer 2012 and 2015 maximum demands fell below 500 MW due to mild weather conditions with summer 2020 closely behind at 508 MW. The 2019 maximum demand rose above 650 MW due to persistent widespread heat, exceptional heatwaves, and below-average rainfall.
- The highest historical summer peak in real power was 657 MW (2018/19) and the highest winter demand was 626 MW (2014/15). The higher summer peak demand indicates that summer loading conditions (when the ambient temperatures are higher and network equipment ratings lower) can be a major driver behind emerging network constraints.
- The historical winter maximum demand has been less variable than summer maximum demand. This is largely due to less variability in weather conditions.
- The hottest day of Summary 2020-21 was recorded on Monday 25 January 2021 where it reached 38°C, which coincided with the peak summer demand of **509 MW** occurring at 2:15 pm (AEDST). It was a milder and wetter summer than previous years.
- In the 2020-21 winter period the coldest day was Tuesday 1 June 2021 where a low of −5.2°C was reached. The peak winter demand of **626 MW** occurred at 6:00pm (AEST) on Thursday 10 June 2021 which had a maximum temperature of 9.3°C after several weeks of cold weather.
- In comparison to 2020, actual summer maximum demand showed close a 20% decrease and actual winter maximum demand a 3% increase. The actual maximum demand variation appears to be mostly a function of the temperature and weather conditions. While winter maximum demand fell within the POE10-POE90 bands forecast last year, the summer value was close to falling below the POE90 forecast last year, indicating an approximately 1 in 10 year event based on cooler summer temperatures.

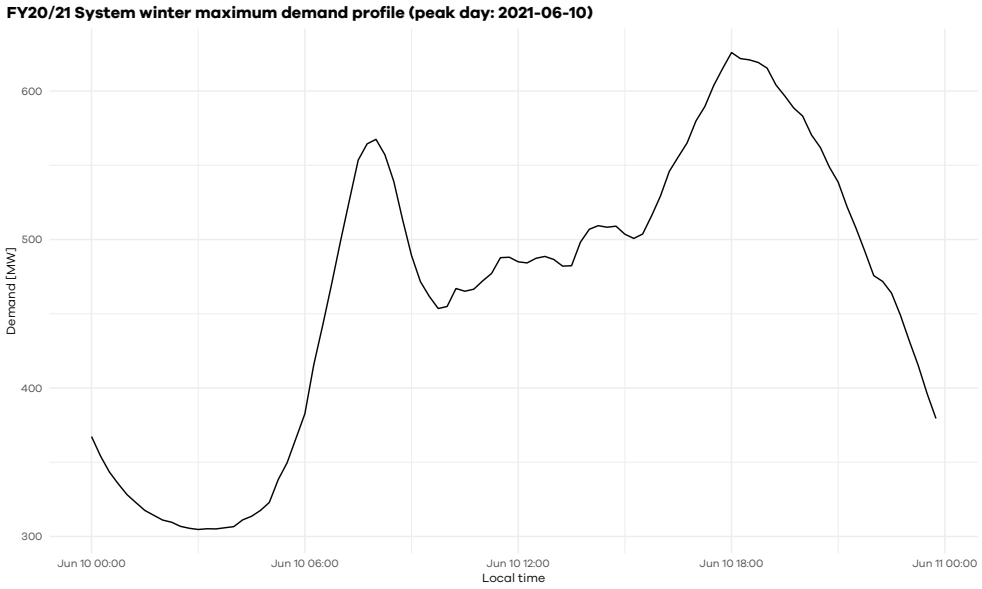
The figures below show the daily demand curve for summer and winter days with distinctly different profiles for summer and winter.

Figure 18. 2021 summer and winter maximum demand day load profiles.[13]



[13] Note: Due to a TNSP metering issue the Summer profile was taken from ADMS SCADA data instead

FY19/20 system winter maximum demand (peak day: 09–08–2019)



5.2.2 System summer and winter maximum demand forecast

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

Evoenergy calculates load forecasts based on 10%, 50% and 90% probability of exceedance. Network planning is based on the medium 50% POE forecast and an additional capacity allowance to cater for credible network contingencies. Evoenergy's maximum and minimum demand forecasts for the ten year period 2022–31 are presented in Figure 19.

There is a forecast increase in demand which exceeds the trend from historical data. This is due to predicted significant increases in data centre load, particularly the construction of Harman Zone Substation which is a customer-initiated project which will be purpose built to supply a large data centre.

System forecast

10-year forecasts based on historical system data estimate an insignificant change in peak summer demand of -0.2 MW per annum[14] and a change in peak winter demand of 1.0 MW per annum[15].

Based on recorded 2020 peak demand values, this corresponds to an expected change of +8% over the next 10 years in peak summer demand, and +9% over the next 10 years in peak winter demand.

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

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

[14] Bayesian 95% credible interval: [-3.5, +3.1] MW p/a
[15] Bayesian 95% credible interval: [-0.1, +2.0] MW p/a

Figure 19. 10-year whole-system summer and winter maximum demand forecast.

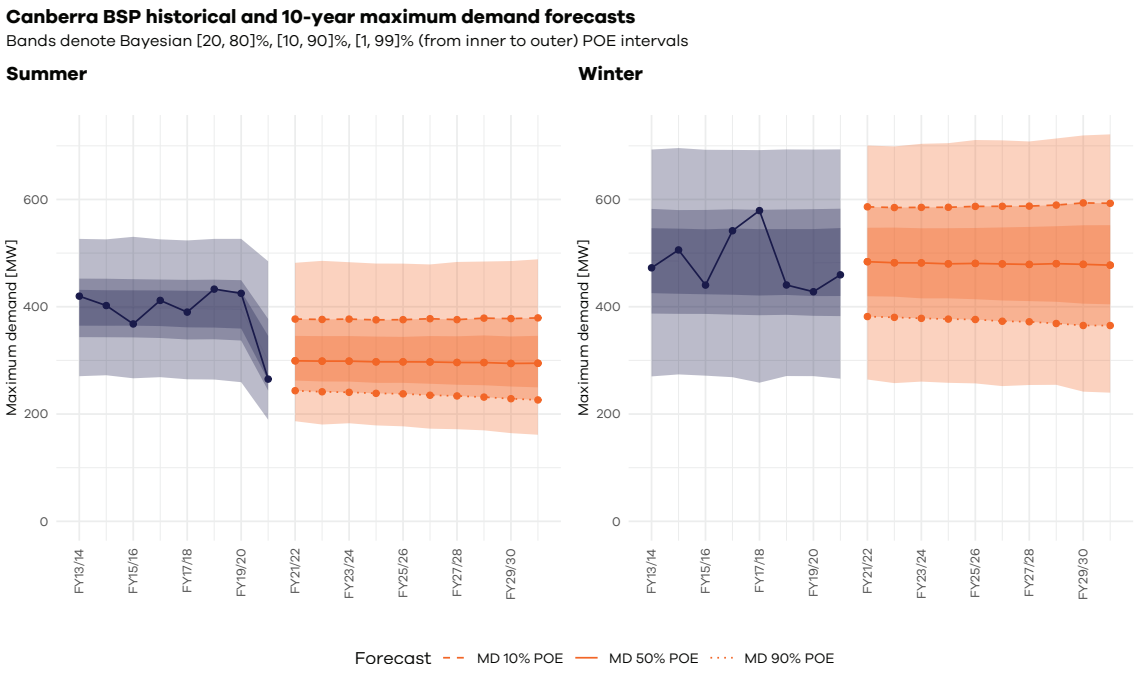


Table 3 provides summer and winter forecast demand (MW) numerical values for three probability of exceedance levels to complement Figure 19.

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

Year	Summer			Winter		
	POE90	POE50	POE10	POE90	POE50	POE10
2022	500	573	660	610	628	645
2023	510	583	668	622	640	658
2024	512	585	672	625	644	662
2025	509	584	673	626	645	663
2026	513	590	678	633	653	671
2027	519	596	684	640	660	679
2028	524	602	690	647	668	687
2029	529	608	697	655	676	695
2030	534	614	705	662	683	703
2031	533	614	707	663	685	705

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 90% PoE and 10% PoE of summer forecasts are much wider than the winter forecasts in Figure 19.
- Both summer and winter maximum demand is forecast to have relatively low growth over the next 10 years however this increase may be accelerated with higher uptake of electric vehicles and the outcome of ACT Government policy decisions related to zero emissions targets.

5.2.3 System summer and winter minimum demand forecast

In AEMO's 2021 Electricity Statement of Opportunities[16] (ESOO) it is forecast that short term (0-5 years) minimum operational demand in NSW (which includes the ACT) is expected to decrease at a faster rate for all scenarios compared to the 2020 ESOO, due to an increased forecast uptake of distributed PV. Medium to long term (5-30 years) minimum operational demand is forecast to continue to decline for the next decade across all scenarios, after which non-coordinated EV update, battery capacity changes, and electrification have a greater impact on the changes in minimum demand.

Figure 21 shows the projected minimum demand in the system over the 10 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 is analysed for both day and night[17]. This is because daytime minimum demand is significantly impacted by distributed generation resources, particularly solar photovoltaics whereas the night-time demand is impacted by organic growth.

The total capacity of rooftop PV has grown by around 45.5 MW during the last year. Continual growth in PV installations has led to a decreasing day time minimum demand. If this trend continues, we can expect a net system export in approximately 15 years (-5, +27).

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

[16] AEMO 2021 Electricity Statement of Opportunities available here: https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2021/2021-nem-esoo.pdf?la=en

[17] Day/night separation is in agreement with AEMO's new point forecasting methodology

Figure 20. 10-year whole-system summer and winter minimum demand forecast.

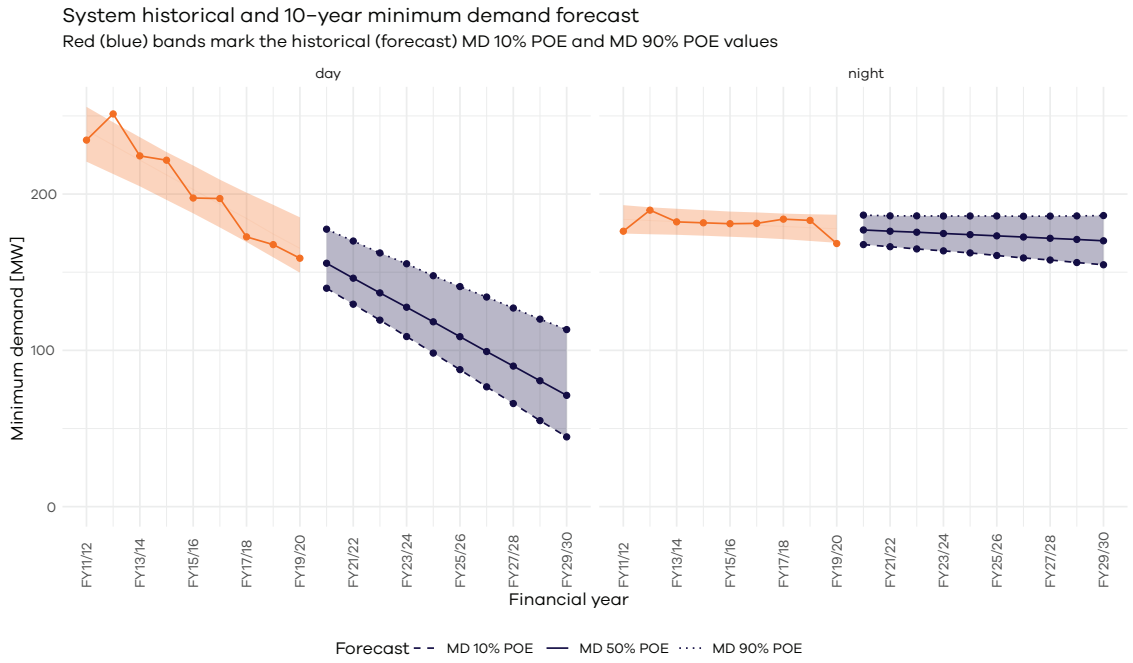


Table 4 provides minimum demand (MW) numerical values to complement the minimum forecast Figure 20.

Table 4. 10-year whole-system day and night minimum demand forecast (MW).

Year	Day			Night		
	POE90	POE50	POE10	POE90	POE50	POE10
2022	118	139	167	160	171	182
2023	107	128	160	158	169	181
2024	96	118	153	156	168	180
2025	84	108	146	154	166	179
2026	73	98	137	152	165	178
2027	61	88	130	149	163	177
2028	50	78	123	147	162	176
2029	38	68	116	145	160	176
2030	26	58	109	143	159	175
2031	15	48	102	141	157	174

5.3 Zone Substation Load Forecasts

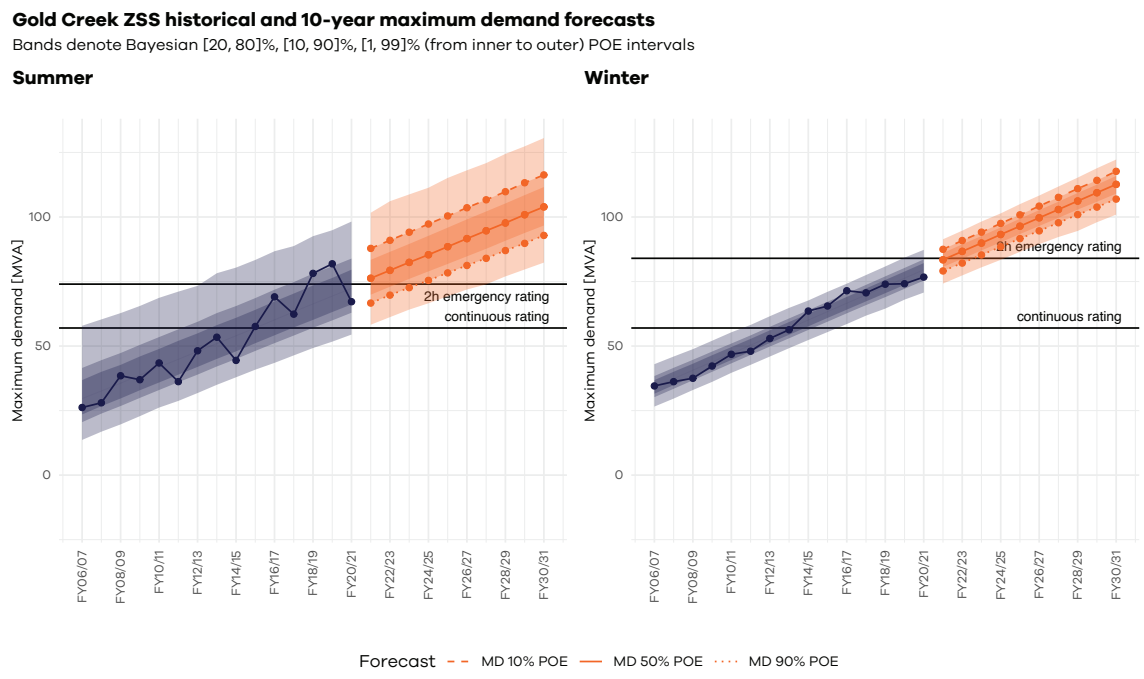
This section provides the highlights of the zone substation demand forecast. The figures below show summer and winter ten year forecast for selected zone substations shown against substation two-hour emergency rating. Appendix E – contains the full set of forecast graphs and figures for zone substations.

5.3.1 Gold Creek Substation

Zone substation limitation

Updated forecasts indicate that the winter 50% POE forecast is expected to exceed two-hour emergency ratings during the 2023/24 financial year. Evoenergy plans to begin the detailed options analysis process, including non-network options analysis, potentially resulting in a RIT-D process in the 2021 calendar year. See section 7.6.4 for more detail.

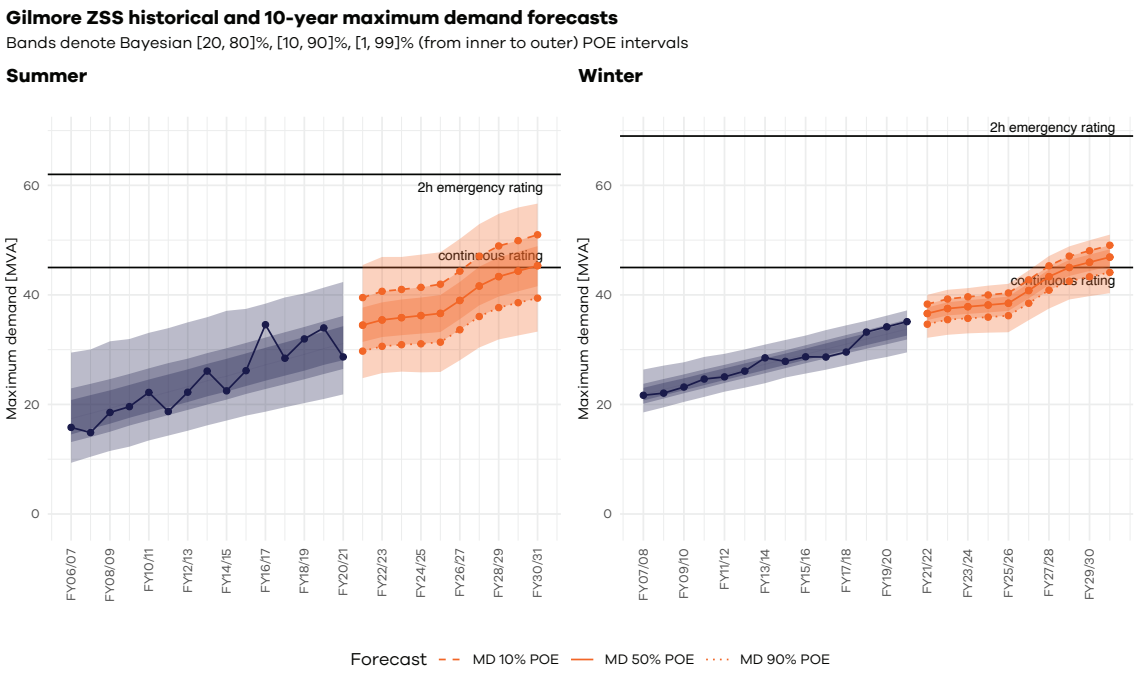
Figure 21. Gold Creek Substation 10-year forecast.



5.3.2 Gilmore Substation

Gilmore Zone Substation (ZSS) forecast (Figure 22) is expected to have significant load growth in the next 10 years due to the expansion of commercial load in the Hume area, primarily the data centres. It is forecast that the demand will exceed the continuous rating in the 2024-29 regulatory period. This additional load along with the aged assets in the zone substation indicate that additional investigation is required at this substation. As this growth is dependent on large projects with some uncertainty this zone substation will continue to be monitored.

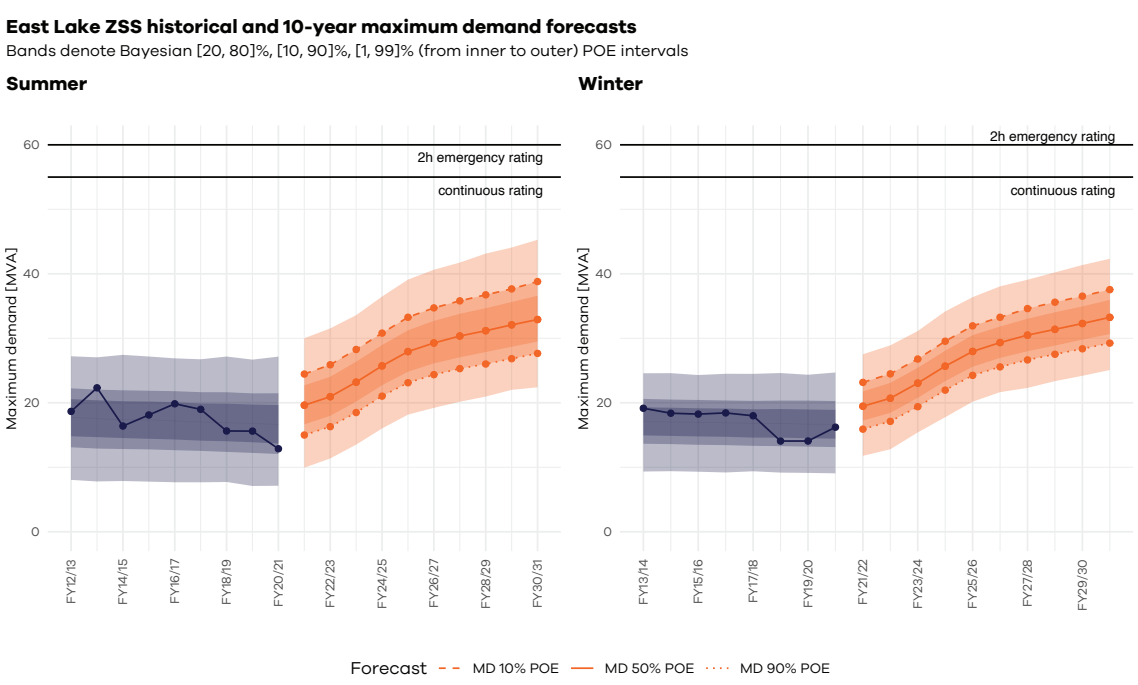
Figure 22. Gilmore Substation 10-year forecast



5.3.3 East Lake Substation

In the forecast shown in Figure 23 we see a steep increase in demand at East Lake Zone Substation. The drivers for this are two-fold. One driver is the increase in commercial load from consumers in the Fyshwick, Causeway and Canberra Airport areas, in particular data centres. The other driver is the decommissioning of Fyshwick Zone Substation by 2024. All the load currently supplied by Fyshwick Zone Substation will need to be supplied by East Lake Zone Substation by 2024. Please see section 7.6.5 for further detail. It is not anticipated that additional augmentation of East Lake Zone Substation will be required within the 10-year planning horizon.

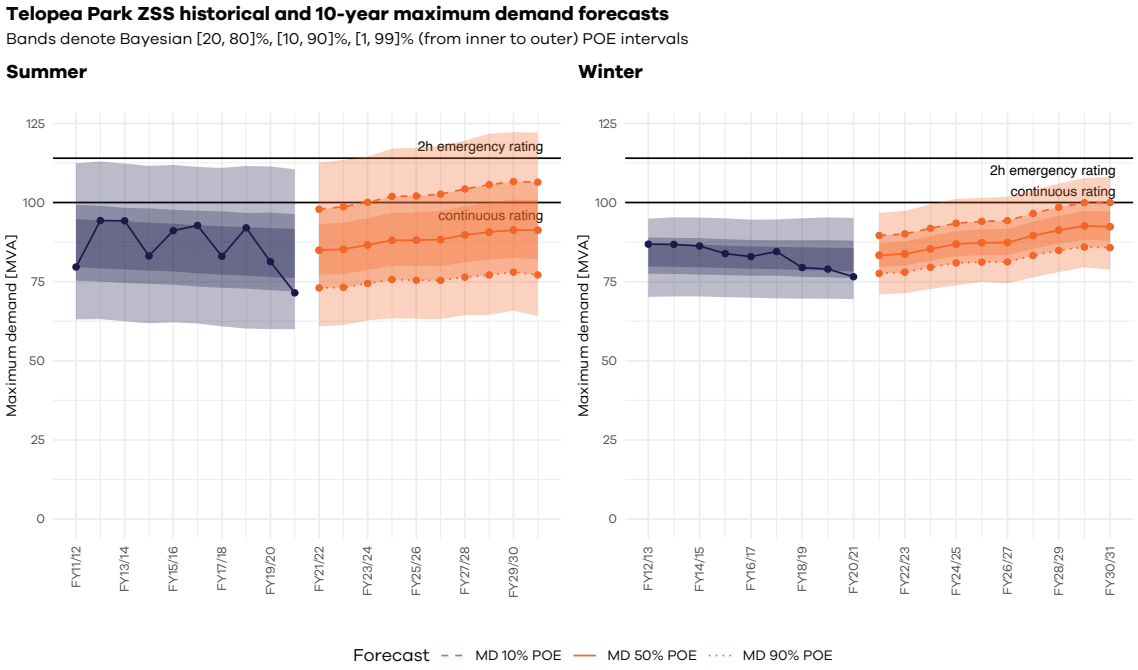
Figure 23. East Lake Substation 10-year forecast



5.3.4 Telopea Park Substation

Telopea Park Zone Substation is forecast to exceed the summer two-hour emergency rating in the later part of the 2024-29 regulatory period. Because this expected increase in demand is based on anticipated customer block loads which are subject to some uncertainty, Evoenergy will review this forecast in the next period and update the planning outcomes accordingly.

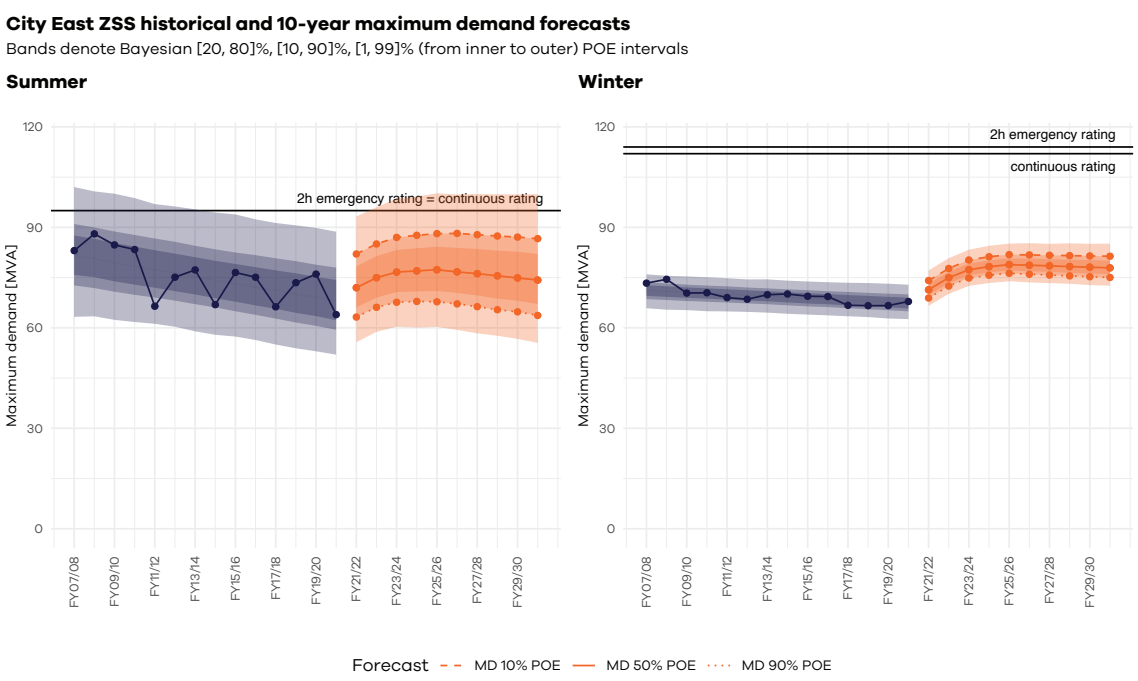
Figure 24. Telopea Park Substation 10-year forecast.



5.3.5 City East Substation

City East Zone Substation is forecast approach the Summer two-hour emergency rating in the 2024-29 regulatory period. Because this expected increase in demand is based on anticipated consumer block loads which are subject to some uncertainty, Evoenergy will review this forecast in the next period and update the planning outcomes accordingly. The proximity of City East Zone Substation to the proposed site of Mitchell Zone Substation provides an opportunity to utilise the future Mitchell zone substation to alleviate load constraints at City East Zone Substation so this has not been identified as a key constraint.

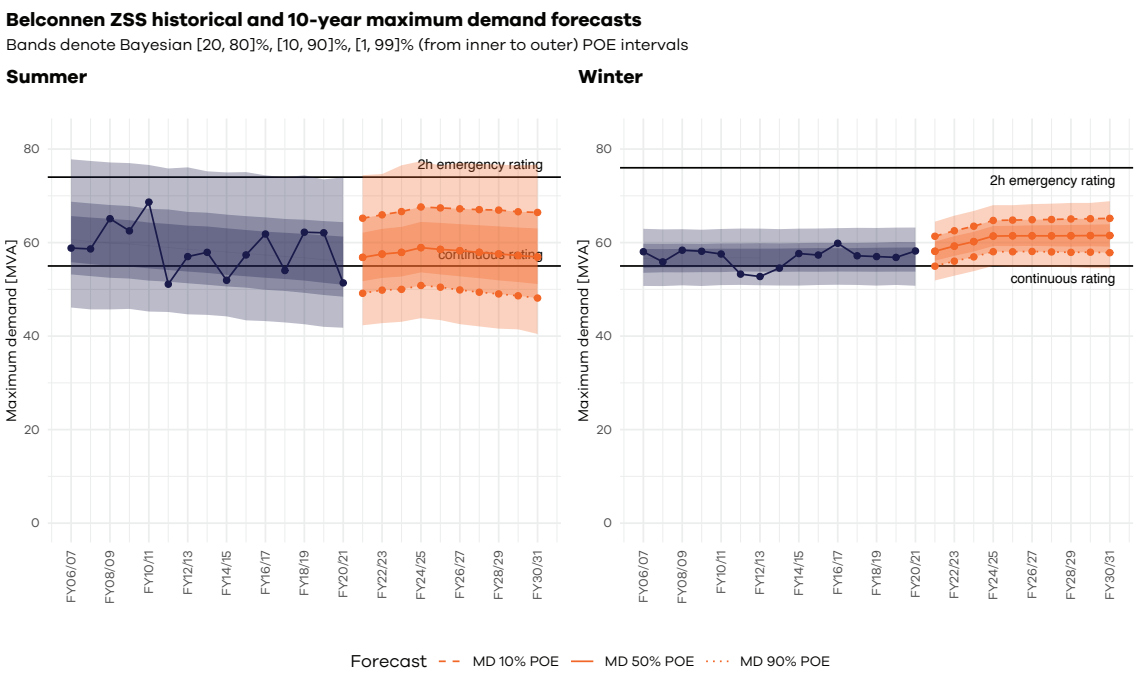
Figure 25. City East Substation 10-year forecast



5.3.6 Belconnen Substation

Belconnen Zone Substation has been consistently operating above the continuous rating during both the summer and winter peak demand periods for several years. Despite this there is minimal load growth expected during the 10-year planning horizon so it is not forecast that the zone substation will operate above the emergency 2-hour rating. For this reason, this zone substation has not been identified as having any critical load constraints.

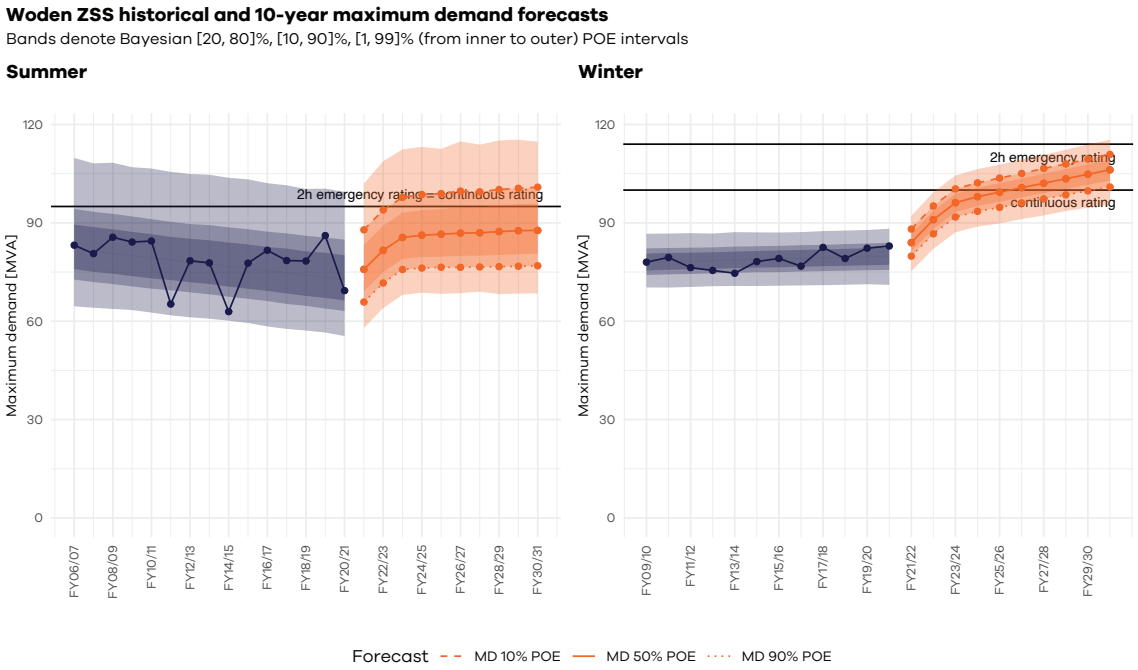
Figure 26. Belconnen Substation 10-year forecast



5.3.7 Woden Substation

There is significant load growth expected in the area currently supplied by Woden Zone Substation due to major residential development in the Molonglo Valley. This load growth will initially be supplied by the proposed Molonglo battery and then the Molonglo Zone Substation. For further detail on this project and the associated RIT-D please see section 7.6.1.

Figure 27. Woden Substation 10-year forecast.



5.4 Load Transfer Capability

Table 5 and Table 6 show the load transfer capability (MW) between Evoenergy's Zone Substations. Transfer capability is calculated based on spare capacity of zone substation transformers and spare capacity of interconnecting 11 kV feeders between substations. This is based on the thermal capacity of the feeders.

Table 5. Load Transfer Capability (MVA) between Evoenergy's Zone Substations in summer

Zone Substation	Belconnen	City East	Civic	East Lake	Fyshwick	Gilmore	Gold Creek	Latham	Telopea Park	Tennent	Theodore	Wanniassa	Woden
Belconnen		7.9	5.5				6.8	5.3					
City East			12.9	1.2					20.5				
Civic	3.3	27.0					3.7	1.7	8.6				
East Lake		3.8							6.5				
Fyshwick		2.6		6.6		0.9			1.1				
Gilmore											3.5	15.4	
Gold Creek	3.2		2.8					1.8					
Latham	13.3		2.4				0.3						
Telopea Park		11.1	6.7	2.1		2.6						4.3	11.1
Tennent													
Theodore						7.2						6.3	
Wanniassa						12.7			0.1		8.4		12.6
Woden									5.1			18.4	

Table 6. Load Transfer Capability (MVA) between Evoenergy's Zone Substations in winter

Zone Substation		To											
		Belconnen	City East	Civic	East Lake	Fyshwick	Gilmore	Gold Creek	Latham	Telopea Park	Tennent	Theodore	Wanniassa	Woden
From	Belconnen		14.0	16.9				7.3	9.2					
	City East	1.1		28.3	2.5					24.9				
	Civic	8.4	17.9					3.1	3.4	11.7				1.6
	East Lake		4.4							15.4				
	Fyshwick		0.1		20.8		2.2			3.3				
	Gilmore									3.2		3.3	16.2	
	Gold Creek	14.4		3.3					2.1					
	Latham	16.5		9.6				3.7						
	Telopea Park		12.1	3.4	8.0		5.1						5.1	20.3
	Tennent													
	Theodore						4.1						8.2	
	Wanniassa						20.4			5.1		11.3		20.7
	Woden			5.6						5.5			24.6	

Chapter 6: Managing existing assets

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

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

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

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

6.1 Primary systems

6.1.1 Existing assets - what are the main investment drivers?

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

- The key observations and drivers reflected in the planning outcomes discussed in this chapter include:
- Continuing focus on aging network assets particularly to identify increased risk of failure of critical assets
- The risk profiles of 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. switchboards, earthing), the dominant risk driver is safety of people or property

6.1.2 Asset Specific Plans

Evoenergy prepares asset specific plans in alignment with the asset management policy, strategy, and objectives. Our ASPs address 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 consumers 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 requirements and monitoring needed to meet the asset management objectives.
- **Asset Failure Modes** – Assessing how assets can fail, the likelihood and consequences of failure (FMECA - Failure Mode, Effects & Criticality Analysis) to forecast the risk associated with our assets facilitating risk centred maintenance to our assets
- **Asset Class Strategy** – outlines the optimal asset class lifecycle strategy and alternative options considered.
- **Asset Health and Expenditure** – forecasts expenditure (CAPEX and OPEX) for the optimal asset class lifecycle strategy and desired future health of our assets.

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

Table 7. Asset Specific Plans (ASP)

Asset Specific Plan (ASP)	Asset Group(s)	Asset Qty	Average Age
Distribution Overhead Network			
Poles	**Total**	**48,788**	**35**
	Concrete Pole	11,425	21
	Fibreglass Pole	4,230	7
	Timber Pole	26,886	48
	Steel Pole	5,892	19
	Stobie Pole	355	74
Pole Substations	**Total**	**1,386**	**36**
	Pole Substation	1,386	36
Overhead Lines and Pole Hardware	Total	2,120 km	53
	Overhead HV Conductors	970 km	51
	Overhead LV Conductors	1,150 km	54
Overhead Switchgear & Automation	**Total**	**8,063**	**51**
	Gas Switch	116	9
	HV Link	1,515	33
	Surge Diverter	2,715	36
	Fault Passage Indicator	547	6
	Drop-out Fuse	1,601	31
	Auto-Recloser	41	15
	Air Break Switch	1,522	20
	Load Break Switch	6	25
Overhead Service Conductors	**Total**	**1,149 km**	**40**
	Overhead Service Cable	1,149 km	40

Asset Specific Plan (ASP)	Asset Group(s)	Asset Qty	Average Age
Distribution Underground Network			
Distribution LV Switchboard Assembly	**Total**	**N/A**	**N/A**
	LV Circuit Breaker	1,183	31
	LV Switchboard	3,726	29
Underground LV Cables	**Total**	**3,763 km**	**47**
	Underground Service Cable	2,143 km	55
	Underground LV Cable	1,620 km	36
LV Pillars	**Total**	**16,593**	**32**
	LV Pillar	15,164	25
	Point of Entry Cubicle	1,429	54
Earthing	**Total**	**26,901**	**42**
	Distribution Pole Earthing	14,584	23
	Ground Substation Earthing	3,741	29
	Overhead Substation Earthing	1,388	37
	Overhead Switch Earthing	1,686	37
	Underground to Overhead Connection Earthing	4,376	42
	Transmission Line Earthing	1,126	38
Distribution Substation/ Switching Station Sites	**Total**	**3,705**	**29**
	Padmount Substation	2,510	27
	HV Switching Station	344	35
	Chamber Substation	480	27
	Stockade Substation	6	34
	Kiosk Substation	365	36
Distribution HV Switchboard Assembly	**Total**	**N/A**	**N/A**
	HV Circuit Breaker	400	18
	HV Switchboard	23	32
Ground Mounted Transformers	**Total**	**3,865**	**30**
	Ground Transformer	3,865	30
Underground HV Cables	**Total**	**N/A**	**65**
	Underground HV Cable	1,219 km	65
	Underground HV Feeder	241	65
Ring Main Units	**Total**	**3889**	**34**
	Ring Main Unit	3889	34
LV Pits	**Total**	**4065**	**-**
	LV Underground Pit	4065	-

Asset Specific Plan (ASP)	Asset Group(s)	Asset Qty	Average Age
Zone Substations			
132 kV & 66 kV Air Insulated Switchgear	**Total**	**569**	**34**
	132 kV & 66 kV Circuit Breakers	39	40
	132 kV & 66 kV Current Transformers	144	28
	132 kV & 66 kV Isolators	149	39
	132 kV & 66 kV Voltage Transformers	89	31
	132 kV & 66 kV Earth Switches	37	37
	132 kV Surge Diverters	111	35
Zone 11 kV Switchboard Assembly	**Total**	**458**	**33**
	11 kV Oil Circuit Breakers	129	44
	11 kV Vacuum Circuit Breakers	243	26
	11 kV Earth/Test Trucks	58	36
	11 kV Switchboards	23	35
Power Transformer Assembly	**Total**	**159**	**33**
	Power Transformers	33	34
	Power Transformer 132kV & 66kV Bushings	96	32
	Online Tap Changers	30	37
Other Transformers	**Total**	**52**	**36**
	Auxiliary Transformers	23	34
	Neutral Earthing Transformers	29	38
Gas Insulated & Mixed Technology Switchgear (GIS & MTS)	**Total**	**227**	**8**
	132kV GIS/MTS Voltage Transformers	36	8
	132kV GIS/MTS Earth Switches	62	8
	132kV GIS/MTS Circuit Breakers	27	8
	132kV GIS/MTS Isolators	18	8
	132kV GIS/MTS Current Transformers	84	8
Backup Generator Auxiliary	**Total**	**28**	**15.5**
	Standby Generators	14	14
	Automatic Transfer Switches	14	17

Asset Specific Plan (ASP)	Asset Group(s)	Asset Qty	Average Age
Transmission Network			
Overhead Transmission Lines	**Total**	**1526**	**34**
	Concrete Pole	888	28
	Timber Pole	429	43
	Steel Tower	201	46
	Steele Pole	8	2
Underground Transmission Lines	**Total**	**183 km**	**41**
	Overhead conductors	183 km	41
	Total	**5km**	**13**
	Underground cables	5km	13

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

Table 8. Completed asset replacement program

Asset Specific Plan (ASP)	Task	Number of Replacements
Distribution Overhead Network		
OH Switchgear and Automation	Replace Overhead Gas Switch	0
	Replace Surge Diverter	20
Poles	Replace Pole	255
Pole Substations	Replace Single Pole Substation	3
	Replace Two Pole Substation	0
Distribution Underground Network		
Distribution Substations / Switching Station Sites	Replace Padmount	5
LV Pillars	Replace Pillar	70
LV Switchboard Assembly	Replace Capstan Link LV Board	2
	Replace LV Pit	3
HV Ring Main Unit	Replace RMU	2
Underground HV Cables	Replace HV Cable Termination	4
Underground LV Cables	Replace LV Pothead	28
	Replace Service Pothead	17

Woden 132 kV Circuit Breaker Replacement

This project proposes replacement of an old minimal oil live tank circuit breaker with a new SF6 dead tank circuit breaker. The circuit breaker has exceeded its useful design and operational life and is known to exhibit operational issues. A detailed condition assessment has been performed on this circuit breaker, the main contacts are in unacceptable poor condition requiring replacement and the mechanism requires major overhaul. The existing circuit breaker is uneconomic to repair.

The replacement of the Woden 132 kV Circuit Breaker was completed in June 2021 and will improve the safety and reliability of a zone substation that feeds the Woden area and Canberra Hospital.

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 9 below summarises review outcomes which relate to transmission and distribution with the value above $200 000 (as per NER, schedule 5.8(b2)). Evoenergy ASPs apply a 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 9. Identified retirements of major assets

Area	Network Element	Primary Driver	RIT-D	Estimated Cost ($ million)	Consult	Decision	Date Required
Woden Zone Substation	132 kV Circuit Breaker	Asset condition & performance	No	$0.35m	N/A	Mar 2020 complete	Jun 2021 complete
Fyshwick Zone Substation	66 kV Assets	Asset condition & performance	No	$2.1m	Jun 2021 complete	Dec 2021 complete	Jun 2024
Latham Zone Substation	Substation Switchboard	Asset condition & performance	No	$3.1m	Dec 2022	Jun 2023	Jun 2024
Wanniassa	Distribution Line Underground Cable	Asset condition & performance	No	$4.3m	Dec 2022	Jun 2023	Jun 2024
Zone Substation supply security	Provisional Power Transformer[18]	Asset condition & performance	No	$2.7m	Mar 2021 complete	Jun 2021 complete	Jun 2022

[18] Not specifically a retirement but major system spare to provide contingency for unplanned zone transformer retirement.

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.

Decommissioning of Fyshwick Zone Substation 66 kV Assets

from TransGrid's Queanbeyan 132/66 kV Substation via two single-circuit wooden pole 66 kV sub-transmission lines. Fyshwick Zone Substation is the only zone substation on Evoenergy's network that comprises 66 kV assets, with Evoenergy's other 12 zone substations all connected to Evoenergy's 132 kV meshed network.

Primary assets at and supplying Fyshwick Zone Substation are at the end of their economic lives. The two 66 kV transmission lines from Queanbeyan to Fyshwick (3.6 km) were constructed in 1959 with wooden poles and Lemon 30/7/3.00 ACSR/GZ conductor. Most of the 52 x 66 kV poles have been reinforced and will require replacement within the next 5 years. The steel core of the ACSR conductor is expected to corrode over time so the Lemon conductor will also require replacement in the near future with AAC, AAAC or similar type conductor. The 66 kV circuit breakers at Fyshwick are ASEA type; four are 1971 vintage and one 1985. These are nearing the end of their economic lives and will require replacement within the next 5 years. Oil water contamination is likely to impact these units as there are issues with leaking seals due to deterioration. There are no spare units available and Evoenergy is unable to sufficiently maintain the units to extend their life.

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

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

A project has been initiated to decommissioning the 66 kV assets at Fyshwick and supply the 11kV from express feeders from East Lake zone substation.

Figure 28 illustrates the condition of existing assets at Fyshwick 66/11 kV Zone Substation.

Figure 28. Fyshwick Zone Substation: Outdoor wooden pole strung busbars. Indoor 66 kV electromechanical protection relays

Latham Zone Substation Switchboard Replacement

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

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

It is proposed to replace one 11 kV switchboard at Latham Zone Substation with modern equivalent at an estimated cost of $3.1 million in 2024. The second Latham 11kV switchboard is planned to be replaced in 2025-26.

Wanniassa Distribution Line Underground Cable

Reid feeder, an 11 kV underground feeder from Wanniassa zone substation, supplies over 1,200 consumers in the Tuggeranong district. This feeder was installed in 1976 and has experienced eight cable faults in the past 10 years.

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

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

Option 1 – Do nothing

Option 2 – Replace 11 kV underground cable

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

Provisional 132 kV Power Transformer

Transformer condition is dictated by the remaining integrity of the internal paper insulation. Generally, the remaining strength, or inversely the 'degree of polymerisation' (DP), of the paper is strongly linked to the remaining life of the transformer.

To determine these levels of insulation, Evoenergy estimates the DP of the paper from furan analysis of the oil. Once this has reached a certain threshold, Evoenergy performs intrusive sampling of the in-tank paper for laboratory assessment. To help manage at risk transformers, Evoenergy has also started installing online Power Transformer Dissolved Gas Analysis Units as summarised in section 6.2.7.

Based on DP and transformer remaining life assessments, there are three zone substations with assets reaching end-of-life at risk of a transformer failure. The sites are Gilmore, Telopea Park and Theodore Zone Substations.

Considering the above, and the estimated 12-18 month lead time of a new transformer, Evoenergy is procuring a new power transformer to be installed at Telopea Park Zone Substation. The existing Telopea Park transformer will be relocated to Gilmore Zone Substation as a system spare. Delivery of the new Power Transformer is scheduled for April 2022.

Grouped asset retirement plan

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

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

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

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

Table 10. Identified group asset retirements

Asset Specific Plan (ASP)	2022		2023		2024		2025		2026		Total	
	Qty	Cost ($m)	Qty	Cost ($m)	Qty	Cost ($m)	Qty	Cost ($m)	Qty	Cost ($m)	Qty	Cost ($m)
Ground Assets												
Distribution HV Switchboard Assembly	2	0.78	2	0.78	2	0.78	2	0.78	2	0.78	10	7.8
Distribution LV Switchboard Assembly	5	0.75	5	0.75	3	0.45	3	0.45	3	0.45	19	2.85
Distribution Substation/ Switching Station Sites	6	1.2	6	1.2	6	1.2	6	1.2	6	1.2	30	6
LV Pillars	25	0.18	25	0.18	25	0.18	25	0.18	25	0.18	125	0.9
UG HV Cables			1	1.61	1	2.69					2	4.30
UG LV Cables	3	0.45	3	0.45	3	0.45	3	0.45	3	0.45	15	2.25
Overhead Assets												
OH Lines and Pole Hardware	511	1.11	511	1.11	511	1.11	511	1.11	511	1.11	2555	5.56
OH Switchgear & Automation	52	0.63	52	0.63	52	0.63	52	0.63	52	0.63	260	3.14
Overhead Transmission Lines	8	1.02	8	1.02	8	1.02	8	1.02	8	1.02	40	5.12
Pole Substations	8	0.4	8	0.4	8	0.4	8	0.4	8	0.4	40	1.99
Poles	285	4.55	285	4.55	285	4.55	285	4.55	285	4.55	1425	22.74

1-Quantity is in number of substations

2- Quantity is in Projects

3- Quantity is in number of jobs of average 200m each

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

Overhead Switchgear and Automation

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

Pole Substations

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

Poles

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

6.1.6 Distribution ground network

Distribution LV Switchboard Assembly

Distribution LV switchboard assembly includes LV switchboard panels and LV circuit breakers in distribution substations. The driver for this replacement program is predominantly operational risk. This replacement program currently focuses on replacing LV switchboards containing Capstan Links. This type of switchboard was installed in Evoenergy's network prior to 1975 and has exposed live components. The Capstan Link switchboard replacement program currently focuses on the chamber substations and has prioritised replacement of the LV switchboards which have LV CBs containing asbestos material.

An inspection program developed by Evoenergy has identified the kiosk/padmount substations having LV switchboards that contain Capstan Links. Presence of Capstan Links together with risk assessment based on the condition of the other components of will inform the priorities for the Evoenergy replacement program.

Distribution Substation/Switching Station Sites

The distribution substation and switching station replacement program includes ground mounted substation and switching station replacements. The program is driven by asset condition and corresponding risk assessment. The condition of switchgear and transformers are the key components which are included in that assessment. Some substations include older HV or LV legacy switchgear designed to standards which were subsequently superseded with the new technical requirements. Some of this equipment may pose an increased operational risk in terms of reliability or operator safety or both. Types of HV switchgear which typically fit into these categories includes Reyrolle, Yorkshire, J&P, Statter, Long and Crawford, and MI Australia. The operational reliability is reduced for the switchgear which is no longer supported by manufacturers and therefore cannot be adequately maintained. For LV, the switchboards that have Capstan Links, exposed live components and aged components such as transformer links that pose an arc flash risk are assessed for replacement priority.

To mitigate the existing operational risks prior to replacement with modern equivalents, Evoenergy has put in place operating and maintenance restrictions at such locations.

Distribution substations may also be nominated for planned replacement due to defective transformers.

LV Pillars

The LV pillar replacement program targets replacing aged pillars in poor condition. The type of LV pillars contained within streetlight columns owned by Transport Canberra and City Services (TCCS) and colloquially referred to as "Pregnant Columns" are generally in poor condition. Another such type is the 'Henley Pillar' that derives its name from the manufacturer. These usually supply large consumers (mostly commercial) and given the size of the cables connected, require a site-specific replacement solution. The LV Pillars that have been prioritised for replacement include Henley Pillars and Pregnant Columns.

Underground LV Cables

LV cables replacement is designed to mitigate risk relating to the failure of LV cables. Some failures may result in a loss of neutral conductor connection. During the 2020/21 FY most replacements were unplanned resulting from a failure of LV cable. However, Evoenergy is in the process of implementing a condition monitoring and testing program which will provide additional data in terms of the asset failure rates, life span and risk including safety. On the basis of the test results Evoenergy intends to develop a structured risk-based approach to LV cable replacements.

Underground HV Cables

Evoenergy's distribution network includes a number of HV cables whose age exceeds the original design life span. These cables include both types - Paper Insulated Lead Cables (PILC) and XLPE. PILC cables are often present in some of Canberra's older suburbs such as Yarralumla, Reid, Griffith, Barton, Civic, Turner, Reid and Deakin. The oldest XLPE cables include the first generation cables of that type which are believed to have a relatively less live span than the later generations of XLPE cables. Evoenergy has identified these cables as a potential operational risk. Evoenergy is progressively evaluating risks associated with these cables. An external service provider was contracted to conduct condition assessment mainly using on-line partial discharge (PD) testing. Outcomes of such testing programs will be used to identify priority for HV cable replacements within Evoenergy network.

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

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

During the last year Evoenergy did not de-rate any distribution or 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 ACT Government department Transport Canberra City Service (TCCS) to Evoenergy.

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

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

6.2 Secondary systems

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

- Supervisory Control and Data Acquisition (SCADA) system which enables network operation, control or switching, monitoring and data acquisition.
- Telecommunication system which supports network protection, SCADA, telephony, video, and corporate data services
- Protection systems which enable fault clearing, isolation and protection of network equipment, and enhance safety of operations.

This section provides information on the current challenges, main secondary system projects progressed or completed over the last year, and projects proposed for the forthcoming period.

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

6.2.1 Secondary assets - what are the main challenges?

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

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

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

The community relies on critical infrastructure to deliver essential services that are crucial to our economic prosperity and our way of life, such as electricity, communications, transport and banking. Secondary Systems is central for the operation, safety and reliability of the electricity network, and as with other technology systems, cyber security is an increasing threat if not managed effectively. On 21 November 2021 the Australian Parliament passed further amendments to the Security of Critical Infrastructure (SOCI) Act from those passed in 2020. In addition to the enhanced cyber security obligations for electricity network operators there are new cyber event reporting requirements. Further amendments in 2022 have been foreshadowed regarding increasing cyber security maturity levels for critical infrastructure operators. Evoenergy is monitoring and addressing the impacts of the requirements of the new regulations.

6.2.2 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. SCADA systems are used at zone substations and major distribution assets in the electrical network. SCADA is also increasingly being utilised to provide additional data for monitoring, control, and asset condition monitoring.

From 2020, Evoenergy is adopting IEC 61850 digital substation technology as part of secondary systems renewal programs. Further information on the IEC 61850 Substation Automation System approach can be found in section 9.1. SCADA renewal works for 2021-2025 include:

- Implementation of an IEC61850 substation automation system at Woden, Telopea Park, Belconnen, and Wanniassa Zone Substations including a new SCADA Remote Terminal Unit (RTU) and Human Machine Interface (HMI).

6.2.3 Protection

Protection assets are located within Evoenergy zone substations, switching stations, and distribution substations, and are used to isolate faults with electrical equipment, 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 potential damage to network infrastructure.

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

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

Evoenergy's 2021-25 protection renewal program includes the following:

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

6.2.4 Telecommunication Systems

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

The primary purpose of the telecommunications network is the support of ADMS/SCADA and protection of network assets. The telecommunications network also supports corporate WAN, VoIP (Voice over Internet Protocol) telephony, engineering LAN, security CCTV monitoring, and access control to sites.

Evoenergy has established an optical fibre network to replace aged communications bearers, such as copper pilot cables and radio. This network uses hybrid OPGW (optical fibre ground wire) cables and UG (underground) optical fibre cable. Installation of OPGW involved replacing the existing overhead earth wire on 132 kV transmission lines to provide optical fibre communications capability.

The optical fibre network is required to meet the following regulatory and business needs:

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

Other telecommunications upgrade programs include:

- Replacement of aging 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) and migrate radio systems to the 4G network. This program will replace SCADA data radios as they reach the end of their serviceable life.

Figure 29 and Figure 30 show current and proposed communications network projects as follows:

- Current UG Fibre Projects
  2. Stockdill-LMWQCC Fibre (2020/21/22)
- Upcoming UG Fibre Projects
  4. City East Redundancy Fibre (2021/22/23)
  5. ANU-Nishi Fibre (2021/22/23)
  15. GDC-LDK Fibre (2021/22/23)
  16. Fyshwick Express Feeders (2021/22/23)
- Proposed UG Fibre Projects
  6. Kings Av to National Library Fibre
  7. Molonglo ZSS (2023/24) UG 132kV line & Fibre
  8. Causeway Decommissioning UG 132 kV line & Fibre
  9. Belconnen-UC Fibre (2023/24)
  10. Mitchell ZSS (2030) UG 132kV line & Fibre
- Proposed Light Rail UG Fibre Projects
  11. Stage 2A City-Commonwealth Av (2026)
  12. Stage 2B Commonwealth Av – Woden (2029+)
- Upcoming OPGW Fibre Projects
  14. Gilmore-Causeway Line (extension Canberra Av to Causeway)
- Proposed OPGW Fibre Projects
  18. Woden-Wanniassa 132 kV line replacement & Fibre

Figure 29 and Figure 30 show current and proposed communications network projects as follows:

Figure 29. Fibre optic network – north ACT

Legend

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

Current UG Fibre Projects

2 Stockdill-LMWQCC Fibre (2020/21/22)

Upcoming UG Fibre Projects

4 City East Redundancy Fibre (2021/22/23)

5 ANU-Nishi Fibre (2021/22/23)

Proposed UG Fibre Projects

7 Molonglo ZSS (2023/24) UG 132kV line & Fibre

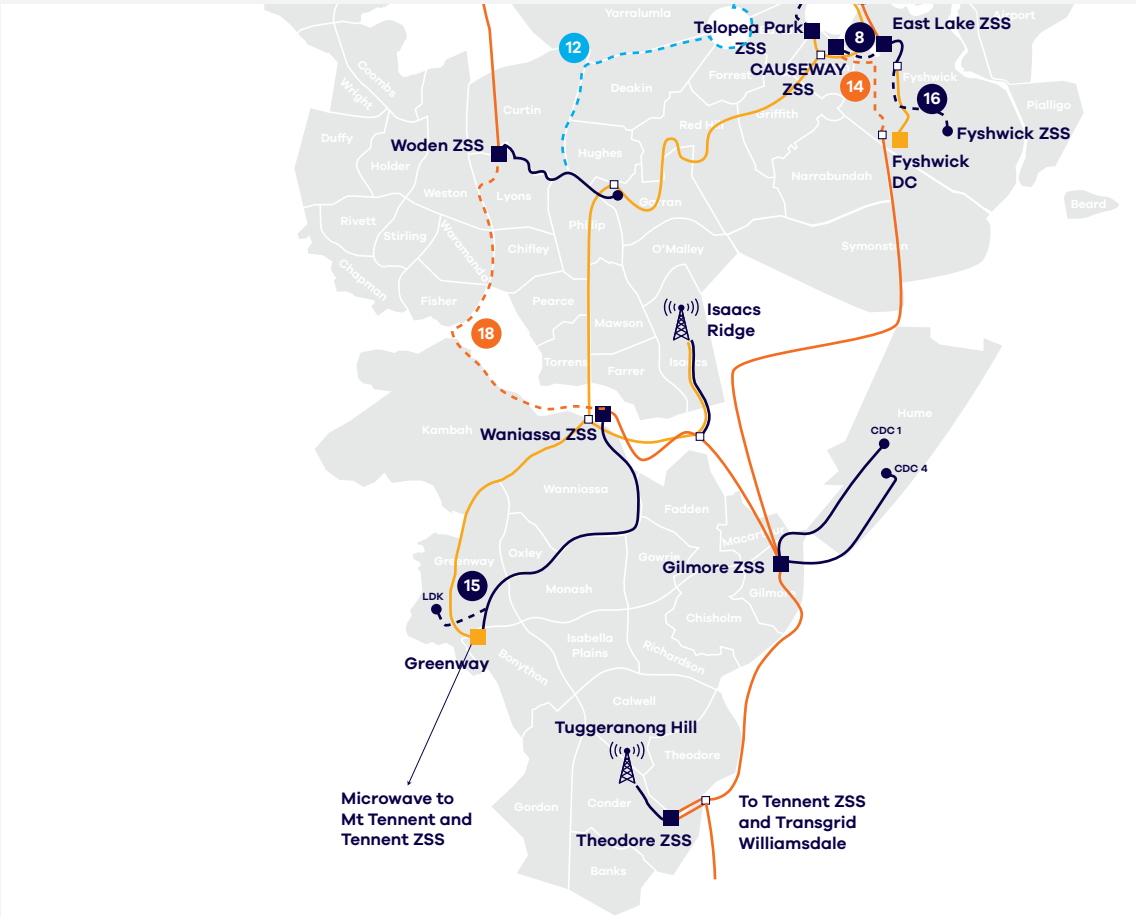
9 Belconnen-UC Fibre (2023/24)

10 Mitchell ZSS (2030) UG 132kV line & Fibre

Proposed Light Rail UG Fibre Projects

11 Stage 2A City-Commonwealth Av (2026)

Figure 30. Fibre optic network – south ACT



Legend

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

Proposed UG Fibre Projects

8 Causeway Decommissioning UG 132 kV line & Fibre

Proposed Light Rail UG Fibre Projects

12 Stage 2B Commonwealth Av – Woden (2029+)

Upcoming OPGW Fibre Projects

14 Gilmore-Causeway Line (extension Canberra Av to

Upcoming UG Fibre Projects

15 GDC-LDK Fibre (2021/22/23)

16 Fyshwick Express Feeders (2021/22/23)

6.2.5 Distribution substation monitoring

A project to install distribution substation monitoring will help Evoenergy monitor and identify power quality issues, which are arising from high penetration of embedded generation in parts of the Evoenergy distribution network. It will support the provision of reliable power quality supplied to energy consumers and help support future energy ambitions. The distribution substation monitoring solution will provide real-time quality of supply monitoring from areas of the network most affected by disruptive technologies and enable load flow and voltage profiling functionality within the Advanced Distribution Management System (ADMS). With this visibility in ADMS, network performance at the low voltage level can be managed proactively and more economically, with voltage compliance assured across the network for all Evoenergy consumers.

The program will address emerging network constraints and voltage issues arising from consumers' energy generation, storage, and emerging technology use. The program will provide opportunities, through improved visibility, to remediate problems at the lowest cost, avoid unnecessary augmentation and asset replacements in brownfield areas, and deliver better network planning and investment outcomes in new developments.

Evoenergy has so far installed 147 distribution substation monitors and will continue installing more devices in 2022. More information on power quality and the challenges Evoenergy has with maintaining voltage compliance can be found in Section 4.2.

6.2.6 What we have achieved in the last year

- During last year Evoenergy completed or progressed and number of secondary system projects including:
- Commenced implementing next generation IEC 61850 digital zone substation secondary systems with zone substation and distribution substation projects.
- Implemented SCADA and protection systems for new and upgraded connections at three customer sites with large scale embedded generation.
- Installed SCADA monitoring and control for six new distribution substations improving visibility and remote switching capability in the 11 kV network.
- Installed on-load tap changers for eight new distribution transformers, improving voltage stability in areas with high penetration of rooftop solar.
- Installed ten network analyser devices to provide remote monitoring and capture of power quality data and events.
- Replaced 132 kV transmission line protection relays at Woden Zone Substation and integrated with the new IEC 61850 system.
- Installed Under Frequency Load Shedding System at Civic Zone Substation.
- Replaced 11 kV feeder protection relays at Gold Creek ZSS.
- Replaced SCADA remote terminal units at Woden ZSS and two distribution substations.
- Power Transformer Dissolved Gas Analysis Units on 4 Zone Substation Power Transformers.
- Installed OPGW between Transgrid Canberra substation, Transgrid Stockdill substation and Woden ZSS.

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

Table 11. Secondary system projects

Constraint/Need	System	Timeframe	Driver	Total Cost ($ million)
Upgrade of Zone Substation HMIs	SCADA	2020-24	Safety Reliability	$0.375m
Distribution Substation Monitoring	SCADA, Communications	2020-25	Quality Reliability	$3.5m
Voltage Regulation System Upgrades	SCADA, Protection	2020-25	Quality Reliability	$2.7m
Secondary Systems Cyber Security Program	SCADA, Communications	2021-24	Safety Reliability	$1m
Woden ZSS Protection Replacement	Protection	2020-21	NER compliance Safety Reliability	$1.92m
Latham ZSS Protection Replacement	Protection	2020-22	NER compliance Safety Reliability	$2.08m
Telopea Park ZSS Protection Replacement	Protection	2021-24	NER compliance Safety Reliability	$2.08m
Belconnen ZSS Protection Replacement	Protection	2023-24	NER compliance Safety Reliability	$2.4m
Power Transformer Dissolved Gas Analysis Unit	Condition Monitoring	2020-21	Safety Reliability	$0.3m
Distribution Network Pilot Cable Replacement (optical fibre)	$0.3m	2021-22	NER compliance Safety Reliability	$0.9m
SCADA Network Radio and 4G Replacements	Communications	2021-25	Safety Reliability	$0.69m
Zone Substation WAN Router Replacements and Upgrades	Communications	2021-25	NER compliance Safety Reliability	$0.72m
Microwave Radio Replacements and Upgrades	Communications	2021-25	NER compliance Safety Reliability	$0.72m
Chamber Substations RTU Replacements and Upgrades	SCADA	2021-25	Safety Reliability	$1.5m

6.2.8 Consumer metering

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

In 2017, the Power of Choice government regulatory reforms introduced changes to the metering arrangements. All new and replacement meters installed from 2017 need to be advanced meters (classified as Type 4 meters under the NER) and moving forward the installation of meters would be performed by the Retailer's metering provider. Evoenergy no longer installs new meters or replacement meters.

Evoenergy continues to manage fleet of meters installed at around 158 000 connection points identified by National Market Identifiers. These locations include a fleet of around 180 000 of Evoenergy revenue meters. 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.

The numbers of Evoenergy meters reduce every year when meters marked for replacement are progressively being installed by independent metering service providers with meters owned by other parties.

6.3 Information and Operational Technology

Information Technology (IT) and Operational Technology (OT) systems are crucial to the operation and management of network assets. This suite of technology systems supports a wide-ranging set of business functions including customer service, works planning, billing, works management, asset management, design, planning, and network operations.

A continuous improvement philosophy is applied to the management of these IT and OT systems to achieve ongoing efficiency, business capability and customer service improvements.

Evoenergy utilises a set of core IT systems alongside a small number of special purpose technology systems to manage the electricity network. Our focus for these customer and asset information systems is consistently one where we leverage individual and collective capabilities to support the business with ongoing benefits realisation and innovation services. This focus continues through current and future programs to deliver changes and updates that apply across end-to-end business processes and to customer service delivery. To this end, a range of key projects have either been completed, are underway or are at a development and planning stage.

6.3.1 Information Technology – Planning Outcomes

Whilst there is an ongoing process of review for major consumer 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 (PoW).

Table 12. Summary of information technology and operation technology program

Program	Project Title	Timeframe	Planned Outcomes
1	ADMS Upgrade	Q4 2022	Extend operational life of system and improve functionality as well as improve cybersecurity.
2	PowerPlan Updates	Q1 through Q4 FY2022	Deliver enhanced Program of Work planning and development capability, including Monetised Risk, Estimating and Fleet forecasting capabilities.
3	Integration Architecture Platform	Q2 through Q4 FY2022	Progressively replace custom system and service integrations with a standards-based Integration Platform and Architecture.
4	Cityworks Portfolio Updates	Several programs running across Q1 to Q4 FY2022	Enhanced mobility, customised field force services, reporting, data management improvements, analytics capabilities, and productivity enhancements.
5.1	ArcFM GIS GDA2020 Datum Research and Upgrade Definition	Q1 FY2022 through Q4 FY2022	Preparation for major platform upgrade to align with industry wide data exchange compliance programs, and to provide greatly increased accuracy and consistency in mapping and visualisation services.
5.2	ArcFM GIS Support and Maintenance	Ongoing programs from Q2 2021 through to Q2 2024	Ongoing maintenance and support updates alongside functional and visualisation improvements.
6	Five Minute Global Settlements	Q4 FY2020 through Q3 FY2022	Regulatory Compliance program.
7	Velocity Billing and Metering Updates	Q4 FY2020 through Q4FY2021	Compliance and Tariff related changes allied with functional improvements plus Life Support, Planned Interruptions, Customer Switching and other Regulatory change programs.
8	Digital Platform	Q1 FY2020 through Q4 FY2024	Enhanced Customer Portal services.
9	Data Storage and Analytics Platform	Q3 FY2020 through Q4 FY2024	Enhanced Data access and reporting services for Consumers, Staff and industry partners alongside data analytics and insight services.
10	Drawing Management Systems	Q1 FY2020 through Q4 FY2024	Enhanced Mobility access systems.

6.3.2 ADMS Upgrade

Evoenergy uses an Advanced Distribution Management System (ADMS) to allow for centralised management of the network including outage management and performance optimisation.

The current system (ADMS 3.4) was introduced in 2016 and has delivered the full requirements of the original business case; however, it currently faces several challenges including the following:

- ADMS 3.4 operating system platforms are reaching the end of their extended operational life
- ADMS 3.4 hardware platforms are reaching the end of their extended operational life
- Limitations of ADMS 3.4 include:
- Limited capabilities (including power flow modelling) for Distributed Energy Resource Management System (DERMS)
- The lack of real time data for probabilistic planning
- Safety improvement opportunity with the introduction of an ArcFlash module
- Operational improvement opportunity with the introduction of an Energy Management System (EMS) module

The qualitative benefits of upgrading to version 3.8 include:

- Reduced risk of system failure
- Improved Cybersecurity posture
- Reduced augmentation costs
- Improved customer experience

The quantifiable benefits include:

- Minimal costs for alignment of network models
- Avoided DER and transmission modelling costs
- Avoided ADMS fixes cost
- Reduced cost of hardware/software support

The ADMS Upgrade is expected to go live in the 2022/23 financial year.

6.3.3 Automating Data Flow between Systems

Activities that improve or address opportunities in data management (related to Programs 3 and 9) practice include:

- Centralising and maintaining a single source of truth dataset for multi-user analytics, reporting, modelling and forecasting services.
- Increasing integration of our core customer and asset information systems including Velocity, Cityworks, Drawing Management System, ArcFM GIS, ADMS, Oracle, PowerPlan, Safety, Certification and Partner Management and Aurion systems
- Simplification of data collection and management processes with a single set of master data that is shared and utilised across multiple business practices
- Providing improvements in quality, integrity, and reliability of data that serves multiple purposes across customer service and product management processes
- Enabling automatic synchronising of meter installations and improving the timeliness by which our network information is updated while decreasing manual effort
- Automated scheduling and actioning of service energising and de-energising
- Improvements in the timeliness and accuracy of notifications of planned and unplanned outages with consumers directly mapped to network supply points
- Visualisation of consumer related incidents, asset location and connectivity, and planned service interruptions and maintenance or augmentation works
- Improved financial management and reporting services, human resource planning, and time management and enhanced analysis and forecasting services
- Forecasting, planning, packaging and scheduling the operational PoW to support efficient and effective use of resources and thereby optimising effort, asset utilisation and minimising service interruptions.

6.3.4 Field Mobility

Field Mobility programs enable work crews to execute key works management activities in the field including creation, actioning, and closure of service orders, asset inspections and work orders. This in turn leads to improvements in timeliness of works scheduling, planning and completion, availability, and accuracy of data. Further benefits to be gained from improvements to mobility services include improved response times to address priority field activities, increased field force productivity, as well as minimising the use of paper and manual process; ultimately delivering improvements in customer service.

Delivered in works related to Programs 4, 5.2, 9, and 10.

6.3.5 Customer Portal

The Evoenergy Customer Portal provides consumers with the capability to register and log in to a secured portal. This portal provides facilities for the consumer to view consumption data, schedule service activations or disconnections, request new and changes to existing assets and service connections, register private assets that are network connected, provide feedback, and view detailed information regarding planned and unplanned (emergency) service interruptions or network outages.

Delivered in works related to Programs 4, 5.2, 7, and 8.

6.3.6 Data Storage and Analytics Platform

Data analytics and reporting oriented projects are supporting improvements in overall service delivery through use of master data from a variety of sources consolidated to a single source.

Enhanced analytic techniques are also being applied to the operational data set to deliver product and service delivery enhancements. Consolidated views of network, consumer, asset and works planning data are also being utilised to provide multidimensional insights that, for example reduce the number and length of planned service interruptions by intelligent scheduling of related or adjacent activities such as maintenance of existing assets or installation of new or replacement assets.

Enhanced reporting and analytic services to support provision of accurate forecasting services, self-service consumer reporting and support services and collection, and storage and management of more extensive and granular consumer and core networks data.

Delivered in works related to Program 3 and 9.

6.3.7 Regulatory, Governance and Compliance

Core and special purpose technology systems are regularly reviewed and assessed for their general and specific alignment with regulatory, governance, and compliance requirements. Opportunities for improvement are identified and programs put in place to maximise the value proposition associated with the collection, management, retention, and use of data.

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 and new asset types and classes. For example, data relating to assets such as Solar Panels, Battery Storage, Smart Meters, and other such technologies are being sourced, included, and maintained in operational and planning data sets to meet evolving consumer and regulatory requirements, and to refine and improve business operations.

New collection, management, reporting, and storage facilities are being progressed to support improved timeliness, reduced complexity, and to reduce the cost of compliance and regulatory reporting practices.

Delivered in works related to Programs 5.1, 6, 8, and 9.

6.3.8 Program of Work Management

Upgrades and augmentation of existing asset information, asset management and asset planning systems will provide a more sophisticated toolkit for accurate forecasting and planning services that involve changing network assets.

Integration works to more closely align and connect core IT systems data is also benefiting the timely and efficient development of the Network Program of Work (PoW).

Predicting which assets need to be maintained using risk weighted data driven methodologies and processes will more appropriately drive programs for asset maintenance, replacement, or augmentation. It will also support improvements to packaging, scheduling and works planning which will further support changes to operate the minimum practical number of service interruptions for consumers and supply partners.

Delivered in works related to Programs 2, 3, 4, 5.2 and 9.

6.3.9 Cyber Security

Cybersecurity programs are delivering improvements to the overall integrity and security of assets and data. Integrated into basic operational process and management practice; capabilities such as privilege management, multi-factor authentication, remote access, secure single-sign-on processes, and exception reporting are embedding a single simplified cybersecurity framework across the Evoenergy organisation.

Cybersecurity improvements at Evoenergy in FY 2022 are expected to focus on core Operational Technology (OT) systems, specifically new implementation of Advanced Distribution Management System (ADMS) and secondary Industrial Control Systems (ICS)/ Supervisory Control and Data Acquisition (SCADA) systems:

- Establishment of Virtual Protected Network (VPN) Overlay – a VPN implementation (Using Dynamic Multipoint Virtual Private Network (DMVPN) technology and strong encryption) creating a government-style sensitive network without the cost of setting up separate comms links or separate network infrastructure.
- Physical Privileged Access Workstation – establishment of dedicated workstations designed to only access the Protected Network Overlay with no access to corporate network. These would be available in designated locations only, with strictly controlled physical access.
- Standard Operating Environment (SOE) build for the Protected Network – custom configuration of dedicated hardware (laptops) to allow SCADA engineers and other critical personnel access to the Protected network during fieldwork (while operating in sub-stations)
- SQL Server Configuration Manager (SSCM) migration – move of current SSCM build from Azure cloud to on-prem data centre, and into the Protected Network Overlay where it can be securely accessed
- Internet of Things (IOT) Gateways – establishment of additional network perimeter control points to protect the Protected Network Overlay (including ADMS) from the consumer-side traffic (rather than just the corporate traffic) and to enable secure interaction with aggregation and management components such as IOT hub.
- Consideration of a need for file transfer capability between the Protected Network and corporate environment
- Secure, severable remote access into the Protected Network for support and maintenance.

Delivered in works related to all Programs.

6.3.10 Information Technology - Future Areas

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

The functionality of customer and asset information systems will continue to be developed to meet key business requirements including enabling, managing and coping with disruption, operational effectiveness, and efficiency and improving customer service and experiences.

These outcomes will be achieved through continuous improvement programs that include usability and functionality releases, regulatory compliance and reporting and process governance enhancements, major and minor system upgrades and augmentations, or system replacements. All programs will work in parallel with, and be underpinned by, the implementation of enterprise integration and consistent data architectures, advanced data management and analytics techniques, and ongoing improvements to the systems and services that empower the consumer and Evoenergy staff

Consumer engagement

Providing our consumer with comprehensive information about their energy consumption and network outages are key aspects of improving data visibility and strengthening the relationship with energy consumers.

- In addition, we are digitising consumer interactions and opening new communication channels to make it easier for our consumers to work with us and so they can obtain the information they need to improve their experiences with Evoenergy. The expected benefits include:
- Timely, accurate, and complete data sets that enable consumers to better manage their energy use and to visualise and plan their energy futures
- Ensuring our industry consumers see interactions with us as adding value to their businesses.
- Greater capability for consumers to view and act on managing their services

Improving and extending the scope of direct communications to include providing information through our consumer's preferred channels..

Data Visibility and Availability

The value in our data is not in its collection or analysis, rather in the use of the data to change processes and improve stakeholder outcomes. Evoenergy is developing an enterprise data architecture and associated management techniques, modelling and analytics platforms, protocols, and assets that enable data to be more readily accessed, easily viewed, analysed, reported, and displayed across the business and to consumers. The expected benefits of delivering such programs are:

- Reduced time, cost, and effort in developing new or in updating or changing existing reporting systems and services
- Increased use of visualisation techniques that bring together multiple data sources and types to create intelligence and actionable insight which was previously unavailable
- Increased capacity and capability for trend analysis that can be leveraged to improve end-to-end business processes and to improve customer experience
- Increased ability to make more meaningful information available to consumers to improve our interactions and enable consumers to have greater management, control, and insight to their energy usage and to empower their decision-making processes for energy use.

Field Digitisation

With the continuous enhancement of works management mobility systems, there is an opportunity to build on the mobility platform to further digitize workforce activities. This includes the provision of offline, regularly updated network maps, job risk assessments, forms management, workflow tools, and safety work method statements. These additional initiatives will be delivered in a continuous improvement pathway to increase functional availability and provide a richer user experience by way of improvements in visualisation and connected master data. The roll-out program will be based on activities that ensure priority for initiatives that have clear business and consumer-oriented benefits.

- The benefits anticipated from continued field mobility changes include:
- Faster data capture at the time and location of an activity to provide greater accuracy and validation of data at the collection point
- Richer data collection with enhanced metadata and new data forms including imagery to enable visualisation of data analytics and support further improvement in the end-to-end process for planned outage notifications to consumers
- Data collection from multiple previously inaccessible sources to increase functionality and insight to field workers in their interactions with industry partners and consumers
- Integration with external data sources to augment the visualisation value of data already collected and utilised across the integrated management and reporting platforms
- Continuing to improve the safety of our workforce and the public through increased availability of accurate up-to-date information.

Enterprise Integration

All core Evoenergy technology systems are tightly 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 nine point-to-point integrations.

- Evoenergy will define and then 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 new integration architecture will enable the removal of bespoke and point to point system integrations, enabling applications to be built, maintained, and released independently of other system maintenance programs.

- Reduced implementation risk associated with large scale projects by cutting scope to focus on individual systems and thereby reducing complexity, project costs, delivery times, and outage impacts of consumers and industry partners

- More effective integrations will ensure that information is not lost between systems, is visible and manageable as it moves between systems, is translated and transferred consistently between platforms, and supports development of reliable and transparent business process flows

6.3.11 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 technology teams through to the field staff.

Generational change has taken place across all core systems that are used within the Evoenergy business including Works Management, Asset Planning and Management, Geospatial Information Systems, and Design and Drawing Management Systems, Billing and Customer Management systems.

Significant changes have also taken place to reduce reliance on office based or fixed location technology with physical upgrades to field and office use technologies.

There has been increased deployment of secured wireless network access and office support technologies for all staff to use in remote and "out of office" work locations allied with updates to latest generation mobility devices and secure communication technologies and techniques.

Customised commercial product use and deployment for the mobile workforce has also enhanced safety programs, certification management, inspection test capabilities, operational flexibility, and productivity.

Significant reductions in cost of service provision and increases in capacity acquisition from the Technology Division has transformed core infrastructure platforms based on a shift from sole use of physical on-premise infrastructures in corporate data centres to a hybrid model that utilises on-premise styled technologies with latest cloud-based systems and services that are available from global service providers and through latest generation commercial data centres.

Chapter 7: System planning

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

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

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

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

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

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

7.1 Network planning - what are the main challenges

Evoenergy plans its energy network to cater for existing and future demand. At the system level the projected summer and winter maximum demand is forecast to be relatively flat. The summer demand is forecast to grow around 8% over the next decade. The winter demand is forecast to increase by 9% during the same period. The network minimum demand is forecasted to reduce significantly over a decade with increasing possibility of ACT exporting power to NSW within the next 20 years. Chapter 5 and Appendix E provide more information on the system and zone substations demand forecast. There are no significant system level constraints identified during the planning review. The network constraints identified in the planning process are localised and relate to distribution system and zone substation capacity limitations. They correspond to the areas of higher residential and commercial growth.

Evoenergy's current network development drivers and challenges are:

- Urban infill medium density residential, high density residential and commercial developments pushing the capacity limits within the distribution system in several established areas
- Urban intensification is also being driven in the light rail corridors both for the existing light rail stages and the planned future stages.
- Increasing proportion of medium and high-density residential developments in the greenfield areas which increases electrical load density within serviced areas in line with the ACT Planning Strategy 2018 which states that 70% of new housing will be built within the existing urban footprint
- Continuation of greenfield developments and expansion into the areas poorly serviced by the existing network including the Molonglo Valley and potential growth in the Western Edge Investigation Area, particularly all-electric developments
- Distributed energy resources impacting voltage regulation on LV distribution network and therefore creating network constraints (usually within low voltage network)
- The medium to long term impacts of the ACT Government energy policies which includes 2045 zero emission target and perpetual neutral carbon target for electricity.
- The impacts of potential decarbonisation of the existing gas network and transport with the implications of this for the peak demand of the electricity network.
- Need for optimising network investment, demand management, non-network solutions and network support including use of new technologies (e.g. network batteries, embedded generation, and distributed energy resources).
- The increase in numbers of electric vehicles and rollout of related infrastructure as the ACT reduces carbon emissions from transport.

Evoenergy is also part of the ACT Government Utilities Working Group, an initiative led by the Chief Engineer, which aims to aid in holistic master planning across the ACT.

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 constructed respectively by TransGrid and Evoenergy was constructed. 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.

Other items covered in the joint planning meetings include the lowering of 132 kV bus voltage float levels at Canberra Substation (to alleviate high voltages at Gold Creek Zone Substation), within Evoenergy's and Transgrid's annual planning reports, and the provision of updated data agreements.

Due to ongoing COVID-19 concerns, this year's joint planning meeting was held for the second time via video conference in March 2021. Evoenergy and Transgrid also have regular discussions in addition to the formal joint planning meetings, to discuss and resolve technical issues. Most years Evoenergy participates in a joint training exercise with Transgrid 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). This training was cancelled in 2021 due to COVID-19 restrictions but is expected to be completed in subsequent years.

Transgrid proposes to carry out replacement of some of its aging major assets at Canberra Substation, including the retirement of two 330/132 kV 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 2021[19].

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

National Transmission Flow Paths (NTFPs) are those portions of transmission networks used to transport large amounts of electricity between generation and load centres. These are generally transmission lines of nominal voltage 220 kV and above. The Australian Energy Market Operator (AEMO) published an updated Integrated System Plan[20](ISP) in July 2020 and is currently working on the 2022 ISP. The ISP identifies investment choices and recommends essential actions to optimise consumer benefits as Australia experiences what is acknowledged to be the world's fastest energy transition. That is, it aims to minimise costs and reduce the risk of events that can adversely impact future power costs and consumer prices, while also maintaining the reliability and security of the power system.

The 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, solar and wind powered generation in particular, and has identified key renewable energy zones (REZ). 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.

It is noted that part of the Evoenergy 132 kV network meets the definition of the dual function asset, because it operates "... in parallel with or in support of the Transgrid's transmission network". However, none of the proposed projects described in this chapter are expected to 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. Evoenergy considers that the key planning outcomes are not directly impacted by the ISP, NSCAS, and Inertia Report, System Strength Report, or power frequency risk review outcomes. These requirements will be subject to future reviews and planning consultation with Transgrid.

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.

[19] https://tapr.transgrid.com.au/transgrid_data/2021%20Transmission%20Annual%20Planning%20Report.pdf

[20] https://aemo.com.au/-/media/files/major-publications/isp/2020/final-2020-integrated-system-plan.pdf?la=en&hash=6BCC72F9535B8E5715216F8ECDB4451C

7.5 Planning outcomes - network constraints and limitations

Table 13 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 stakeholder consultation process. Chapter 6 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 13. The following is the list of the major residential developments planned within the five-year planning horizon which have identified during the planning review from the ACT Government Indicative Land Release Program or consumer enquiries:

1. Ginninderry Estate, West Belconnen – Projected growth of approximately 300 dwellings per year throughout planning period. MacNamara currently in progress.
2. University of Canberra residential blocks, Bruce – two major high-rise developments with 3300 dwellings by 2024
3. Jacka Estate, Gungahlin –Stages 2 and 3 currently in progress for a total of approximately 700 dwellings.
4. Denman Prospect Estate, Molonglo Valley –Future stages totalling approximately 3-4,000 dwellings in various stages of development. Expected release of approximately 200-300 dwellings per year.
5. Whitlam Estate, Molonglo Valley – residential development. Stages 1 & 2 for constructed and energised with Stage 3 in progress. Future stages to come up to 2000 dwellings. Expected release of approximately 500-600 dwellings per year.
6. Kenny Estate, Gungahlin – 1000 dwellings expected with construction beginning in 2023.
7. Weston Blk 1 Sec 82 – Reticulation (HV & LV)

7.5.1.2 COMMERCIAL AND MIXED DEVELOPMENTS

Planned commercial and mixed developments cause some of the anticipated network limitations summarised in Table 13. The following is the list of commercial and mixed developments identified during the planning review:

1. Gungahlin Town Centre East – multiple high-rise residential developments with 2,244 dwellings and commercial development with approximately 127,000m2 space in next 5 years.
2. Belconnen Town Centre – multiple high-rise residential and commercial developments, approximately 32,000m2 commercial space and 1,000 residential dwellings.
3. Canberra North – several residential developments with 4,800 dwellings and commercial developments of approximately 155,000m2 space in the next 5 years.
4. Canberra Central Business District – multiple high-rise residential developments with 5,900 dwellings and commercial developments of approximately 308,000m2 space within next 10 years.
5. Canberra Airport precinct - various commercial developments and data centre in next 5 years period.
6. Kingston - Kingston Arts Precinct & Kingston Foreshore – multiple high-rise residential developments with 4,600 dwellings and commercial developments of approximately 62,000m2 space
7. Woden – multiple residential development with 1,300 dwellings and commercial developments of approximately 9,500m2 space. Stages 1, 2 & 3 of CIT campus relocation and bus interchange and depot upgrade
8. Canberra Hospital Supply Upgrade – 6.5 MVA full-electric hospital expansion project
9. Hume – multiple data centres
10. Tuggeranong Town Centre – Aspen Development, 2,000m2 commercial space and 622 residential units

7.5.1.3 LARGE SCALE EMBEDDED GENERATION PROJECTS

A number of consumers have submitted Embedded Generation Special Connection Request (SCR) forms to Evoenergy, and are in various stages of the connection process. Evoenergy considers all embedded generation over 1.5 MW to be connected to the network to be large scale. The following projects are currently under consideration[21]:

1. A 5 MW Battery Energy Storage System in the Molonglo Valley[22]
2. An expansion of a landfill gas generator from 4 MVA to 20 MVA including a potential battery energy storage system

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

In addition to this, the ACT Government is looking to implement 250 MW of batteries as part of the *Big Canberra Battery*[23]project. The ACT Government is still in the planning stages for this project and Evoenergy does not yet have information on how these batteries may interact with the ACT electricity network.

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

[21] Note: Backup generators have not been included in this summary

[22] More information can be found in Section 7.6.1

[23] https://www.environment.act.gov.au/cc/big-canberra-battery

Table 13. Network limitations

				MVA Required (cumulative)**					Dates					
Location	**Network Element**	**Limitation**	**RIT-D**	**2022**	**2023**	**2024**	**2025**	**2026**	**Consult**	**Decision**	**Required**	**Estimated Cost*** **	**Project Driver(s)**	**Project Reference**
Dickson - Dooring St	Feeder	Capacity	No	0.4	1.5	2.8	4.1	4.1	Dec-19^	Jun-20	Feb-22	$3.8m	See section 7.5.1.2.3	See section 7.6.3
Braddon – Donaldson St	Feeder	Capacity	No	-	-	1.0	2.1	3.9	Jun-22	Dec-22	Jun-24	$2.5m	See section 7.5.1.2.3	See section 7.8.3
Molonglo Valley	Zone Substation & Feeders	Capacity	Yes	4.7	11.8	19.0	23.4	24.3	Mar-20	Jun-20	Jun-22	$13.7m	See sections 7.5.1.1.4, 7.5.1.2.5	See section 7.6.1 & 7.6.2
Strathnairn	Feeder	Capacity	No	-	-	0.4	1.4	2.4	Jun-22^	Dec-22	Jun-23	$2.4m	See section 7.5.1.1.1	See section 7.8.1
Pialligo	Feeder	Capacity	No	6.0	7.8	7.8	8.5	8.5	Dec-21^	Mar-22	Dec-22	$4.8m	See section 7.5.1.2.5	See section 7.8.4
Belconnen Town Centre	Feeder	Capacity	No	-	1.0	2.6	4.1	4.1	Dec-22	Mar-23	Dec-23	$1.3m	See sections 7.5.1.1.2, 7.5.1.2.2	See section 7.8.2
Fyshwick	Feeder	Capacity	No	4.0	3.0	31.0	31.0	31.0	Jun-21	Dec-21	Dec-23	$5.5m	See sections 7.6.5	See sections 7.6.5
Mitchell / Gold Creek	Zone Substation	Capacity	Yes	19.0	22.0	25.0	28.0	32.0	Dec-21	Jun-22	Jun-24	$6.2m	See section 5.2.1	See section 7.6.4
North Canberra	Transmission	Voltage	No	-	-	-	-	-	Jun-22	Dec-22	Jun-24	TBC	See section 4.2	See section 7.6.4
Kingston	Feeder	Capacity	No					2024-29 period					See section 7.5.1.2.6	See section 7.9.4
Lyneham	Feeder	Capacity	No					2024-29 period					See section 7.5.1.2.3	See section 7.9.5
Phillip	Feeder	Capacity	No					2024-29 period					See section 7.5.1.2.7	See section 7.9.6
Strathnairn	Zone Substation	Capacity	Yes					2024-29 period					See section 7.5.1.1.1	See section 7.9.3

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

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

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

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

Table 14. Locations where constraints are no longer applicable

Location	Reason for Revision
Gungahlin Town Centre	Valley Feeder project complete

7.6 Projects Currently In-Progress

7.6.1 Molonglo Zone Substation

The Molonglo Valley District is a greenfield development area situated in Canberra's west, approximately 10 kilometres from the Canberra central business district (CBD). Over the next 30 years, the area, as one of the major urban growth corridors in Canberra, will be developed into the new suburbs of North Weston, Coombs, Wright, Denman Prospect, Whitlam, and Molonglo[24].

Land releases and development have already commenced in parts of the Molonglo Valley, with several new suburbs established. Land releases between 2020 and 2024 will support an estimated 4,357 residential dwellings in addition to a shopping centre, schools, commercial areas, and community facilities.

Initial 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 Whitlam commenced construction in 2019 with the first houses energised in 2021. Initial supply to Whitlam will be provided by the Black Mountain feeder from Civic Zone Substation.

Throughout 2020 and 2021 there were some delays to the anticipated land release in Whitlam, however there was a significant acceleration of construction in Denman Prospect, shifting the anticipated constraint further west.

In the short term there is a rapidly approaching constraint in the 11 kV distribution network. Peak demand is forecast to exceed the combined thermal capacity of the existing 11 kV feeders supplying the area by Winter of 2022. Over the longer term, the load in the Molonglo Valley will be sufficient to fully utilise a large zone substation with multiple transformers. This proposed Zone Substation is known as the Molonglo Zone Substation.

The Regulatory Investment Test for Distribution (RIT-D) was completed for the Molonglo Zone Substation project in 2020.

Evoenergy's assessment of permanent options covers both the feeder constraint and constraints on the zone substations that either currently or potentially in the future may supply the Molonglo Valley.

The tables below present forecast maximum demand for the central forecast scenario for winter and summer. Red values indicate demand is greater than the winter (23.4 MVA) or summer (20.9 MVA) thermal capacities of the existing 11 kV feeders. Although the constraint was initially expected in Summer of 2021 this was not realised for a number of reasons including the re-rating of the Black Mountain feeder, an unusually mild Summer and delays in load coming online in Whitlam.

Table 15. Maximum Demand Forecast – Winter (MVA)

Scenario	2021	2022	2023	2024	2025	2026	2025
Base	50	20.0	25.3	28.9	31.0	32.5	33.6

Table 16. Maximum Demand Forecast – Summer (MVA)

Scenario	POE	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
Base	50	16.7	21.6	24.8	26.7	28.0	29.5

[24] Coombs, Wright, Denman Prospect, Whitlam and North Weston are partially constructed. Construction is either in the early stages or not commenced at the other suburbs listed.

The first stage of the preferred network option is to relocate Evoenergy's mobile substation (MOSS), which is a skid-mounted 132/11 kV setup with 15 MVA transformer capacity, and to install two new feeders from the MOSS to the Molonglo Valley load centre. The first stage also includes civil works to establish the zone substation site, including space for the future permanent transformers and switchgear that will be installed in stages 2 and 3.

To enable the delivery of electricity from the substation to loads in the Molonglo Valley, Evoenergy will install new underground 11 kV cable feeders (including the undergrounding and reconfiguration of a section of the Black Mountain feeder) from the Molonglo zone substation during 2021-24 as well as an extension and reconfiguration of the Streeton feeder to supply Denman Prospect from the new zone substation.

Stages 2 and 3 are expected to occur after 2025 and are to address long-term zone substation transformer constraints in the Molonglo Valley. Additional feeders will be installed during stage 2 as this stage will add additional 11 kV switches to enable more feeders to be connected to the zone substation. The timing of all three stages will be continually reviewed based on updated actual and forecast load.

The total cost of this option is $31.2 million or $27.8 million in present value terms.

Figure 31. Evoenergy's 132 kV transmission lines and proposed Molonglo Zone Substation Site

Evoenergy's initial assessment of non-network solutions for the Molonglo Valley area found two credible non-network options. These were both based on the use of batteries to temporarily defer investment in a network augmentation. Option 1 involves two or more batteries located within the Molonglo Valley District near the load centre. This could include residential batteries aggregated by a Virtual Power Plant (VPP) scheme and controllable loads or larger more centralised batteries. Option 2 involves a single large battery located at or near the future Molonglo zone substation site. Option 2 requires Evoenergy to complete initial civil works at the future zone substation site and a feeder extension to connect the site, so the deferral value of this option is lower than for Option 1.

The potential credible options assumed that a battery or batteries will be installed with a primary purpose that is not to support Evoenergy's network. Examples of additional investment drivers include as part of a larger energy investment project, due to a government program obligation, for wholesale electricity price arbitrage, participation in the FCAS market or as part of a back-up system for an electricity user. The majority of the battery's value will likely come from these additional purposes, with network support payments from Evoenergy providing an additional revenue stream. Evoenergy undertook a preliminary evaluation of a wide range of non-network options for Molonglo such as demand management and embedded generation. These services were assessed as less likely to deliver a credible non-network solution for the Molonglo constraint.

Evoenergy received three submissions from non-network providers in response to the Non-Network Options Report. Of these submissions one, proposing a Battery Energy Storage System (BESS) at the future Molonglo Zone Substation site was considered compliant and is considered the recommended option.

The implementation of the BESS will be undertaken in two stages. Stage 1 involves a 4.95 MW connection capacity in operation by Winter 2022, while stage 2 involves the full capacity. The timeline for Stage 2 is to be confirmed. The second phase of the BESS is currently not required for the identified need but is proposed by the non-network provider to derive additional revenue from the wholesale and FCAS markets.

The BESS is to be located adjacent to the future Molonglo zone substation site and specifically adjacent to the Black Mountain feeder. Connections to the Evoenergy network will be via underground cables. This solution aligns with non-network option 2 from the NNOR and meets the identified need to defer network investment of the Molonglo zone substation to at least 2023 under a base POE50 scenario.

Enablement of this Stage 2 of this solution is underpinned by Evoenergy undertaking construction of an 11 kV switching station and extension of the Streeton feeder to the BESS.

There have been significant delays to this project due to difficulties in obtaining access to the land for the zone substation. Evoenergy is working closely with the ACT Government to resolve these issues and begin construction.

Detailed information on the RIT-D including the full Non-Network Options Report and Final Project Assessment Report can be found on Evoenergy's Website[25].

Interacting with this project, as part of the proposed residential developments, the Suburban Land Agency has requested the replacement of sections of two Evoenergy 132 kV 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-2022
- Stage 2: Civic–Woden line section approximately 2030.

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

7.6.2 Supply to Whitlam

Due to delays in the construction of the Molonglo Zone Substation and associated non-network solution due to difficulties in procuring and accessing the allocated land Evoenergy had to consider deferring the requirement for a BESS or Zone Substation using minor augmentation.

The following two options were considered for this purpose:

Option 1: Extend Belconnen Way South feeder from Springvale Drive to William Hovell Drive after transferring load to neighbouring 11kV feeders.

Option 2: Extend Weir feeder from Hawker to Sub11389 in Whitlam along William Hovell Drive after transferring load to neighbouring 11kV feeders.

Table 17. Options and Evaluation Summary

Ref	Option type	Total indicative cost ($ millions)	Evaluation Summary
1	Extend Belconnen Way South feeder	1.32	• Defer Molonglo ZSS construction completion to June 2023 • As per thermal ratings, 5.6MVA capacity available in winter • Feeder route has less environmental complications • Provide some flexibility if the BESS is delayed
2	Extend Weir feeder	2.16	• Defer Molonglo ZSS construction completion to June 2023 • As per thermal ratings, 6MVA capacity available in winter • Feeder route will be affected with William Hovel Dr expansion project and higher environmental complications.

Option 1 is the recommended option due to lowest cost. The forecasted loading of Streeton, Black Mountain and Hilder feeders is expected to exceed thermal capacity of both Black Mountain and Hilder feeders by summer 2022. Option 1 will defer exceedance of the thermal capacities of those feeders until winter 2023 as shown in Table 6.

7.6.3 Supply to Dickson

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

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

Evoenergy has considered two options to supply the additional load as follows:

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

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

Option 2 considers non-network initiatives including:

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

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

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

This feeder project interacts with the Haig feeder extension (completed) and the Donaldson feeder project outlined in section 7.8.4 which together form part of a master plan for the area.

The Dooring Feeder is currently under construction and expected to be energised in February 2022.

7.6.4 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 coincident peak spare capacity in existing 11 kV feeders to the area and insufficient coincident peak spare capacity in the two nearest zone substations at Gold Creek and Belconnen.

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

Ref	Option type	Description
1	Network	Install the 3rd transformer at Gold Creek Zone Substation
2	Non -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 11 kV 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 132 kV/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. The current estimated maximum transfer capacity is no more than 18.5 MVA.

Evoenergy is currently undertaking a detailed technical study to determine the interaction between the capacity constraints and quality of supply constraints in the area which will lead into a RIT-D for this project to be concluded in the 2021/22 financial year.

7.6.5 Feeders from East Lake Zone Substation to Fyshwick Zone Substation

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

The proposed cable route length from East Lake to Fyshwick is approximately 2.7 km.

Estimated cost is $5.51 million. Proposed project completion is by December 2023.

7.6.6 Other Projects currently In Progress

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

- 132 kV Transmission line relocations in the 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. This project is in the construction phase with forecasted completion in September of 2022. This project is entirely customer funded.
- Proposed Harman 132/11 kV Zone Substation and 2.2 km of 132 kV overhead transmission line to supply increased load in the surrounding area. This is a customer-initiated project entirely funded by the external parties. Negotiation for customer agreement and for procurement contracts are underway with planned completion of construction by September 2023.
- Denman 1B - 2E1, 2E2, 2E3 & 2E4 - Reticulation (HV & LV) for residential development are in progress with energisation expected June 2022
- Denman North - Reticulation (HV & LV) for residential development are in progress with energisation expected Sep 2022.
- Jacka stages 1,2 & 3 - Reticulation (HV & LV) for residential development are in progress with energisation expected Dec 2022.
- McNamara - Reticulation (HV & LV) for residential development are in progress with energisation expected Dec 2022.
- Whitlam 3 3A - Reticulation (HV & LV) for residential development are in progress with energisation expected Dec 2022.
- Weston blk 1 sec 82 - Reticulation (HV & LV) for residential development are in progress with energisation expected Dec 2022.
- Supply upgrade (11kV, 2 additional feeders from Woden ZS) of Canberra Hospital at Garran – customer funded – Design works are in progress with planned completion of the project by Dec 2022.
- New Supply (2 x 11kV feeders from East Lake ZS) to Data Centre in Airport Precinct – Only design works commenced with customer's firm commitment with anticipated completion of the project by early 2023.
- Causeway SWS decommissioning & 132kV & 11kV relocation at Kingston Area (100% funded by Customer) - Only design works commenced with customer's firm commitment with anticipated completion of the project by early 2024.
- Embedded Generation (bio-generation) Large Scale (2 x 10MVA) connection (2 x 11kV connections with Gilmore ZS) connecting to the Gilmore Zone Substation (Proposed) – Customer negotiation just commence with customer's proposed timeline for completion in mid-late 2023.

7.7 Projects Completed

Significant projects completed during the year include:

- Security of Bulk Supply to the ACT – The connection of new Transgrid 330/132kV Substation at Stockdill Drive, West Belconnen to Evoenergy's network to provide additional security of supply to the ACT. The Substation was commissioned in December 2020. As part of this project Evoenergy constructed a new double circuit 132kV line from Stockdill to the Canberra-Woden 132kV line to form a Stockdill-Canberra circuit and a Stockdill-Woden circuit. This arrangement will provide the immediate 375MW back-up capability to the ACT in the event of a total loss of Canberra Substation.
- Supply to Gungahlin Town Centre – The construction of the Valley Feeder from the Gold Creek Zone Substation to supply approximately 7.6 MVA to developments in the Gungahlin Town Centre.
- Strathnairn 2A1, 2A2, 2A3, 2B, 2B3 – Reticulation (HV & LV) for residential development was completed for energisation in April 2021
- Whitlam 1 – 1A, 1B & 1C – Reticulation (HV & LV) for residential development was completed for energisation in 2021.
- Hume – Customer funded commercial development supplying a data centre requiring the construction of two 11 kV Bulk Supply Points and associated 11 kV feeders from Gilmore Zone Substation to supply 19 MVA of requested load. Completed in November 2020.
- Taylor 3 2A, 2B & 3 – Reticulation (HV & LV) for residential development was completed for energisation in 2021.
- Red Hill Precinct – Reticulation (HV & LV) for residential development was completed in 2021.

7.8 Proposed Network Developments

7.8.1 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 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.

In 2021 a customer constructed and energised a 2.66MW/5MWh BESS in Holt connected to the Latham Feeder. This BESS has interactions with this project as there is the potential to engage the customer for demand management services.

Estimated cost for extending the O'Loghlen feeder to the Strathnairn development is $3.0 million with proposed to commence in January 2023. The project timing has changed with the addition of demand management options in the area which can be utilised to reduce maximum demand and peak lopping of existing two feeders, Latham, and Macrossan. For further detail on demand management initiatives in the area please see section 9.5.

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

See section 7.9.2 for additional details.

7.8.2 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 a precinct of five proposed apartment buildings, and proposed development at the University of Canberra are driving residential growth, whereas proposed development of the Belconnen Trades Centre is driving commercial and light industrial growth.

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 new load centres	$1.3m	Preferred
2	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 new load centres. The length of the feeder would be approximately 1.5 km.

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

Estimated cost is $1.3 million and proposed project completion is by December 2023

7.8.3 Supply to Braddon

New 11 kV feeder from City East Zone Substation to Donaldson Street by December 2023 to supply new developments in the Canberra City North area. Estimated cost is $2.5 million.

The Canberra City North area, including Braddon and Reid suburbs, is experiencing significant load growth, driven by the ACT Government's Urban Renewal program.

This involves the demolition of many old residential buildings and their replacement with multi-storey apartment and commercial buildings. Further redevelopment of existing open carparks to high-rise commercial and residential buildings with basement carparks (e.g. Canberra Centre extension).

Evoenergy has considered 2 options to supply the additional load as follows:

Option	Option type	Description	Cost	Evaluation
1	Network	Construct a new 11 kV cable feeder from City East Zone Substation to Canberra Centre at the corner of Cooyong St and Donaldson St, Canberra City North.	$2.5m	Preferred
2	Non -network	Demand side management and embedded generation	N/A	Not preferred as does not meet need

Option 1 involves constructing a new 11 kV feeder from City East Zone Substation to Canberra Centre at the corner of Cooyong Street and Donaldson Street, Canberra City North. With the proposed network augmentation solution of construct new 11 kV cable feeder from City East Substation to Canberra Centre will fully mitigate the network capacity and unserved energy risks.

Option 2 Considers non-network initiatives including:

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

To defer the Donaldson feeder to the next regulatory control period (beyond 2024), it is estimated that non-network solutions would need to provide a maximum demand of approximately 1.7 MVA per annum.

Latent demand management within the existing customer base was investigated, with a maximum estimated capacity of 0.8 MVA. This does not meet the minimum capacity to enable the new feeder to be deferred.

7.8.4 Supply to Pialligo

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

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

This project proposes one new 11 kV cable feeder to be installed from East Lake Zone Substation and a spare conduit to be installed towards a new chamber substation on Scherger Drive. The proposed feeder from East Lake towards Brindabella Business Park is to meet the a growing customer demand. The length of the feeder is approximately 3.2 km. The spare conduit from East Lake will allow a future feeder to be installed to supply the forecast demand of the Fairbairn Business Park.

For supply security to the airport and the Fyshwick industrial area, two additional feeders are proposed from the East Lake towards Molonglo river. These feeders will cut into existing Airport and Pialligo feeders and supply these areas directly from East Lake in preparation for the upcoming decommissioning of Fyshwick zone substation.

Two switch stations are proposed to be constructed at the point where the new cables from East Lake meet the existing Airport and Pialligo feeders.

Other options considered include the installation of additional feeders from Fyshwick Zone Substation and demand management either to defer or remove the augmentation requirement. The feeders from Fyshwick were excluded due to a high net present cost (compared to the preferred option). Demand management was not considered feasible due to the insufficient existing capacity such that there is a requirement for 60% of new demand to be offset. The grid battery was excluded due to a higher net present cost and the relative certainty of the demand increase (noting grid batteries and other modular solutions deliver a higher options value in the context of uncertain demand).

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

7.8.5 Decommissioning of Causeway 132 kV Switching Station

Please note that this project is initiated and fully funded by the customer and hence timelines are dependent on the customer.

Causeway Switching Station located in the Kingston suburb at the eastern end of Lake Burley-Griffin, provides a point of 132 kV interconnection between City East, East Lake, Telopea Park and Gilmore zone substations. Connections to Causeway Switching Station comprise three 132 kV underground cable circuits to Telopea Park Zone Substation, a single circuit 132 kV overhead line to Gilmore Zone Substation, a single circuit 132 kV overhead line to City East Zone Substation, and a single circuit 132 kV overhead line to East Lake Zone Substation. Sections of these latter two lines traverse the Jerrabomberra wetlands nature reserve.

The site of Causeway Switching Station is surrounded by new apartment buildings and the Suburban Land Agency (SLA) has indicated their desire to redevelop the switching station site for similar residential purposes. The SLA has requested Evoenergy to convert the 132 kV overhead lines in the vicinity of Causeway to underground cables and decommission the switching station. The proposed scope of works is as follows:

- Install three 132 kV cable circuits comprising one single core cable per phase (each circuit 3 x 1c/630 mm2 Cu XLPE) from East Lake Zone Substation through the Jerrabomberra wetlands to Causeway Switching Station to through-joints to the existing Causeway–Telopea Park cable circuits. This route includes directional drilling under the Jerrabomberra Creek. This will create three 132 kV underground cable circuits all the way from East Lake to Telopea Park, each rated at 127 MVA. These existing circuits are currently transformer feeders as there is no 132 kV bus at Telopea Park Zone Substation. It is proposed to retain them as transformer feeders.
- The East Lake–Causeway 132 kV circuit is currently approximately 1.4 km underground cable connected to approximately 1.6 km overhead line. The cable section will be reconnected to the City East line and the overhead section demolished. This will create a new East Lake–City East 132 kV circuit rated at 220 MVA.
- The Causeway–Gilmore 132 kV circuit is currently all overhead. A 132 kV underground cable circuit comprising twin single core cables per phase (6 x 1c/1600mm2 Cu XLPE) will be installed approximately 2.9 km from East Lake Zone Substation to connect to the existing overhead line at a new three concrete pole UGOH structure to replace pole no T87 at the corner of Canberra Ave and Monaro Highway. This will create a new East Lake–Gilmore 132 kV circuit rated at 457 MVA.
- Causeway Switching Station will be subsequently decommissioned and dismantled.

Figure 32 shows the existing Causeway 132 kV Switching Station.

Figure 32. 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 however, it is likely to change as the timing is driven by SLA development program that is yet to be forecasted in this area.

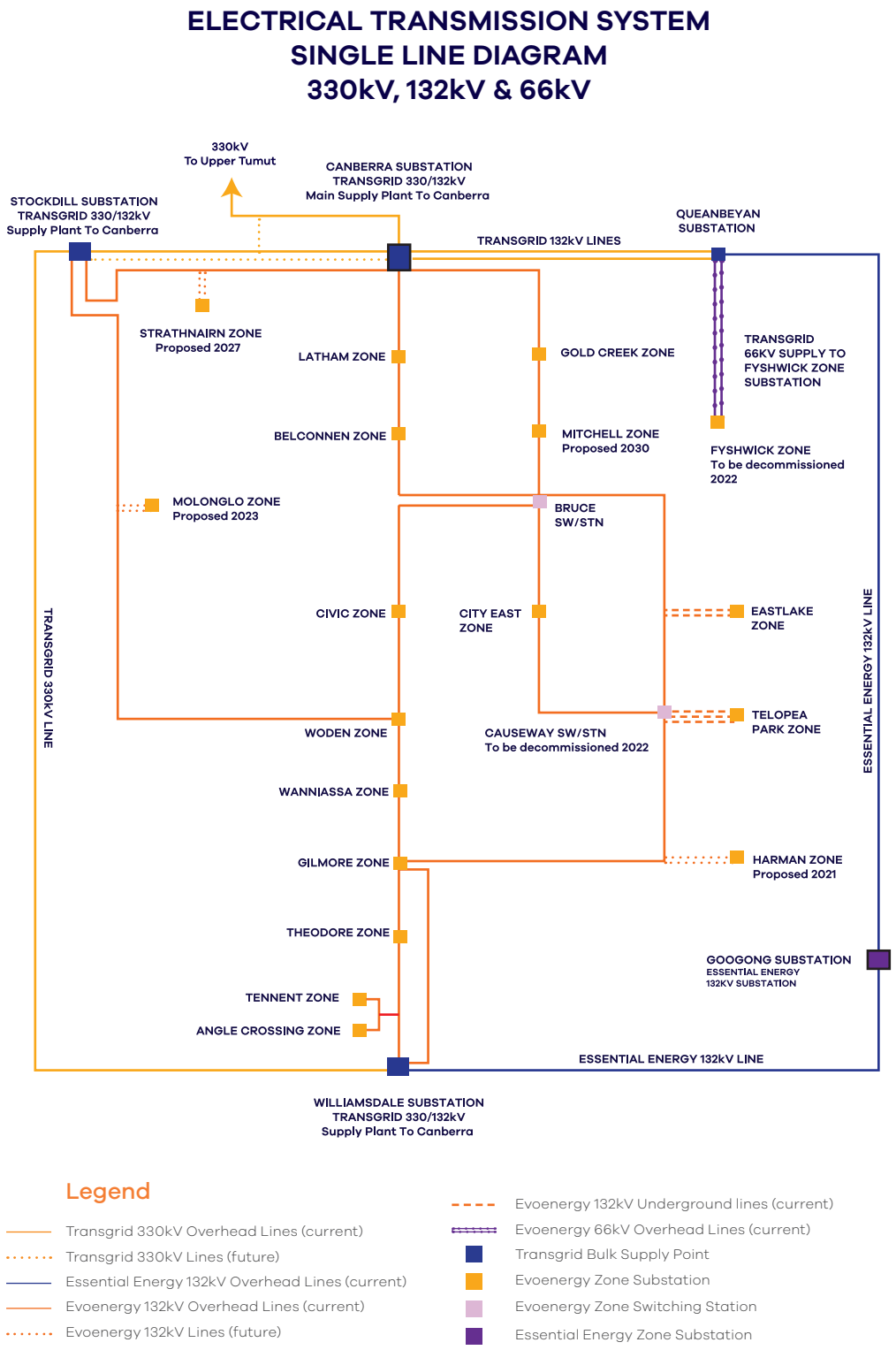
Figure 33 illustrates this proposed development.

Figure 33. Causeway Switching Station – Proposed 132 kV Cabling

7.8.6 Future Transmission Network

Figure 34 shows future development of thetransmission network over the next ten years.

Figure 34. Future (10 years) Transmission Network



7.9 Constraints Requiring Detailed Technical Studies

7.9.1 Contingency Voltage Support

During joint planning with TransGrid the voltage levels in the system under the special contingency condition were considered. Analysis showed that in the event of a total Canberra Substation outage, after Stockdill substation commissioning, voltage levels in the northern part of Evoenergy's network could fall below regulation levels.

In order for voltage levels to be maintained for this non-credible contingency event, Evoenergy has investigated the installation of reactive support equipment, with the most cost-effective solution being the installation of an 11 kV 10 MVAr capacitor bank at each of Evoenergy's northern zone substations.

Evoenergy is working closely with Transgrid to determine the best solution for this issue.

This potential constraint will continue to be kept under review due to the increased penetration of distributed energy resources including the large batteries proposed under the ACT Government renewables reverse auction process and other programs.

7.9.2 Strathnairn Zone Substation

When complete, Ginninderry is expected to have approximately 11,500 dwellings. 6,500 of these are proposed to be in the ACT and 5,000 in NSW. Latham Zone Substation is the closest for supply, however distances from Latham Zone to the later stages are expected to result in voltage regulation challenges. Currently there is provision for a new zone substation in the development, known as Strathnairn Zone Substation. Further studies need to be conducted to understand the full range of options available to supply later stages of the development.

7.9.3 Supply to Kingston

There are several major residential, commercial and community developments planned for the Kingston Foreshore area in the next 5-10 years. These include the Kingston Arts Precinct and the Causeway development. Most of these developments currently have unclear timelines. The Telopea Park Zone Substation is the closest Zone Substation to these developments; however it does not have sufficient capacity or available circuit breakers.

This proposed feeder would transfer load from Telopea Park Zone Substation to East Lake Zone Substation. It is expected that this feeder will be required in the 2024-2029 regulatory period. As the details of these developments become clear Evoenergy will perform the necessary detailed technical studies.

7.9.4 Supply to Lyneham

The Lyneham area is anticipated to experience significant growth with new mixed developments in the Yowani & Thoroughbred Park areas. It is expected that a new feeder will be required to supply this load from Civic Zone Substation, as the closer Zone Substation, City East, has limited capacity and available circuit breakers. The feeder would be approximately 5km long and is expected to be required in approximately 2026. As the details of these developments become clear as well as the results of the Gold Creek RIT-D this feeder will undergo detailed technical studies.

7.9.5 Supply to Woden/Phillip

It is anticipated that a new 11kV feeder will be required from Woden Zone Substation to Callam St Phillip in the Woden Valley to supply new developments in the area as Woden undergoes urban intensification. Woden is expected to experience significant load growth in the coming years as Stage 2 of the Canberra Metro light rail is constructed which is expected to trigger significant growth in the area. Woden is also expected to have a new electric bus depot supplied from Wanniassa Zone Substation.

It is expected that this feeder will be required in the 2024-2029 regulatory period. As the details of these developments become clear Evoenergy will perform the necessary detailed technical studies.

7.10 Regulatory Investment Test

Under NER projects above $6 million funded by Evoenergy are subject to regulatory investment test. There were no regulatory investment tests completed in 2021, however in 2020 Evoenergy completed at RIT-D for the Molonglo Zone Substation and the resulting project is ingoing. Subject to the outcome of detailed technical studies, currently the network limitations identified during the planning review include two additional limitations which are likely to require regulatory investment test: Gold Creek/ Mitchell and Strathairn. The RIT-D for Gold Creek is planned to be completed in the first half of the 2022 calendar year.

Chapter 8: Demand Management

8.1 Overview

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

Historically, DM has been focused on addressing network constraints resulting from a growth in demand using 'non-network' options. These options are increasingly capable of being leveraged to address additional constraints, such as thermal or quality of supply issues, resulting from increased DER penetration. The drivers of network constraints, including DER, are outlined in Chapter 4 and Chapter 5.

Effective application of DM can defer the need to augment parts of the network to address constraints. This reduces the capital costs of assets and leads to lower costs to consumers. Evoenergy intends 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.

We encourage all customers interested in participating in demand management to engage with Evoenergy through the pathways outlined in Chapter 1.

8.2 Demand management challenges

There are a number of challenges for both Evoenergy and proponents of demand management that affect the proliferation of DM within the network. Some of the key challenges for Evoenergy include:

- **Identification of need** – the ability to identify the demand management opportunities driven by factors impacting future network development (as outlined in Chapter 2) with sufficient time to establish a non-network solution. This is especially evident on small-to-medium scale constraints where the timeframe from need identification to implementation is reduced
- **Communication of need** – communicating the constraint and relevant information to proponents in a way that is targeted, timely and effective to enable proponents to engage with DM opportunities
- **Availability of options** – there are a limited number of established DM options that can be deployed in targeted network locations where a localised constraint is identified
- **Commercial considerations** – the implementation of technology-based DM requires robust commercial arrangements where the proponent is satisfied and Evoenergy ensures that risks related to the safe, reliable, and secure management of the network are appropriately managed
- **Regulations** – the regulatory framework restricts Evoenergy's ability to effectively deploy some DM solutions to address network constraints. The review of the framework and associated market rules currently being performed by governing bodies may address these challenges or pose additional regulatory challenges.

Some of the current challenges for proponents of DM solutions include:

- **Cost** – the cost of technology-based DM solutions and establishment remains prohibitive for a number of scenarios, such as community batteries
- **Assurance of Investment** – proponents of DM solutions want to minimise the risk to returns on invested capital. This is difficult with potential changes to market structures occurring in over the medium term[26].
- **Technology** – although technology is evolving rapidly, a number of DM-capable solutions are yet to mature or adhere to common standards required for application. This is expected to change in the near term.

Evoenergy is working to address these challenges and maintaining an awareness of the challenges facing proponents to ensure that the full scale of DM options is addressed against network needs.

8.3 Demand management initiatives

Evoenergy have several existing mechanisms to promote demand management and address key challenges as outlined below:

Need identification

- Planning processes for the distribution network consider non-network options within business cases and project justification reports. This provides assurance that the optimal solution is identified and overall cost benefit impact for both network and non-network options are evaluated
- Proactive engagement with consumers in large greenfield estates, such as Ginninderry, have resulted in DM solutions being implemented.

Communication

- Evoenergy has developed a Demand Side Engagement Strategy (DSES) that is published on our website[27]. This strategy outlines the approach to building and promoting constructive working relationship between Evoenergy and non-network solution providers
- Forecast network constraints are published in the Annual Planning Report (Chapter 7)
- Evoenergy maintains a Demand Side Engagement Register[28] where network service providers can register as an interested party
- We maintain direct engagement with major customers to identify and implement DM solutions where required.

Availability of Options

- Through arrangements with aggregators the use of virtual power plants to address network constraints is developing wider coverage across the network – investigating and testing options to
- Evoenergy engages in a number of DM innovation projects, as outlined below, to support the development and application of non-network options

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Commercial Considerations

- Evoenergy have established contracts with aggregators and is increasingly engaging more proponents in the DER Aggregation program
- Large customers have been engaged under DM contracts to reduce peak demand.

Regulations

- Evoenergy maintains active participation in industry bodies to support advocacy in pursuit of the national electricity objective
- Our network management processes include maintaining visibility of, and responding to, rule change proposals and consultations from electricity governing bodies such as the AEMC, AER and AEMO as well as jurisdictional bodies such as the UTR and ICRC that address regulatory barriers associated with DM implementation.

[26] Energy Security Board post 2025 market review http://www.coagenergycouncil.gov.au/energy-security-board/post-2025

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

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

These mechanisms are supported by a number of projects demonstrating application of different demand management solutions on the network:

- **Ginninderry Residential Battery Trial** - exploring the DM capabilities of smart residential battery systems in managing local network constraints in this fully electric, 100% solar uptake greenfield developments
- **Molonglo RIT-D** - a greenfield development where load is rapidly approaching network capacity and a battery energy storage system has been assessed as a credible option as a result of the RIT-D process
- **DER Integration and Automation Project** - investigating and testing options to effectively integrate DER into the energy system and enabling consumer utilisation of DER to their full potential
- **Peak Demand Tariffs** – Peak demand tariffs were introduced as the default option for customers with smart meters in December 2017. Uptake has been monitored and will be analysed for resulting DM effects.
- **Tariff Trials** – As the uptake of battery technology (both residential and large-scale) increases, these trials aim to explore the suitability of highly cost reflective tariffs for customers with batteries and modern energy technologies. The tariffs are designed to provide energy customers who have batteries with sharper pricing signals, and the opportunity to better manage their load on the network and their network bill. This includes sending customers a price signal about the costs of importing and exporting energy at peak and non-peak times and incentivising efficient use of the distribution network. This has the potential to improve network utilisation and allow for the efficient integration of DERs, as battery technology becomes more widespread.

Chapter 7 and Chapter 9 contain additional details regarding these projects

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8.4 Demand Management Future

Evoenergy is committed to continue actively seeking to implement non-network solutions to replace or complement the need for network investment where this delivers a lower cost outcome that benefits all consumers.

In addition to the existing mechanisms Evoenergy is currently employing to develop our interaction with consumers and DM proponents, we are aiming to:

- Enhance our publication of network constraint reporting by developing our ability to identify network constraints, including those originating from DER, and publish these to proponents
- Grow our DER aggregation program both by supporting consumer uptake of DER and by engaging DER aggregators to provide DM and data services. Under the Next Generation Energy Storage program (Next Gen)[29], the ACT Government is supporting up to 5,000 battery storage systems in ACT homes and businesses. To be eligible for the program, battery systems are required to have the capability to send real-time data to the ACT Government. This is usually achieved through capabilities provided by a DER aggregator. Evoenergy is actively engaging with Next Gen providers with the intention of growing the Aggregation program by procuring data and DM services, especially in areas where a network need is identified
- Invest in, prepare for, and leverage future technologies. Through strategic initiatives and innovation projects, Evoenergy is ensuring that the DM opportunities presented by these technologies are effectively leveraged to manage network constraints. Additional detail regarding current innovation projects is included in Chapter 9
- Further advocacy and engagement with stakeholders. Evoenergy is proactively engaging with local government to identify upcoming DM opportunities such as land releases, urban infill incentive schemes and changes to government policies.
- Review the network tariff structures to ensure they incentivise efficient use of the network to help integrate increasing numbers of batteries, solar, electric vehicles and other DER related technologies.

Evoenergy aims to utilise the outcomes from these activities to develop a DM toolkit that supports existing planning and operational processes to facilitate the application of DM on the network.

[29] https://www.actsmart.act.gov.au/what-can-i-do/homes/discounted-battery-storage

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 advances are impacting all parts of the supply chain and are offering opportunities for us to change the way we design, construct, and manage the Evoenergy network. This chapter provides additional detail for the key activities we have undertaken to leverage technology and provide benefit energy consumers in support of Evoenergy's business strategy and strategic initiatives.

9.2 Substation Automation Systems – IEC 61850

As outlined in Chapter 6, Evoenergy is currently working on upgrading the substation automation systems for numerous Zone Substations across the ACT. These systems will utilise the latest industry developments in protection and SCADA technology and will be based on the IEC 61850 international standard. The IEC 61850 standard provides tools which assist in the implementation of substation automation systems including communications protocols that allow Intelligent Electronic Devices (IED) such as protection relays to exchange high speed messages and standard data structures that allow IEDs from different vendors to be easily integrated.

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

Safety benefits

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

Financial benefits

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

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9.3 Advanced Fault Detection and Auto-Reclosing Schemes

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

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

This technology sends a low energy pulse of current down the line to detect if the fault has cleared before initiating a reclose operation. This significantly reduces the amount of current during reclosing and thus reduces the possibility of a resulting bushfire.

This also reduces the possibility of damage to cable sections of a feeder. Evoenergy and the switchgear supplier have jointly developed a Voltage supervised Sensitive Earth Fault (V-SEF) protection "bushfire algorithm" that will detect very low energy earth faults to isolate and clear such faults. Such faults are typically caused by vegetation contacting overhead conductors and can cause localised heating that could lead to a bushfire.

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

9.4 Virtual Power Plants (VPPs)

A Virtual Power Plant (VPP) consists of a combination of several small-scale distributed energy resources, such as rooftop solar photovoltaic 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. Leveraging these smart Distributed Energy Resource (DER) technologies to efficiently manage and operate the network would be critical as Evoenergy evolves into a Distribution System Operator (DSO).

Evoenergy has undertaken a number of VPP trials with DER aggregators. The trials attempted to orchestrate solar PV generation and battery storage to provide support to the network when energy demand is at the maximum, typically on extremely hot or cold days. The VPPs were also used to investigate innovative techniques to value add to the functionality of the DER in the network to manage power quality issues that end users, the consumers, were reporting.

In the past year, the fleet of DER available for VPP operations has increased by 30% as additional consumers in the ACT opted for solar and battery solutions at their residences. This meant Evoenergy has a wide array of devices and combinations of inverters and batteries to test the functionality of network support from consumer residences and observe the typical usage pattern of consumers based on the data reported back from the devices. The fleet is expected to continue to grow in the future.

Evoenergy is using the lessons learnt from aggregator operations to form the basis of targeted network trials to leverage DER/VPPs to tackle the upcoming challenges for the local network. Evoenergy's approach is to transition the trial to business-as-usual based on the amount of DER installed in parts of the network where they can help alleviate network congestion. VPP trials are expected to continue to run as the DER and VPP space is evolving, both from regulatory and market design perspectives.

9.5 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 obtained a Territory Plan Waiver from the ACT Government's Environment, Planning and Sustainable Development Directorate (EPSDD) to allow Stage 1 of the development to be built without gas reticulation to its residents – making it the first ACT neighbourhood to be fully electric with 100% of dwellings having solar PV systems.

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 Distributed Energy Resources (DER) aggregators who can install Home Energy Management Systems (HEMS) at the residences, which can integrate with Evoenergy for network support 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. In line with this objective, in September 2020, Evoenergy received a grant from the ACT Government under the Renewable Energy Innovation Fund (REIF) for the Ginninderry Residential Battery Trial. This grant is being used to provide further subsidies for residential batteries in Stage 1A of the development, in addition to the Next Gen Battery rebates. The Trial is aimed at exploring how HEMS enabled residential battery systems can be leveraged to manage the local network in this fully electric, 100% PV penetration scenario.

Power system modelling has indicated that 100% PV penetration will likely cause undesirable voltage fluctuations due to the difference between the extremes of peak export in the summer months and the peak consumption period in the winter months (which is further exacerbated by the consumers not having access to gas supply). These fluctuations can be managed by adjusting the transformer 'taps' to keep the voltage in the acceptable range. Stage 1 of Ginninderry has been developed by installing automatic On-Load Tap Changer (OLTC) substations and other combinations of technologies are to be trialled in subsequent stages.

Once the construction / installation of the relevant infrastructure is completed, the Ginninderry EPP will provide vital real-time information to the Ginninderry Joint Venture and Evoenergy to inform future stages of Ginninderry and other developments exploring emerging energy options for neighbourhoods and communities.

The EPP is the outcome of two years of work between the Ginninderry JV, Evoenergy, energy retailers, product suppliers, research institutions, the 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. Evoenergy considers optimum network and non-network solutions for Ginninderry development and from the network capacity limitations perspective it is also discussed in Chapter 7.

9.6 DER Integration and Automation Project

The DER Integration and Automation Project investigated and tested options for how DER can effectively integrate into the energy system and how they can be used by consumers to their full potential. The project demonstrated how collaboration between a Distributed Energy Resources Management System - DERMS (Schneider Electric's DERMS) and a DER marketplace (GreenSync Decentralised Energy Exchange - deX) platform could unlock existing network hosting capacity to enable consumers gain more value from their energy assets such as solar, batteries and electric vehicles. The project was co-funded by the Australian Renewable Energy Agency (ARENA) with Evoenergy as the lead party on the project along with partners including Schneider Electric, GreenSync, and Withywindle (knowledge sharing partner).

The goal of the DER Integration and Automation project was to simulate the utilisation and control of DER to ensure that the network is maintained within technical limits. This would allow for deferral of grid augmentation investment and at the same time increase network capacity to host more DERs.

The DER Integration and Automation Project was completed in 2021 and a high-level summary of the outcomes are detailed below

a. The project successfully integrated the IoT Hub and EcoStruxure ADMS v3.9 which included the enhanced DERMS module platforms to understand the impact of high penetration of DER and the possible constraints that would be caused by such DER uptake.
b. The project demonstrated that market operators can be given visibility over distribution level impacts of their intended calls on the DER within a specific geographical location to ensure that actions by retailers or aggregators in response to spot price hedging or VPP calls do not cause network constraints in the distribution network. This in turn would assist in maintaining reliability in the electricity network as well as protecting system security.
c. The project confirmed that DNSPs can showcase optimising the operations from DERs through increasing the visibility and intended operations from DERs via planned schedules and proposed dynamic limits through the integration of deX platform through the IoT Hub and the DERMS platforms.
d. The project successfully showcased that flexibility of DER exports can be coordinated and actioned by network management platforms and DER market and aggregator platforms.
e. The API integration provides a pathway and capability of ingesting network limits from network management systems via an IoT Hub integration.
f. The project verified that NSPs now have a viable alternative to investment in the low voltage and medium voltage network in comparison to the traditional network asset option. If the project is implemented in a production environment, DER operators will be able to invest and deploy DER with greater confidence with the knowledge of network limitations being applied in uniform and appropriate manner without holistic changes in their operations and capabilities.

9.7 Tariff Trials

Undertaking tariff trials is a continuation of Evoenergy's Tariff Structure Statement (TSS) strategy and allows Evoenergy to future-proof its tariff structure, so that it is ready to accommodate a growing number of consumers with batteries, solar, electric vehicles and other advanced energy technologies.

These tariffs will help consumers manage their network bills, improve network utilisation, and reduce long-term costs while helping support a safe and reliable electricity distribution network. The design of the tariff trials has been informed by close engagement with consumers (including consumer groups and large-scale battery proponents) and retailers.

Evoenergy is currently trialling two tariffs - a Residential Battery Tariff and a Large-Scale Battery Tariff.

1. Residential Battery Tariff

The residential battery tariff structure has been specifically designed with 'prosumer' residential customers in mind. These are customers who may have a home energy management system (HEMS) and can use this technology to automatically respond to network price signals, with little or no ongoing input from the customer.

This technology also provides a mechanism for Evoenergy to send sharper, more cost reflective price signals since the HEMS device will primarily be responsible for optimising import/export behaviour on the customers' behalf. This allows customers who respond, to access lower network bills associated with their efficient use of the network.

2. Large Scale Battery Tariff

   The purpose of the large-scale battery tariff trial is to test new charging arrangements that give recognition to both the costs and benefits of large-scale batteries and encourage their efficient participation in the distribution network.

   The sophisticated nature of their connections means that large scale batteries are uniquely placed to respond to highly cost reflective price signals and contribute to improving network utilisation. In turn, improving network utilisation may require large scale batteries to respond differently depending on where in the distribution network they are located (i.e. in a commercial or residential area).

Evoenergy is committed to collaborating with the AER, consumers and retailers as these tariff trials progress. Further engagement on tariffs is taking place as Evoenergy develops its Tariff Structure Statement (TSS) for the 2024-29 regulatory period. Engagement and feedback from stakeholders will help inform and drive the development of tariffs which will allow consumers to make informed decisions about how and when they use the electricity network, while enabling an equitable distribution of network costs through tariffs to meet consumer needs and preferences.

9.8 Innovation Projects

In addition to the targeted activities outlined above, Evoenergy is currently engaged in several innovative projects that will help shape the future working and operation of our business. These projects are in conjunction with universities, private enterprises, retailers, and other network providers who are investigating options to maximise the consumer benefit of the existing infrastructure while unlocking the value generated by consumers. These projects enhance the capabilities of Evoenergy to transition into a Distribution System Operator (DSO) in line with our strategy.

Table 18 outlines some of the key projects we are currently involved in and their proposed timings.

Table 18. Innovation Projects

Innovation Projects	Timing	Details	Website
Realising Electric Vehicle to Grid Services (REVS)	2020- 22	Demonstrate the economic, technical, and social case for leveraging V2G (Vehicle to Grid) services within the electricity grid, and reduce the complexity and confusion for consumers, business, and policy decision-makers. The deployment of the systems and capabilities outlined by the project, as well as the research and analysis from all parties will provide the roadmap for accelerated V2G adoption both in ACT and nationally	Link
DER Lab Project	2019- 22	Establish a test facility at the Australian National University to allow for safe testing of new DER-based technologies, market participation software and other innovative new products under development.	Link
Community Energy Models	2019- 21	Investigate community energy models, where distributed generation, storage and load are not co-located behind a single metered, connection point. Through this work, the project aims to provide the basis for greater adoption and deployment of community energy models both in Australia and around the world.	Link

Innovation Projects	Timing	Details	Website
DER Lab Project	2019- 22	Establish a test facility at the Australian National University to allow for safe testing of new DER-based technologies, market participation software and other innovative new products under development.	Link
Community Energy Models	2019- 21	Investigate community energy models, where distributed generation, storage and load are not co-located behind a single metered, connection point. Through this work, the project aims to provide the basis for greater adoption and deployment of community energy models both in Australia and around the world.	Link
Ginninderry Residential Battery Trial	2021-24	Develop and implement capabilities for managing demand in fully electric developments and/or areas with high solar PV uptake. With the support of the Ginninderry Joint Venture and the ACT Government's Renewable Energy Innovation Fund, Evoenergy is offering residents of selected blocks within Ginninderry Stage 1A an exclusive offer to receive a subsidy on eligible battery storage systems. This is enabling Evoenergy to collaborate with battery owners to alleviate network congestion. This project will play an important role in helping evolve the way we manage peak demand and excess solar generation on the network and ensure our energy network continues to be resilient, reliable, and cost efficient well into the future.	Link
EVGrid Trial	2021-23	Develop and demonstrate demand management (DM) capabilities required to efficiently manage peak electricity demand from residential electric vehicle (EV) charging in line with consumer expectations. Evoenergy is collaborating with EV owners in the ACT to test the concept of managing EV charging dynamically with real-time assessment of available network capacity. This project aligns with Evoenergy's strategic intent to support rapid uptake of EVs while utilising existing electricity distribution network infrastructure efficiently and avoiding unnecessary network expenditure.	Link
Battery Tariff Trials	2021-24	Develop and implement cost reflective tariffs for residential and grid connected battery storage systems to reduce network congestion caused by high levels of solar exports during the middle of the day and incentivise exports during peak consumption hours when upstream assets are under heavy loads. Evoenergy received approval from the AER to trial the battery tariffs to provide pr icing signals to BESS units in the network and encourage efficient utilisation of network assets while promoting uptake in renewable energy systems.	Link

Appendix A: Glossary of Terms

Term	Definition
ACT	Australian Capital Territory
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AGGREGATOR	A party that facilitates the grouping of DER to act as single entity in the market
APR	Annual Planning Report
BESS	Battery Energy Storage System
BSP	Bulk Supply Point
CAIDI	Customer Average Interruption Duration Index
CESS	Capital Expenditure Sharing Scheme
DDRN	Digital data radio network
DER	Distributed Energy Resource
DM	Demand Management
DMIS	Demand Management Incentive Scheme
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
FCAS	Frequency Control Ancillary Services
FLISR	Fault Location, Isolation and Supply Restoration

Term	Definition
HMI	Human Machine Interface
HV	High voltage
ICRC	Independent Competition and Regulatory Commission
MVA	Mega Volt Amperes
MW	Mega Watts
NPC	Net Present Cost
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
NPV	Net Present Value
NSCAS	Network Support and Control Ancillary Services
NTFP	National Transmission Flow Path
NTNDP	National Transmission Network Development Plan
N-1	Security Standard where supply is maintained following a single credible contingency event
OPGW	Optical Ground Wire
PFC	Power Factor Correction
PoC	Power of Choice
PoE	Probability of Exceedance
PoW	Program of Works
PV	Photovoltaic
QOS	Quality of Supply
RAPS	Remote Area Power Supply
RDSE	Register of Demand Side Engagement
REZ	Renewable Energy Zones
RIT-D	Regulatory Investment Test for Distribution
RIT-T	Regulatory Investment Test for Transmission
RTU	Remote Terminal Unit
VPP	Virtual Power Plant
ZSS	Zone Substation

Appendix B: Network physical characteristics

In addition to the overview provided in Chapter 2, 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 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 thirteen 132/11 kV zone substations and two 132 kV switching stations. There is also a single 66/11 kV zone substation. All 132 kV and 66 kV connections have N-1 transmission security, with the exception of Tennent Zone Substation which is connected via a single circuit 132 kV tee-connection. There are four bulk supply points supplying the Evoenergy network, all owned and operated by TransGrid Limited as follows:

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

Evoenergy's assets include 132 kV transmission lines, 66 kV sub-transmission lines, 132/11 kV and 66/11 kV zone substations, 22 kV and 11 kV distribution feeders, 22/0.400 kV and 11/0.400 kV distribution substations, low voltage 400 V circuits, and equipment such as distribution pillars and pits to provide connection points to consumers. Evoenergy also owns a 132/11 kV 14 MVA mobile substation that can be deployed as required at short notice.

With the planned decommissioning of Fyshwick Zone Substation, the Queanbeyan Bulk Supply point no longer supply ACT and Evoenergy's 66 kV lines will become obsolete.

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 some redundancy based on 2-hour emergency rating. In a case of network N-1 contingency such as a transformer outage, Evoenergy would allow remaining transformer(s) to be loaded up to their 2-hour emergency rating for a limited time.

There are currently 265 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 54% of Evoenergy's distribution network and 2% of the transmission network is underground.

The network supplies around 204,700 electricity consumers. There are 35 consumers directly connected at 11 kV, two consumers directly connected at 22 kV, and no consumers directly connected at either 66 kV or 132 kV. The remaining consumers are connected to the low voltage network (400 V three phase or 230 V single phase). 11kV / 400 V distribution stations are ground-mounted, pole-mounted, or installed inside buildings such as chamber substations, and range in size from 25 kVA to 1500 kVA.

Consumers are primarily commercial, light industrial or residential connections. There are no major industrial consumers.

Electrical energy consumed in the ACT is generated mainly outside the ACT and enters via TransGrid's transmission network. However, 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 forecast 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 132/66 kV bulk supply point and three 330/132 kV bulk supply points interconnecting Evoenergy network to NSW network.

The three 132 kV bulk supply points are Canberra Substation, Stockdill Substation, and Williamsdale Substation. The 66 kV bulk supply point is located at TransGrid's Queanbeyan Substation.

All 132 kV lines have sufficient capacity to supply full capacity to each zone substation without constraint in the event of an outage of a 132 kV 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 19.

Table 19. Evoenergy Network Assets

Asset Type	Nominal Voltage	Quantity
Bulk Supply Points[30]	330/132 kV	3
	132/66 kV	1
Transmission Lines	132 kV	176 km Overhead
	132 kV	5 km Underground
Sub-transmission Lines	66 kV	7 km Overhead
Switching Stations	132 kV	2
Zone Substations	132/11 kV	12 (+ 1 mobile substation)
	66/11 kV	1
Power transformers	132/11 kV	30
	66/11 kV	3
Feeders	22 kV	2
	11 kV	265
Distribution Substations	22 kV/400 V	10
Distribution Substations	11 kV/400 V	4,736
Distribution Switching Stations	11 kV	356

[30] What is this reference?

Asset Type	Nominal Voltage	Quantity
Number of transmission towers and pole structures	132 kV	1,462
	66 kV	63
Number of poles	22 kV, 11 kV and 400 V	48,819
Circuit km of distribution overhead lines	22 kV, 11 kV and 400 V	2,121 km
Circuit km of distribution underground cables	11 kV and 400 V	2,504 km
Number of customer connections	22 kV	2
	11 kV	35
	400 V / 230 V	204,670
Coverage area		2,358 km^2
System maximum demand (FY20/21)		635 MW

Ratings of zone substations and transmission lines

Zone substation ratings

Evoenergy operates the thirteen 132/11 kV zone substations and one 66/11 kV substation. Table 20 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. an outage of one of the power transformers).

Table 20. 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	12/14 MVA	1
Belconnen	1977	132/11 kV	110 MVA	55 MVA	2
City East	1979	132/11 kV	169 MVA	95/110 MVA	3
Civic	1967	132/11 kV	165 MVA	110 MVA	3
East Lake	2013	132/11 kV	110 MVA	50/55 MVA	2
Fyshwick	1982	66/11 kV	70 MVA	28 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	95/100 MVA	3
Telopea Park	1986	132/11 kV	150 MVA	100 MVA	3
Tennent	2017	132/11 kV	15 MVA	15 MVA	1
Theodore	1990	132/11 kV	90 MVA	45 MVA	2
Wanniassa	1975	132/11 kV	150 MVA	95/100 MVA	3
Woden	1967	132/11 kV	150 MVA	95/100 MVA	3

Additional notes on zone substation ratings: In addition to the ratings listed in Table 19, for network planning and operations, Evoenergy is using 2 hour emergency rating of the transformers. 2-hour emergency rating refers to the estimated level of electrical load which transformer could supply for up to two hours.

Transmission line ratings

Evoenergy currently operates a number 132 kV lines and two 66 kV lines. Table 21 list continuous rating and emergency rating of Evoenergy lines.

Table 21. Evoenergy Transmission Line Ratings

LINE			CURRENT RATING (AMPS)			
			Summer Day (35°C ambient temperature)		Winter Day (15°C ambient temperature)	
From	To	ID No	Continuous	Emergency	Continuous	Emergency
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	Stockdill	9HC/1	1955	2958	2545	3325
Stockdill	Woden	9HC/2	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
Civic	Telopea Park 3	A-53	390	390	390	390
Gilmore	Woden	A-10	1955	2958	2545	3325
Gilmore	Theodore	A-43	968	1458	1257	1638
Gilmore	Wanniassa	A-41	968	1458	1257	1638
Wanniassa	Williamsdale	97F	968	1458	1257	1638
Angle Crossing Tee	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	Tennent Tee	97H/3	968	1458	1257	1638
Tennent	Tennent Tee	97H/4	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 5-10 kW to a 20 MW solar PV farm. The total installed capacity of embedded generation is approximately 247.3 MW as of 30 June 2021. Of this 190.6 MWs are Micro and Low Voltage (small-scale and medium scale) rooftop solar PV, and the remainder is a mixture of High Voltage (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 (5 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 169.7 MW of installed residential rooftop photo-voltaic (PV) generation capacity consisting of around 37,235 installations as of 30 June 2021. This represents approximately 20% of residential dwellings[31]. 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.

The table below summarises data for connection enquiries and connection applications.

PV installations – number of enquiries, number of applications and time to process applications; FY 2020 – 2021.

Installation Size	Number of Enquiries	Number of Applications	Average timeframe to process connection application (days)
< 5kW Basic Micro	N/A*	3847	<5
< 30kW Complex Micro	N/A*	3664	9.5
> 30kW Low Voltage and High Voltage	58	50	117

*N/A – not applicable

[31] As the latest ABS Census was in 2016 this was based on an estimated population of 462,000, a household size of 2.37 and an estimate of 83.2% of dwellings being separate houses.

To date there are approximately 2500 domestic battery systems connected beyond-the-meter and one privately owned and operated 2.66MW/5MWh battery storage system connected directly to the Evoenergy distribution network in Holt. 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 consumers to the network. Reverse power flows tend to raise voltage levels on the low voltage network. High levels of generation export also can exceed the ratings of Evoenergy's equipment especially power cables and distribution transformers. Evoenergy needs to manage reverse power flows and hosting capacity of the network to avoid these issues.

Figure 35. Distribution of domestic rooftop solar PV installations throughout the ACT.

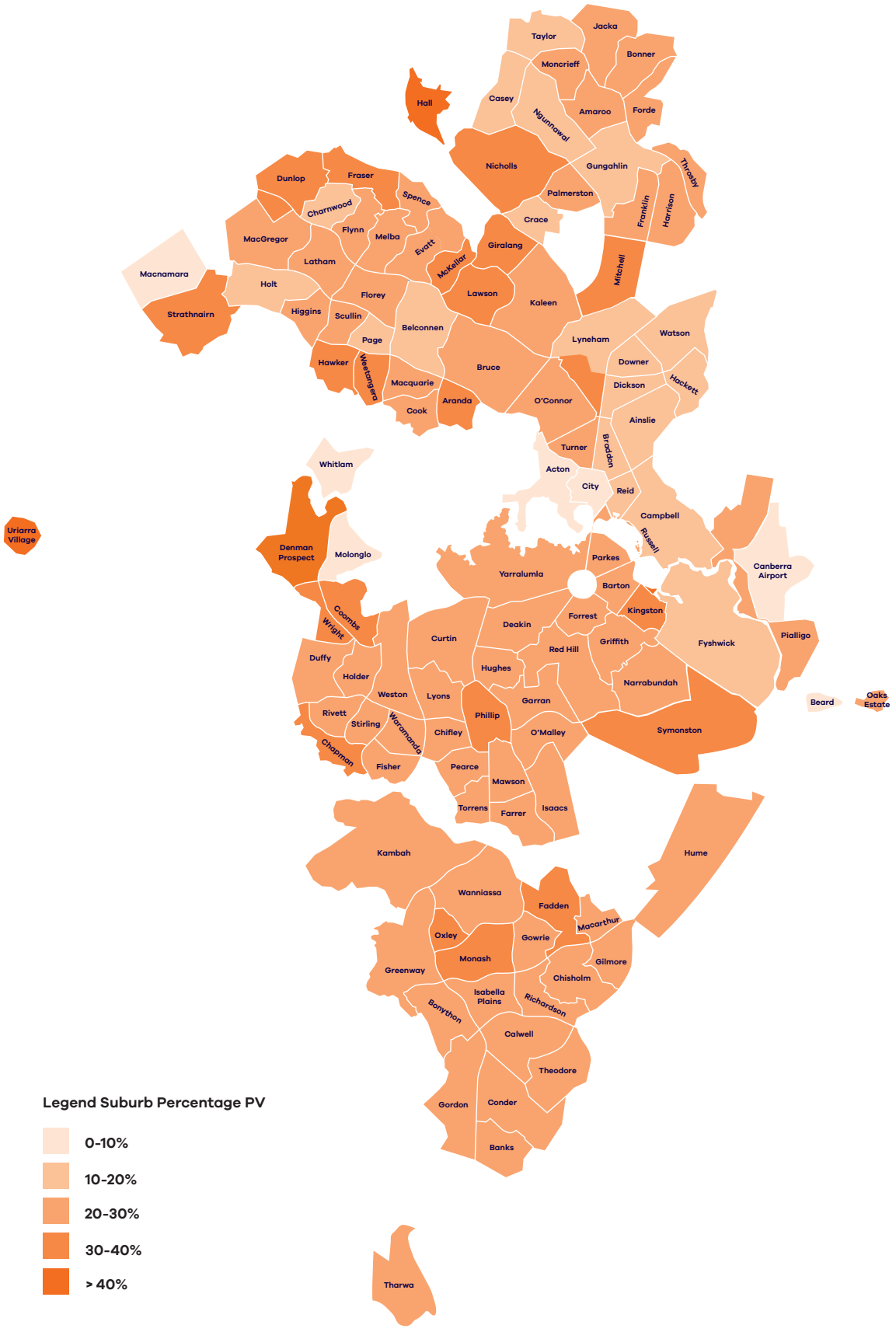


Table 22. Rooftop solar PV generation (Micro and LV) installations by feeder as of 30 June 2021

Zone Substation / Feeder	No. of Sites	Installed Capacity (kW)
BELCONNEN	**3,666**	**18,240**
Baldwin-Joy Cummins	464	2,061
Battye	14	99
Benjamin-Laurie	524	2,356
Cameron South	37	131
Chuculba	316	1,492
Eardley	95	402
Emu Bank	1	3
Haydon	203	1,088
Maribyrnong	73	675
Mcguiness-Bellbird	331	1,750
Meacham-Bean	583	2,937
Shannon	420	1,951
Swinden-Lampard	113	624
William Slim	492	2,673
CITY EAST	**2,597**	**14,200**
Aero Park	2	200
Allara	5	400
Braddon	3	107
Chisholm	183	962
Constitution	3	147
Cowper	155	807
Duffy	236	1,325
Ebden	444	1,994
Electricity House	3	90
Fairbairn	9	47
Ferdinand	263	1,296
Haig	35	299
Ijong	19	158
Mackenzie	445	2,410
Masson	12	109
Northbourne	8	57
Petrie	2	30
Quick	28	196

Table 22. Rooftop solar PV generation (Micro and LV) installations by feeder as of 30 June 2021

Zone Substation / Feeder	No. of Sites	Installed Capacity (kW)
Wakefield	183	920
Wolseley	182	919
CIVIC	**2,355**	**12,173**
ANU No 1,2,3,4,5	14	98
Belconnen Way North	258	1,305
Belconnen Way South	402	1,848
Black Mtn	758	3,802
Christian	0	0
CSIRO	1	180
Dryandra	374	1,705
Edinburgh	5	25
Girrahween	3	133
Hobart Long	1	55
Hobart Short	2	140
Jolimont	1	30
McCaughey	43	285
Miller	431	2,132
Nicholson	60	389
Wattle	2	48
EASTLAKE	**98**	**3,696**
Dairy North	42	2,123
Dairy South	8	554
Isa	26	546
Lyell	22	473
FYSHWICK	**99**	**2,222**
Abattoir	30	198
Airport	3	200
Barrier	10	489
Domayne	16	370
Gladstone	11	252
Tennent	13	325
Whyalla-Pialligo	16	387

Table 22. Rooftop solar PV generation (Micro and LV) installations by feeder as of 30 June 2021

Zone Substation / Feeder	No. of Sites	Installed Capacity (kW)
GOLD CREEK	**6,913**	**38,601**
Anthony Rolfe	207	1,552
Barrington	629	3,424
Birrigai	543	3,123
Ferguson	668	2,861
Gribble	31	1,091
Gungahlin	136	1,211
Hamer	677	3,666
Lander	516	2,361
Lexcen	489	2,607
Ling-Hughes	382	1,740
Magenta-Boulevard North	209	1,854
Nona	368	1,763
Riley	194	1,320
Saunders	574	3,043
Valley	81	687
Wanganeen-Bunburung	300	1,546
Wellington-Gurrang	336	1,925
West	573	2,827
LATHAM	**7,008**	**34,379**
Bowley	465	2,313
Conley	223	1,106
Copland	255	1,091
Elkington	372	1,858
Fielder	86	713
Florey	591	2,635
Homann	327	1,885
Latham	522	2,341
Lhotsky	807	3,656
Low Molonglo East	65	347
Low Molonglo West	176	890
Macrossan	321	1,447
Markell	413	2,357
Melba	325	1,728

Table 22. Rooftop solar PV generation (Micro and LV) installations by feeder as of 30 June 2021

Zone Substation / Feeder	No. of Sites	Installed Capacity (kW)
O-Loghlen	360	1,712
Paterick	193	968
Powers	198	902
Seal	332	1,550
Tillyard	343	1,664
Verbrugghen	223	1,176
Weir	411	2,043
TELOPEA PARK	**1,885**	**11,738**
Blackall	2	80
Cunningham	487	2,344
Empire	267	1,477
Forster	128	867
Giles	53	295
Jardine	2	16
KF1	54	452
King Edward + Belmore	69	614
Kurrajong	2	7
Mildura	1	100
Monash	19	135
Mundaring-Russell No 3	1	28
NSW Cres	31	450
Ovens	20	130
Power House	120	574
Queen Victoria Terrace	1	80
Riverside	1	25
Strzelecki	165	763
Sturt	165	1,148
Telopea Park East	16	137
Throsby	281	2,017

Table 22. Rooftop solar PV generation (Micro and LV) installations by feeder as of 30 June 2021

Zone Substation / Feeder	No. of Sites	Installed Capacity (kW)
THEODORE	**3,567**	**17,455**
Banyule	311	1,393
Callister	605	2,944
Chippindall	454	2,244
Eaglemont	538	2,665
Fairley	375	1,815
Lawrence Wackett	432	2,045
Lethbridge	312	1,716
Morison	332	1,470
Templestowe	208	1,163
WANNIASSA	**6,919**	**34,074**
Ashley	259	1,306
Athllon	355	1,533
Bissenberger-Hawkesbury	774	3,744
Brookman	264	1,420
Conolly	262	1,236
Fincham	7	51
Gaunson	237	1,126
Gouger	179	851
Grimshaw	819	2,808
Hawker-Pridham	397	1,895
Hemmings	238	1,142
Lambrigg	189	1,058
Langdon	393	2,084
Longmore	420	2,048
Mannheim	234	1,110
Marconi	329	1,484
Matthews	331	1,599
Mugga	1	25
Muresk	438	2,369
Pitman-Rowland	14	1,213
Reid	405	2,053
Sainsbury	173	930

Table 22. Rooftop solar PV generation (Micro and LV) installations by feeder as of 30 June 2021

Zone Substation / Feeder	No. of Sites	Installed Capacity (kW)
Sternberg	1	28
Symers	200	960
WODEN	**5,752**	**31,225**
Bunbury	487	2,555
Carruthers	303	1,624
Cooleman	181	816
Corinna	2	60
Cotter 11kV	489	2,881
Curtin North	330	1,594
Daplyn	296	1,363
Deakin No 1	185	1,280
Deakin No 2	119	693
Devonport	65	346
Easty	6	226
Follingsby	421	2,091
Hilder	425	2,162
King	31	320
Launceston	1	83
Lyons West	437	2,096
McInnes	277	1,265
Phillip North	13	246
Phillip South	3	10
Streeton	518	2,999
Theodore	304	1,947
Tidbinbilla 22kV	5	106
Weston East	316	1,506
Wilson	385	2,049
Yarralumla	153	907
Grand Total	**43,363**	**234,712**

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 5 MVA generator is connected to Gilmore Zone Substation via a shared 11 kV feeder and is planned to expand in 2022. 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

Section 2.3 provides an overview of Evoenergy regulatory environment. This appendix includes additional commentary on Evoenergy as a regulated entity.

The National Energy Market (NEM) physical infrastructure comprises both government owned and private assets managed by participants. The NEM includes operation of physical infrastructure including national grid and the operation of energy market. The market uses sophisticated algorithms to dispatch generation according to demand, network capacity, network availability, energy price, and available generation capacity.

Evoenergy is a Registered Participant in the NEM. Evoenergy is registered as the Distribution Network Service Provider (DNSP) and Transmission Network Services Provider (TNSP) in the ACT. The networks are regulated entities. The regulated entities within NEM are ring-fenced from the competitive market to ensure that the competition is not distorted either through cost transfer or some competitors gaining unfair advantage. Day to day operation of NEM is managed by the Australian Energy Market Operator (AEMO) with the oversight of wholesale generation, dispatch, and transmission of electricity in Queensland, New South Wales, South Australia, Victoria, the ACT and Tasmania. AEMO manages NEM in line with the National Electricity Law (NEL) and the National Electricity Rules (NER).

The National Electricity Objective (NEO), as stated in the NEL is to:

"...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 NEO requires Registered NEM participants to balance the costs and risks associated with electricity supply.

The economic regulation within NEM is managed by the Australian Energy Regulator (AER) in accordance with the NER, and procedures and guidelines developed under NER. Every five years, after detailed review, the AER which determines the revenue allowance which Evoenergy is allowed to earn in the following five years.

The Australian Energy Market Commission (AEMC) is the rule making body which administers National Electricity Rules, consults on proposed changes with the NEM participants and publishes the changes. Some obligations relating to consumers are covered in the National Energy Retail Rules and National Energy Retail regulations under the umbrella of National Energy Customer Framework (NECF).

Evoenergy is a holder of the distribution licence in the Australian Capital Territory which was granted by the Independent Competition and Regulatory Commission (ICRC). The ICRC also monitors compliance with the licence conditions. The licence is granted under Utilities Act (2000) ACT. More detailed requirements under the act are covered in the industry codes, such as the Consumer Protection Code which includes Guaranteed Service Levels and the corresponding penalties which are applicable if Evoenergy performance falls below the stated levels. The Code is administered by the ICRC.

The ACT Technical Regulator's role is to ensure safe and reliable energy services to the community. The Utilities Technical Regulation team (UTR) supports the technical regulator. The Director-General of the Environment and Planning Directorate is the ACT's Technical Regulator. 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.

The paragraphs below provide a brief description of key regulatory artefacts relevant to network planning and asset management.

National Electricity Rules

The NER covers a broad range of economic, technical, and legal obligations which NEM participants must comply with. From the network planning perspective, NER Chapter 5 and Chapter 5A describe the main requirements and operating criteria that must be applied by Network Service Providers to their networks. These criteria specify certain electrical performance standards that must be met such as voltage levels, voltage unbalance, voltage fluctuations, harmonics levels, protection operating times, power quality and power system stability.

Electricity Distribution Supply Standards Code

The Electricity Distribution Supply Standards Code sets out technical performance standards for Evoenergy's distribution network. Evoenergy is required to take all reasonable steps to ensure that its Electricity Network will have sufficient capacity to make an agreed level of supply available.

This code specifies reliability standards that Evoenergy must endeavour to meet when planning, operating, and maintaining the distribution network. It also specifies power quality parameters that must be met including limits on voltage flicker, voltage dips, switching transients, earth potential rise, voltage unbalance, harmonics, and direct current content.

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

Clause 5.16 of the NER describes the Regulatory Investment Test for Transmission (RIT-T) and clause 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 including non-network alternatives without bias.

Incentive schemes

Service Target Performance Incentive Scheme

Evoenergy is subject to the AER's Service Target Performance Incentive Scheme (STPIS).

Reliability refers to the extent that consumers have a continuous supply of electricity. The main objective of the STPIS is to provide TNSP's and DNSP's with an incentive to maintain or improve reliability levels and response to consumer outages. STPIS achieves this by rewarding network businesses that outperform their targets or by penalising network businesses that do not.

The AER applied the STPIS to Evoenergy for the 2019-24 regulatory control period. The AER set the targets based on the Evoenergy's reliability performance for the previous 5 years. The value of annual incentive is capped at 5% or revenue. The estimated monetary value of reliability is a based on economic value of reliability to consumers as approved by the AER.

For full details of the STPIS refer to the AER Electricity Distribution Network Service Providers - Service Target Performance Incentive Scheme Guideline v2.0 - 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 consumer interruption (in consumer minutes) divided by the total number of distribution consumers (urban or rural). Unplanned SAIDI excludes momentary interruptions.

Unplanned SAIFI (System Average Interruption Frequency Index)

The total number of unplanned sustained consumer interruptions divided by the total number of distribution consumers (urban or rural). Unplanned SAIFI excludes momentary interruptions. Key points:

- The parameters are separately applied to the two feeder types that Evoenergy has – urban and short rural
- The performance targets are set at the start of each regulatory period and will remain the same for the full 5-year regulatory period.

For further detailed discussion on performance metrics relating to reliability refer to Chapter 4. In addition to reliability performance, the scheme also includes the customer service performance measure based on the customer contact centre telephone answering times.

Capital Expenditure Sharing Scheme

Evoenergy is subject to the AER's Capital Expenditure Sharing Scheme (CESS) administered by the Australian Energy Regulator.

The main objective of the CESS is to provide DNSPs with an incentive to undertake efficient capital expenditure (capex) during a regulatory control period. It achieves this by rewarding DNSPs that outperform their capex allowance by making efficiency gains and spending less than forecast or by penalising DNSPs that spend more than their capex allowance because of a lack of efficiency gains.

Consumers generally benefit from improved capital efficiency through lower regulated prices. Under the CESS, a service provider retains 30% of any underspend or overspend while consumers retain 70% of underspend or overspend. This means that for a one dollar saving in capex, the service provider retains 30 cents of the benefit while consumers keep 70 cents of the benefit. The management of capital expenditure by Evoenergy must be carefully managed because it is subject to factors which are outside our control. For example, the residential or commercial land development programs or customer-initiated works may fluctuate significantly according to market conditions. Higher level activity in those areas may translate to capital expenditure above the allocated regulatory allowance. For the overall capital expenditure to stay within the regulatory envelope, a reduction in other capital programs must offset higher customer-initiated capital programs.

Efficiency Benefit Sharing Scheme (EBSS)

The EBSS is designed to ensure electricity distributors are provided with a continuous incentive throughout the regulatory control period to achieve the lowest efficient levels of operating expenditure through the sharing of efficiency gains and losses with consumers. The EBSS gives a consistent incentive to deliver efficiency improvements throughout the regulatory period by allowing the distributor to retain a share of the efficiency gains over time. For the five-year regulatory period, efficiency gains or losses are shared approximately 30% to the distributor and the remaining 70% to consumers.

The EBSS scheme is relevant to the network investment decisions for several reasons. Different solutions to network limitations may be associated with different levels of operating expenditure. More importantly, many non-networks and demand side management solutions, especially involving other parties replace the capital investment in the network with operating investment. For example, if Evoenergy provides an incentive for another party to install a network battery, the incentive amount would count as operating expenditure. Similarly, if Evoenergy contracts consumers to reduce electrical demand in exchange for the monetary compensation, any incentive paid out would count towards our operating expenditure.

The additional details on EBSS are contained in the AER's Efficiency Sharing Scheme Guidelines, November 2013 (EBSS guideline) available from the AER website.

Demand Management Incentive Allowance Mechanism

Currently, Evoenergy is subject to 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 DMIAM provides Evoenergy with an allowance which is available for eligible projects. The allowance for the regulatory period is capped at a fixed percentage of the distributor's revenue allowance. For Evoenergy for the five-year regulatory period the allowance is estimated at around $1.5 million dollars. Evoenergy is supporting DMIAM and considers eligible projects as part of its network planning process. Further information on DMIAM is provided in the AER's Demand Management Incentive Mechanism Guideline, December 2017 available form AER's website.

Demand Management Incentive Scheme

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 net-benefit constraints stipulated in the AER guidelines for the scheme. The overall uplift which can be allowed to Evoenergy under the scheme is subject to an overall annual limit. The scheme recognises that some existing regulatory settings provide disincentives to non-network and demand side management solutions. DMIS is designed to provide a greater incentive for the distributors to implement demand management solutions. Evoenergy supports in principle application of DMIS to non-network projects. As part of its network planning process, Evoenergy considers projects eligible for the scheme.

A comprehensive description of the DMIS is provided in the AER's Demand Management incentive Allowance Guideline, December 2017 which is available from the AER website.

Efficiency Benefit Sharing Scheme (EBSS)

The EBSS is designed to ensure electricity distributors are provided with a continuous incentive throughout the regulatory control period to achieve the lowest efficient levels of operating expenditure through the sharing of efficiency gains and losses with consumers. The EBSS gives a consistent incentive to deliver efficiency improvements throughout the regulatory period by allowing the distributor to retain a share of the efficiency gains over time. For the five-year regulatory period, efficiency gains or losses are shared approximately 30% to the distributor and the remaining 70% to consumers.

The EBSS scheme is relevant to the network investment decisions for several reasons. Different solutions to network limitations may be associated with different levels of operating expenditure. More importantly, many non-networks and demand side management solutions, especially involving other parties replace the capital investment in the network with operating investment. For example, if Evoenergy provides an incentive for another party to install a network battery, the incentive amount would count as operating expenditure. Similarly, if Evoenergy contracts consumers to reduce electrical demand in exchange for the monetary compensation, any incentive paid out would count towards our operating expenditure.

The additional details on EBSS are contained in the AER's Efficiency Sharing Scheme Guidelines, November 2013 (EBSS guideline) available from the AER website.

Demand Management Incentive Allowance Mechanism

Currently, Evoenergy is subject to 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 DMIAM provides Evoenergy with an allowance which is available for eligible projects. The allowance for the regulatory period is capped at a fixed percentage of the distributor's revenue allowance. For Evoenergy for the five-year regulatory period the allowance is estimated at around $1.5 million dollars. Evoenergy is supporting DMIAM and considers eligible projects as part of its network planning process. Further information on DMIAM is provided in the AER's Demand Management Incentive Mechanism Guideline, December 2017 available form AER's website.

Demand Management Incentive Scheme

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 net-benefit constraints stipulated in the AER guidelines for the scheme. The overall uplift which can be allowed to Evoenergy under the scheme is subject to an overall annual limit. The scheme recognises that some existing regulatory settings provide disincentives to non-network and demand side management solutions. DMIS is designed to provide a greater incentive for the distributors to implement demand management solutions. Evoenergy supports in principle application of DMIS to non-network projects. As part of its network planning process, Evoenergy considers projects eligible for the scheme.

A comprehensive description of the DMIS is provided in the AER's Demand Management incentive Allowance Guideline, December 2017 which is available from the AER website.

Appendix D: Asset Management System Certification

Certification of Asset Management System to ISO 55001:

ISO 55001 states the requirements for an integrated, effective management system for asset management, the intent being to maximize value for money from assets. Evoenergy has adopted ISO 55001 as the reference for measuring asset management continuous improvement and compliance.

Evoenergy holds a current certification under the standard.

Annual audits are undertaken on our Asset Management System in order to retain our certification to ISO 55001.

BUREAU VERITAS
Certification

Certification

Awarded to

ACTEWAGL DISTRIBUTION T/A EVO ENERGY

Cnr Oakden and Anketell Street, Greenway, ACT
AUSTRALIA

Bureau Veritas certify that the Management System of the above organisation has been audited and found to be in accordance with the requirements of the management system standards indicated below

STANDARD

ISO 55001:2014

SCOPE OF SUPPLY

PLANNING, DESIGN, DEVELOPMENT, INSTALLATION, OPERATION AND MAINTENANCE OF ELECTRICITY TRANSMISSION AND DISTRIBUTION ASSETS

Original Approval Date: 11 January 2018

Subject to the continued satisfactory operation of the organisation's Management System

10 January 2024

this certificate is valid until:

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 organization.

Certificate Number: AU004286.1

Date: 5 January 2021

Andrew Martinuzzi
Vice President – GP Pacific Region

JAS-ANZ

Appendix E: Demand forecasts – supplementary information

This appendix provides supplementary information in relation to the demand forecasts discussed in Chapter 5.

The information provided includes:

- The key relevant definitions, formulas, assumptions, and a high-level explanation of the forecasting methodology
- Demand forecast tables for connection points of Evoenergy network to TransGrid network (bulk supply points)
- Zone substation demand forecast tables and charts.

Overview

Maximum demand forecasts provide long-term summer and winter maximum demand estimates conditional on observed annual historical data during those seasons. Similarly, minimum demand forecasts provide long-term daytime and night-time minimum demand estimates conditional on observed annual historical data during those time-of-day periods.

In alignment with previous years' reports and compliant with AEMO's revised connection point forecasting methodology, forecasts provide:

- seasonal maximum demand (as apparent power in MVA) for the zone substations Belconnen, City East, Civic, East Lake, Fyshwick, Gilmore, Gold Creek, Latham, Telopea Park, Theodore, Wanniassa, and Woden,
- seasonal maximum demand (as real power in MW) for the bulk supply points Canberra Bulk Supply Point, Queanbeyan Bulk Supply Point, Williamsdale Bulk Supply Point; and
- seasonal maximum and time-of-day minimum demand (as real power in MW) for the system.

The demand forecasting horizon is 10 years except for Fyshwick Zone Substation and Queanbeyan Bulk Supply Point for which the forecasting horizon is 4 years (due to the planned decommissioning of Fyshwick Zone Substation by 2024).

In addition, the forecast includes seasonal 10-year maximum demand forecasts for the new Stockdill Bulk Supply Point. The forecast is based on seasonal Canberra Bulk Supply Point forecast and load sharing between Canberra Substation and Stockdill Substation estimated through a load flow analysis. The forecasts are summarised in the "Bulk Supply Points Demand Forecasts" section below.

Key forecasting terms as applied by evoenergy in this report

Maximum demand

Zone substations

For zone substations, maximum demand is defined as the maximum apparent power S (in MVA) recorded during a specific financial year and season.

$$\text{Maximum demand (in MVA)} = \max_t S_t \text{, and}$$
$$\overset{\text{Maximum demand}}{t} = \arg\max_t S_t.$$

Annual & seasonal zone substation maximum demands are non-coincident maximum demands, i.e. maximum demands correspond to the absolute maximum values recorded at every individual asset, and timestamps of the individual assets' maximum demands do not coincide with the timestamp of the overall system maximum demand.

Bulk supply points

For bulk supply points (BSP), maximum demand is defined as the maximum real power P (in MW), recorded during a specific financial year and season.

$$\text{Maximum demand (in MW)} = \max_t P_t \text{, and}$$
$$\overset{\text{Maximum demand}}{t} = \arg\max_t P_t.$$

As with the zone substation maximum demands, annual & seasonal bulk supply point maximum demands are non-coincident maximum demands.

System maximum demand

The annual & seasonal system maximum demand is the overall maximum of the coincident sum of individual maximum demands (in MW) measured at every zone substation and Queanbeyan BSP[32]. The time t covers all 15-minute intervals within a specific financial year and season.

Maximum demand (in MW) =

$$\max_t \sum_{i \in \text{ZSS Queanbeyan BSP}} \text{Maximum demand (in MW)}_{i,t.}$$

System minimum demand

The system minimum demand is defined as the minimum of the coincident sum of individual maximum demands (in MW) measured at every zone substation and Queanbeyan BSP[32]. The time t covers all 15-minute intervals within a specific financial year and time of day.

Minimum demand (in MW) =

$$\min_t \sum_{i \in \text{ZSS Queanbeyan BSP}} \text{Maximum demand (in MW)}_{i,t.}$$

Financial year

A financial year (FY) is defined as the period from (and including) 1 July, 00:00 AEST until (and excluding) 30 June, 00:00 AEST (left-inclusive interval). Throughout this section, the terms "year" and "financial year" are used interchangeably, and always refer to a financial year as the unit of time.

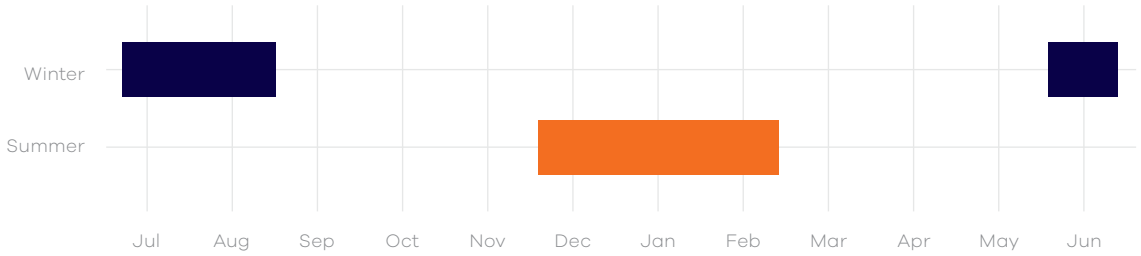
Seasons

The summer and winter seasons are defined by the months

- "Summer": December, January, February,
- "Winter": July, August, June.

[32] This approach different from last year's strategy, as Evoenergy does not have access yet to metering data from Stockdill BSP through the market-compliant process. Obtaining total system load as the coincident sum of demands measured at all BSPs is therefore not possible.

Seasons across one financial year



Note that "Winter" is a non-contiguous period.

Time-of-day periods

The daytime and night-time periods are defined by hours

- "daytime": 8:00 AM – 8:00 PM
- "night-time": 8:00 AM – 8:00 PM

Which is a definition used commonly within the industry.

Probability of exceedance

Compliant with the National Electricity Rules (NER) on load forecasting, forecasts show estimates for "least-likely" and "most-likely" scenarios. Specifically, the forecasting model provides estimates for the maximum and minimum demand data (both historical and forecasts) at different probability of exceedance (PoE) levels; maximum and minimum demands at the 10%, 50% and 90% PoE level correspond to values that are expected to be exceeded in 1, 5, and 9 out of 10 years, respectively. Additionally, forecasts also show demand estimates at the (1%, 99%) and (20%, 80%) PoE levels, corresponding to values that are expected to be exceeded in (1, 99) out of 100 years, and (1, 4) out of 5 years, respectively.

Source Data

Maximum demand data

Historical data of seasonal maximum demands during previous financial years excluding the current financial year (FY20/21) for the zone substations (in MVA), bulk supply points (in MW) and the system (in MW) are measured by the network metering installed in those locations.

Data for the current financial year (FY20/21) are extracted from measured energy values recorded by network metering installed at bulk supply points (operated by TransGrid) and zone substations (operated by Evoenergy).

Energies are then converted to powers as follows: Active (real) powers P and reactive powers Q are calculated from the corresponding real and reactive energy consumptions, by assuming uniform usage during the time interval

P [in MW] = 4×10^{-3} × active energy consumption [in kWh]

Q [in MVAR] =4×10^{-3} × reactive energy consumption [in kVARh].

The factor of 4 is due to the fact that there are four 15-minute intervals per hour, and consumptions are measured in kilo watt (volt ampere reactive) hours over a 15-minute interval.

For zone substation data, the apparent power S is then calculated from P and Q as

$$S = \sqrt{P^2 + Q^2}.$$

Minimum demand data

All historical system data are extracted from measured energy values recorded by network metering installed at the TransGrid connection points and at the zone substations.

Real energy consumption values at the bulk supply points are converted to real power values, for the 15-minute interval and as detailed in the previous subsection.

Block loads

Forecasts account for known commercial and residential block loads. The block load information was collated on the connection enquires, applications and government land release programs, and are summarised in Table 30.

Forecasting Model

A fully Bayesian model for seasonal maximum and time-of-day minimum demand data was developed, motivated by the need for coherence, plausibility and parsimony of model assumptions and predictors affecting long term demand forecasts. The predictive performance of the model was assessed by comparing maximum demand forecasts with those from last year's annual planning report using the same historical data. 10-year forecasting results using the new parsimonious Bayesian model is consistent with the previously used Monash Electricity Forecasting Model (MEFM); and demonstrate the suitability of the Bayesian model framework for long term demand forecasting, both minimal and maximal.

The new long-term demand forecasting model implements a joint model for temperature T and maximum/minimum demand "MD" as a function of time (corresponding to a specific financial year and season/time-of-day) t. Specifically, the maximum/minimum demand of measurement i is

$$\begin{aligned} \mathrm{MD}_i &\sim N(\mu_{\mathrm{MD},i}, \sigma_{\mathrm{MD}}), \\ \mu_{\mathrm{MD},i} &= \mu_{\mathrm{baseline},i} + \mu_{\mathrm{temp},i} + \mu_{\mathrm{growth},i}, \end{aligned}$$

where

$$\begin{aligned} \mu_{\mathrm{baseline},i} &= \beta_{00,\mathrm{MD}} + \sum_{k=1}^{N_{\mathrm{ch}}} I(t_i, t_{\mathrm{ch},k})\beta_{0k,\mathrm{MD}}, \\ \mu_{\mathrm{temp},i} &= \beta_{1,\mathrm{MD}}(T_i - \min(T_i)), \\ \mu_{\mathrm{growth},i} &= \beta_{2,\mathrm{MD}} t_i, \end{aligned}$$

and the likelihood of is modelled using a Gumbel distribution:

$$\begin{aligned} T_i &\sim \mathrm{Gumbel}(\mu_{T,i}, \sigma_T), \\ \mu_{T,i} &= \beta_{0,T} + \beta_{1,T} t_i. \end{aligned}$$

The following (weakly) informative priors are used:

$$\begin{aligned} \beta_{0,T} &\sim \mathrm{N}(\min(T), \sqrt{\mathrm{abs}(\min(T))}), \\ \beta_{1,T} &\sim \mathrm{N}(0.01, 0.001), \\ \sigma_T &\sim \text{Half-Cauchy}(0, 2.5), \\ \beta_{00,\mathrm{MD}} &\sim \mathrm{N}(\mathrm{mean}(\mathrm{MD}), 10\sqrt{\mathrm{mean}(\mathrm{MD})}), \\ \beta_{0k,\mathrm{MD}} &\sim \mathrm{N}(0, 10), \\ \beta_{1,\mathrm{MD}} &\sim \begin{cases} \mathrm{N}(0,10) & \text{for maximum demand modelling,} \\ \mathrm{N}(0,0.1) & \text{for minimum demand modelling,} \end{cases} \\ \beta_{2,\mathrm{MD}} &\sim \mathrm{N}(0,3), \\ \sigma_{\mathrm{MD}} &\sim \text{Half-Cauchy}(0, 2.5). \end{aligned}$$

Key features of the model can be summarised as follows:

- Maximum demand is decomposed into a baseline, temperature and (organic) growth component. All three components have either a direct (baseline, growth) or indirect time dependence (temperature).

the baseline component allows for historic block loads by fitting a piecewise constant to the observed data using the indicator function

$$I(t_i, t_{\mathrm{ch},k}) = \begin{cases} 1 & \text{if } t_i \geq t_{\mathrm{ch},k}, \\ 0 & \text{else}, \end{cases}$$

where $t_{\mathrm{ch},k}$ is the time of the th change point (block load).

- For maximum demand modelling, the temperature component uses recorded annual extremal temperatures (maximum temperatures for the summer MD model, minimum temperatures for the winter MD model) for the years with recorded historical MD data. Simultaneously, the model estimates the parameters of the underlying Gumbel temperature distribution using *all* available temperature data. Annual extremal temperature data are available from 1996 onwards, and are averaged across two weather stations in the ACT (Canberra Airport and Isabella Plains (Tuggeranong). Characterising both models jointly ensures that uncertainties in the parameter estimates from both the MD and T models are properly included in the long-term MD forecasts. For minimum demand modelling, a narrow and strongly informative prior centred around zero is chosen for $\beta_{1,\mathrm{MD}}$, whose regularisation properties characterise the lack of any strong temperature dependence in minimum demand data.
- In alignment with model parsimony, organic growth is modelled using a simple linear time dependence; it was confirmed that a higher-order polynomial fit to the historical MD data does not provide better forecasts. The organic growth component can be interpreted as the compound effect that captures economic growth as well as the MD offset due to increased PV generation.

- As with all Bayesian models, using sensible prior distributions on all parameters is critical to obtaining meaningful posterior densities. Specifically, a narrow and informative prior was chosen for $\beta_{1,T}$ to include a small and realistic time-dependent global warming effect. The mean time-dependent effect of 0.01 °C per year is in agreement with the observed changes in the global Australian climate system of about 1 °C since 1910 [Australian Government Department of Agriculture, Water and the Environment, Climate change]. All other weakly informative priors are chosen in agreement with common prior choice recommendations [Gelman, Prior Choice Recommendations].

Forecasts are then obtained following a three-step process:

- First, forecasts of temperature values T_{pred} for future years t_{pred} are obtained based on the fitted Gumbel model with posterior densities for the location μ_T and scale parameters σ_T.
- Posterior predictive densities of T_{pred} as well as posterior densities of all MD model parameters are then used to obtain MD predictions as posterior predictive densities MD_{pred} for all future years.
- Posterior predictive densities of maximum demand estimates are then adjusted for future block loads using afore-mentioned indicator function $I(t_i, t_{ch})$ which shifts the posterior predictive density by the future block load BL_a at time t_a. A table summarising future block loads is given in Table 29. Final MD estimates at the 100α% level is then obtained from the $100(1 - \alpha)$% quantiles of the posterior predictive MD density at every year. Posterior predictive densities of minimum demand densities are not adjusted for future block loads, as the effect of block loads on minimum demand is difficult to assess; consequently, minimum demand estimates provide a lower bound on the forecast minimum demand trends.

All models are fitted to maximum and minimum demand data using the Bayesian inference framework and probabilistic programming language Stan [Stan Development Team, 2020, Stan Modeling Language Users Guide and Reference Manual] through the R interface rstan [Stan Development Team, 2020, RStan: the R interface to Stan, R package].

Feeder forecast

Evoenergy does not prepare routinely feeder forecasts and feeder forecasts are not included in this report. The distribution system capacity limitations are usually identified by Evoenergy for a supply area and often include several interconnected feeders. The area forecasts are based on the inherent load trends specific to that area and known block loads. The project justification reports include forecast for respective areas and projected feeder loadings which are available for any network studies or consultation on non-network solutions.

Bulk Supply Points Demand Forecasts

Tables below show the results for the summer and winter demand forecast for bulk supply point at Canberra Substation, Stockdill Substation, Williamsdale Substation, and Queanbeyan Substation. These are connection points between the Evoenergy network and TransGrid network operated by TransGrid.

Please note that the minimum demand forecast included in the APR this year is based on the updated methodology which differs to the one which was employed last year. The methodology is subject of further consultation between NEM participants and AEMO.

Canberra Bulk Supply Point Demand Forecast

The demand forecasts at Canberra Zone Substation take energisation of Stockdill Substation into account by introducing a changepoint in the model. The model fit then provides an estimate for the proportional division of load between Canberra and Stockdill. This factor agrees with results from an indicative load flow study at the sub-transmission level, and was used to obtain forecasts for Stockdill based on scaled Canberra forecasts.

It must be noted that Williamsdale forecasts were not changed.

The model estimates Canberra to take approximately 77% of the pre-Stockdill energisation load; this is in agreement with results from the load flow study, indicating that post-Stockdill energisation Canberra would take approximately 73% of the previously forecast load in summer and 72% of the previously forecast load in winter.

Table 23. Summer (Su) and Winter (Wi) maximum demand forecast table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2022	241	299	377	273	346	419
2023	241	299	377	273	346	419
2024	239	298	376	271	346	420
2025	239	298	376	270	345	422
2026	237	297	377	269	345	421
2027	234	296	377	266	345	422
2028	233	296	377	265	344	424
2029	230	296	377	264	344	424
2030	227	294	378	262	343	426
2031	226	295	380	263	344	427

Stockdill Bulk Supply Point Demand Forecast

Stockdill substation was energised in December 2020. Because of this there is no historical data at the site which can be used for forecasting. Please see the Canberra Bulk Supply Point Demand Forecast section above for further details on methodology.

On the basis of the load flow studies, it has been assumed that Stockdill would take approximately 27% of the Canberra Substation load in summer and 28% of the load in winter. Based on the observed reduction of load at Canberra Substation in summer, the forecasting model estimates a Stockdill load of 23% of the Canberra Substation load.

Table 24. Summer (Su) and Winter (Wi) maximum demand forecast table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2022	68	84	106	107	136	164
2023	68	84	106	107	135	164
2024	67	84	106	106	135	164
2025	67	84	106	106	135	165
2026	67	84	106	105	135	165
2027	66	83	106	104	135	165
2028	66	83	106	104	135	166
2029	65	83	106	103	135	166
2030	64	83	106	102	134	167
2031	63	83	107	103	134	167

Queanbeyan Bulk Supply Point Demand Forecast

Please note once Fyshwick Zone Substation is decommissioned Evoenergy will contribute no load to Queanbeyan BSP hence there is no forecast for these years.

Table 25. Summer (Su) and Winter (Wi) maximum demand forecast table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2022	22	28	34	19	25	30
2023	22	28	34	19	25	31
2024	22	28	34	19	25	31
2025	22	28	35	19	25	31
2026	-	-	-	-	-	-
2027	-	-	-	-	-	-
2028	-	-	-	-	-	-
2029	-	-	-	-	-	-
2030	-	-	-	-	-	-
2031	-	-	-	-	-	-

Williamsdale Bulk Supply Point Demand Forecast

Table 26. Summer (Su) and Winter (Wi) maximum demand forecast table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2022	134	189	242	160	199	235
2023	134	190	244	160	199	235
2024	134	191	246	161	200	236
2025	135	192	247	161	200	238
2026	134	193	249	161	201	239
2027	134	193	251	160	202	240
2028	133	194	252	161	202	241
2029	133	195	255	160	203	243
2030	133	196	256	160	204	244
2031	133	198	259	160	204	246

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. POE10, POE50 and POE90 are included in the tables. The identified limitations over the 10-year period are highlighted in **the orange font**.

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

ZSS	Continuous Rating	Emergency 2-hr Rating	POE	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Belconnen	55	74	90	49	50	50	51	50	50	49	49	49	48
			50	57	57	58	59	59	58	58	57	57	57
			10	65	66	67	68	67	67	67	67	67	66
City East	95	95	90	63	66	68	68	68	67	66	66	65	64
			50	72	75	77	77	77	77	76	76	75	74
			10	82	86	87	88	89	88	88	88	88	87
Civic	110	114	90	51	54	58	59	59	60	60	61	61	61
			50	57	60	64	65	65	66	67	67	67	68
			10	64	67	71	72	72	74	74	75	75	76
East Lake	50	60	90	15	16	19	21	23	24	25	26	27	28
			50	20	21	23	26	28	29	30	31	32	33
			10	25	26	28	31	33	35	36	37	38	39
Fyshwick	28	28	90	24	24	24	24	-	-	-	-	-	-
			50	**30**	**30**	**30**	**31**	-	-	-	-	-	-
			10	**36**	**37**	**37**	**37**	-	-	-	-	-	-
Gilmore	45	62	90	30	31	31	31	31	34	36	38	39	39
			50	34	36	36	36	37	39	42	43	44	45
			10	40	41	41	41	42	44	47	49	50	51
Gold Creek	57	74	90	67	70	72	**75**	**78**	**81**	**84**	**87**	**90**	**93**
			50	**76**	**79**	**82**	**85**	**89**	**92**	**95**	**98**	**101**	**104**
			10	**88**	**91**	**94**	**97**	**101**	**103**	**107**	**110**	**113**	**116**
Latham	95	95	90	47	48	49	50	50	51	52	52	53	53
			50	54	55	55	56	57	58	59	59	60	61
			10	62	63	64	65	66	66	67	68	69	70
Telopea Park	100	114	90	73	73	74	76	76	75	77	77	78	77
			50	85	85	87	88	88	88	90	91	91	91
			10	98	98	100	101	102	102	104	105	106	106

ZSS	Continuous Rating	Emergency 2-hr Rating	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2030
Theodore	45	62	90	21	21	21	21	21	20	20	20	20	20
			50	25	25	25	25	24	24	24	24	24	24
			10	29	29	29	29	29	29	29	29	29	29
Wanniassa	95	95	90	53	54	54	53	53	52	51	51	50	49
			61	63	64	64	63	63	62	62	61	61	60
			10	74	75	75	75	74	74	74	74	73	73
Woden	95	95	90	66	72	76	76	76	76	76	77	77	77
			50	76	82	86	86	87	87	87	87	87	88
			10	88	94	**98**	**98**	**99**	**99**	**99**	**100**	**101**	**101**

Note: Tennent Zone Substation has not been included in this table as no forecast is required.

Table 28. Zone substation - winter forecast demand (MVA) summary

ZSS	Continuous Rating	Emergency 2-hr Rating	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2030
Belconnen	55	76	90	55	56	57	58	58	58	58	58	58	58
			50	58	59	60	61	61	61	61	62	62	62
			10	61	63	63	65	65	65	65	65	65	65
City East	110	114	90	69	73	75	76	76	76	76	75	75	75
			50	71	75	77	78	79	79	78	78	78	78
			10	74	78	80	81	82	82	82	82	82	82
Civic	110	143	90	51	54	58	59	60	61	62	63	63	64
			50	53	56	60	61	62	63	64	65	66	66
			10	55	59	62	64	64	66	67	68	68	69
East Lake	55	60	90	16	17	19	22	24	26	27	28	28	29
			50	19	21	23	26	28	29	30	31	32	33
			10	23	24	27	30	32	33	35	36	37	38
Fyshwick	28	28	90	20	20	20	20	-	-	-	-	-	-
			50	27	27	27	27	-	-	-	-	-	-
			10	33	34	34	34	-	-	-	-	-	-
Gilmore	45	69	90	35	36	36	36	36	38	41	43	43	44
			50	37	38	38	38	38	41	43	45	46	47
			10	38	39	40	40	40	43	45	47	48	49

ZSS	Continuous Rating	Emergency 2-hr Rating	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2030
Gold Creek	57	84	90	79	82	**85**	**88**	**92**	**95**	**98**	**101**	**104**	**107**
			50	83	**87**	**90**	**93**	**96**	**100**	**103**	**106**	**109**	**113**
			10	**88**	**91**	**94**	**97**	**101**	**104**	**108**	**111**	**114**	**118**
Latham	100	114	90	64	65	66	67	67	68	68	69	70	70
			50	68	69	69	71	71	72	73	73	74	75
			10	72	73	73	75	75	76	77	78	79	79
Telopea Park	100	114	90	78	78	80	81	81	81	83	85	86	86
			50	83	84	85	87	87	87	90	91	93	92
			10	90	90	92	94	94	94	97	99	100	100
Theodore	45	69	90	26	26	26	26	26	26	25	25	25	25
			50	28	27	27	27	27	27	27	26	26	26
			10	29	29	28	28	28	28	28	28	28	28
Wanniassa	100	114	90	68	68	68	67	66	65	64	63	62	61
			50	70	71	71	70	69	68	67	66	65	64
			10	73	74	74	73	72	72	71	70	69	68
Woden	100	114	90	80	87	92	93	95	96	97	98	100	101
			50	84	91	96	98	99	101	102	103	105	106
			10	88	95	100	102	104	105	107	108	110	111

Notes:

Woden substation load includes the load of the future Molonglo Zone Substation

Tennent Zone Substation has not been included in this table as forecast is required due to the nature of the load (please refer to the table below)

Figure 36. Belconnen Substation 10-year summer and winter demand forecast chart

Belconnen ZSS historical and 10-year maximum demand forecasts

Bands denote Bayesian [20, 80]%, [10, 90]%, [1, 99]% (from inner to outer) POE intervals

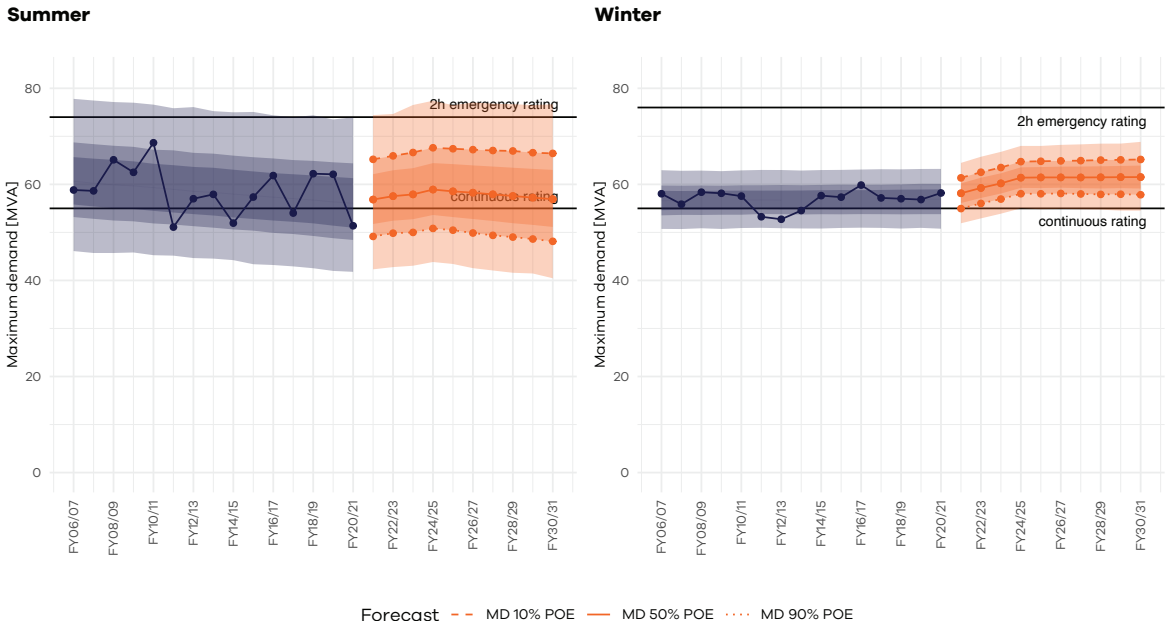


Figure 37. City East Substation 10-year summer and winter demand forecast chart

City East ZSS historical and 10-year maximum demand forecasts

Bands denote Bayesian [20, 80]%, [10, 90]%, [1, 99]% (from inner to outer) POE intervals

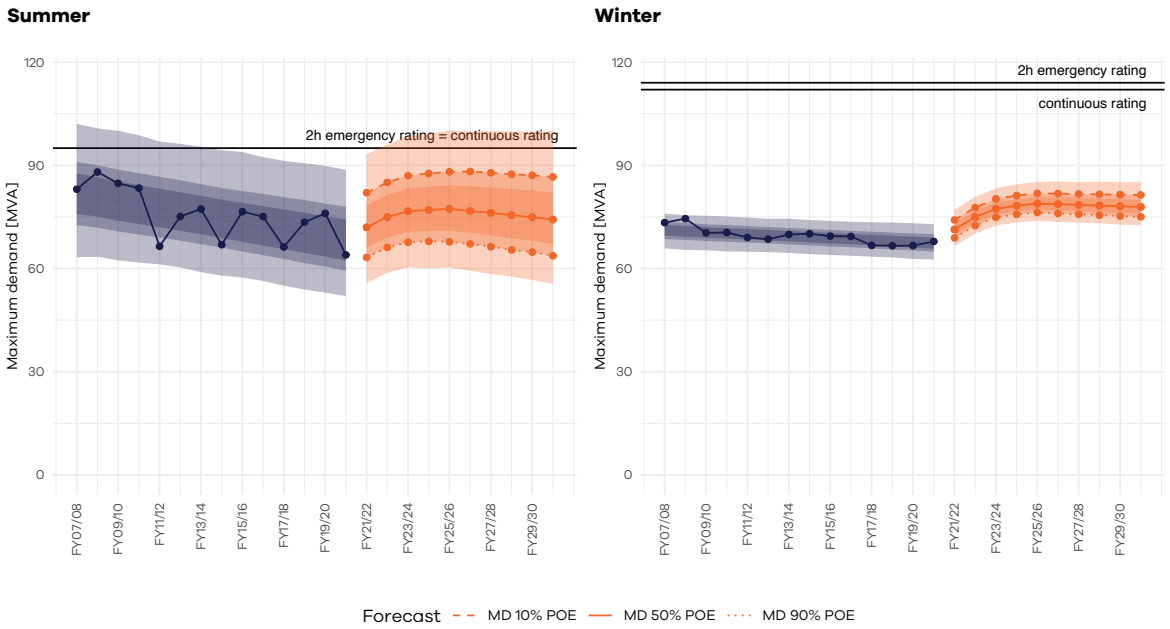


Figure 38. Civic Substation 10-year summer and winter demand forecast chart

Civic ZSS historical and 10-year maximum demand forecasts

Bands denote Bayesian [20, 80]%, [10, 90]%, [1, 99]% (from inner to outer) POE intervals

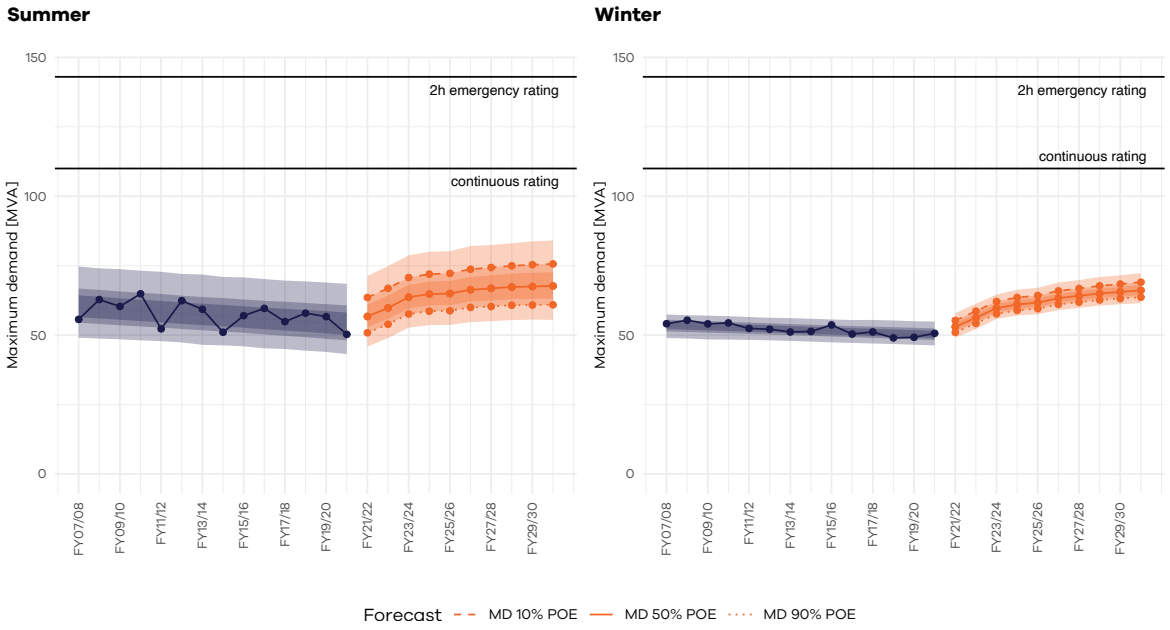


Figure 39. East Lake Substation 10-year summer and winter demand forecast chart

East Lake ZSS historical and 10-year maximum demand forecasts

Bands denote Bayesian [20, 80]%, [10, 90]%, [1, 99]% (from inner to outer) POE intervals

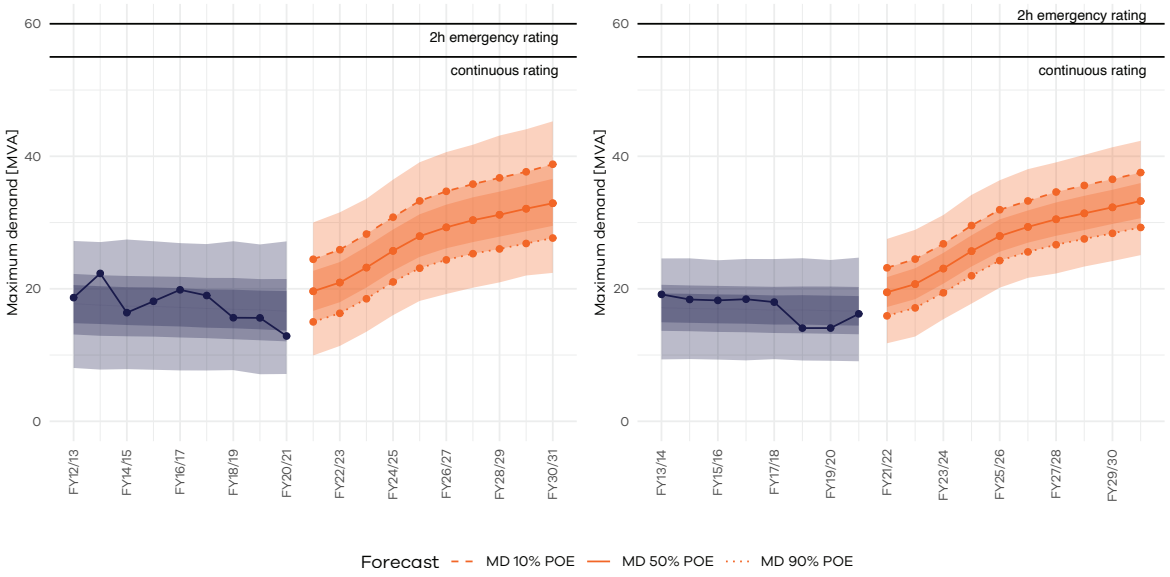


Figure 40. Fyshwick Substation 10-year summer and winter demand forecast chart

Fyshwick ZSS historical and 4-year maximum demand forecasts
Bands denote Bayesian [20, 80]%, [10, 90]%, [1, 99]% (from inner to outer) POE intervals

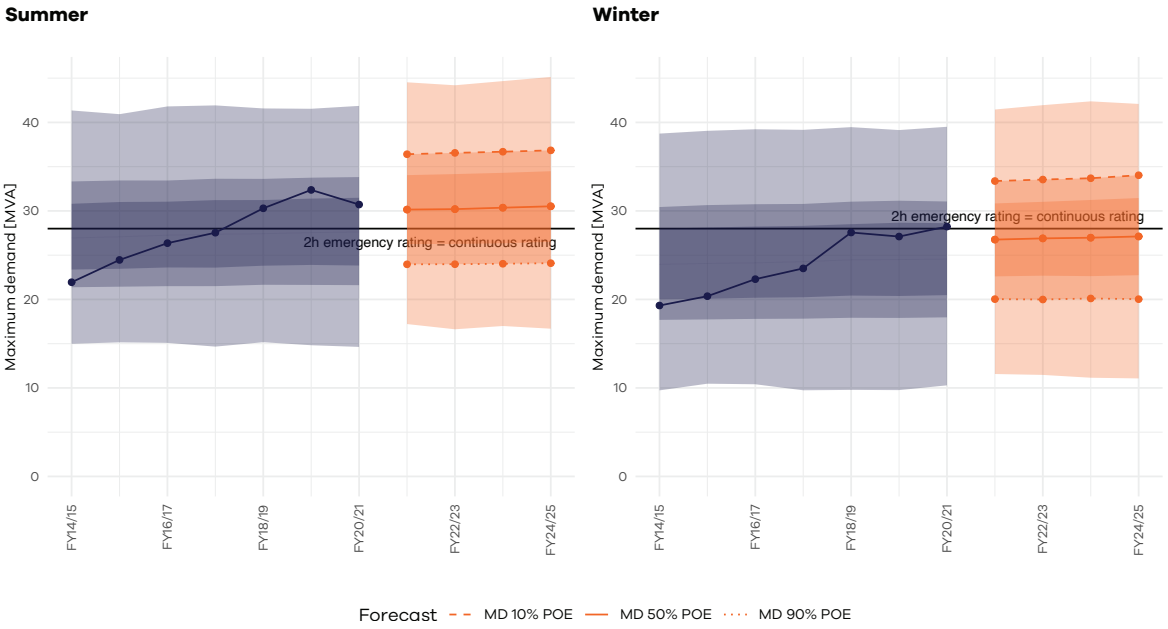


Figure 41. Gilmore Substation 10-year summer and winter demand forecast chart

Gilmore ZSS historical and 10-year maximum demand forecasts
Bands denote Bayesian [20, 80]%, [10, 90]%, [1, 99]% (from inner to outer) POE intervals

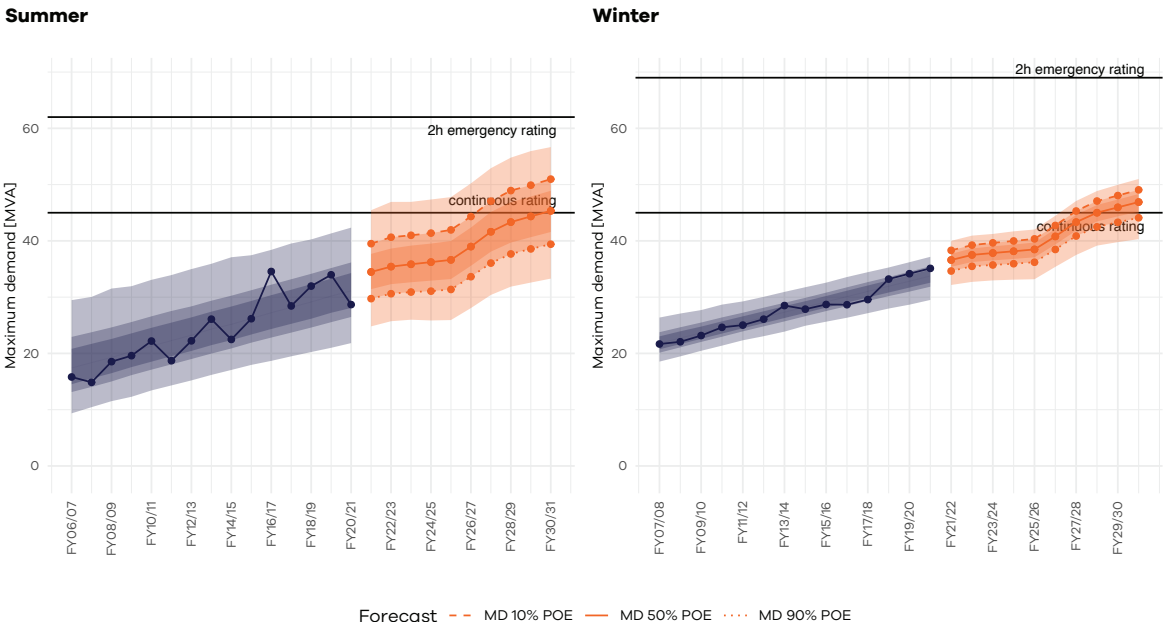


Figure 42. Gold Creek Substation 10-year summer and winter demand forecast chart

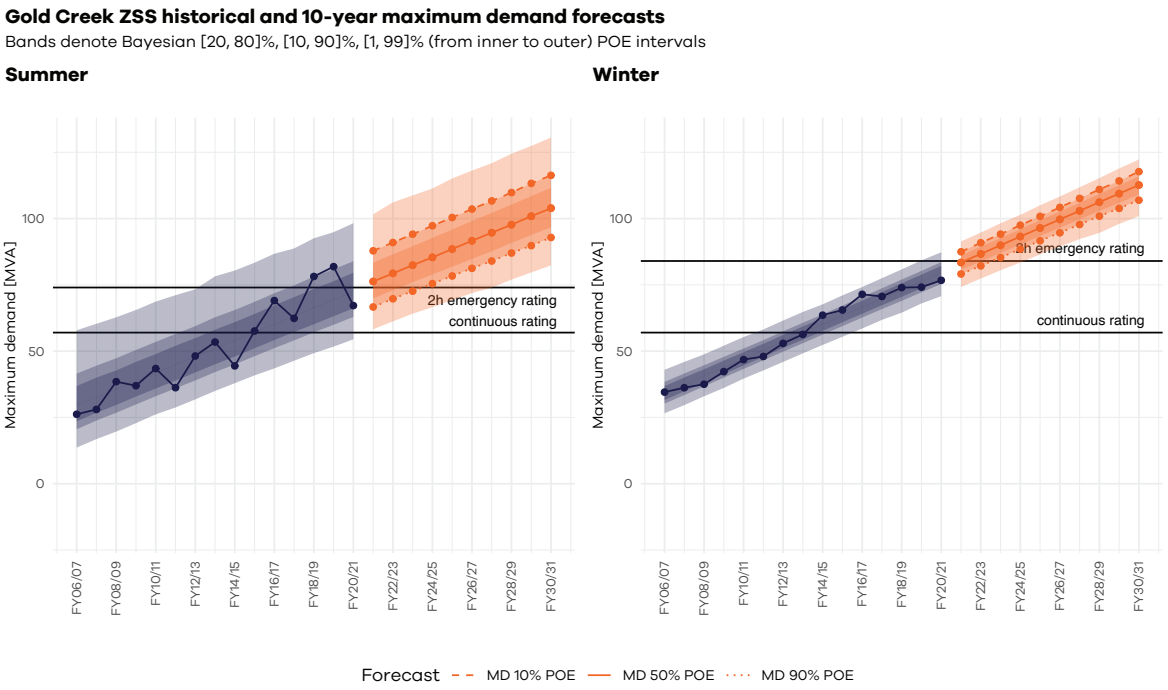


Figure 43. Latham Substation 10-year summer and winter demand forecast chart

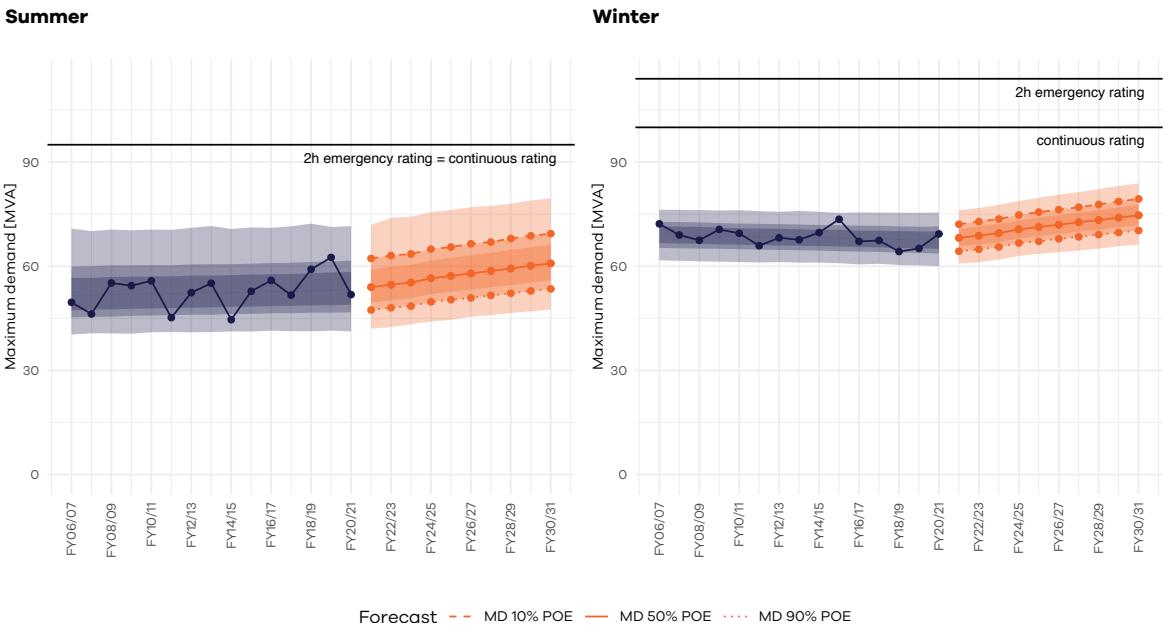


Figure 44. Telopea Park Substation 10-year summer and winter demand forecast

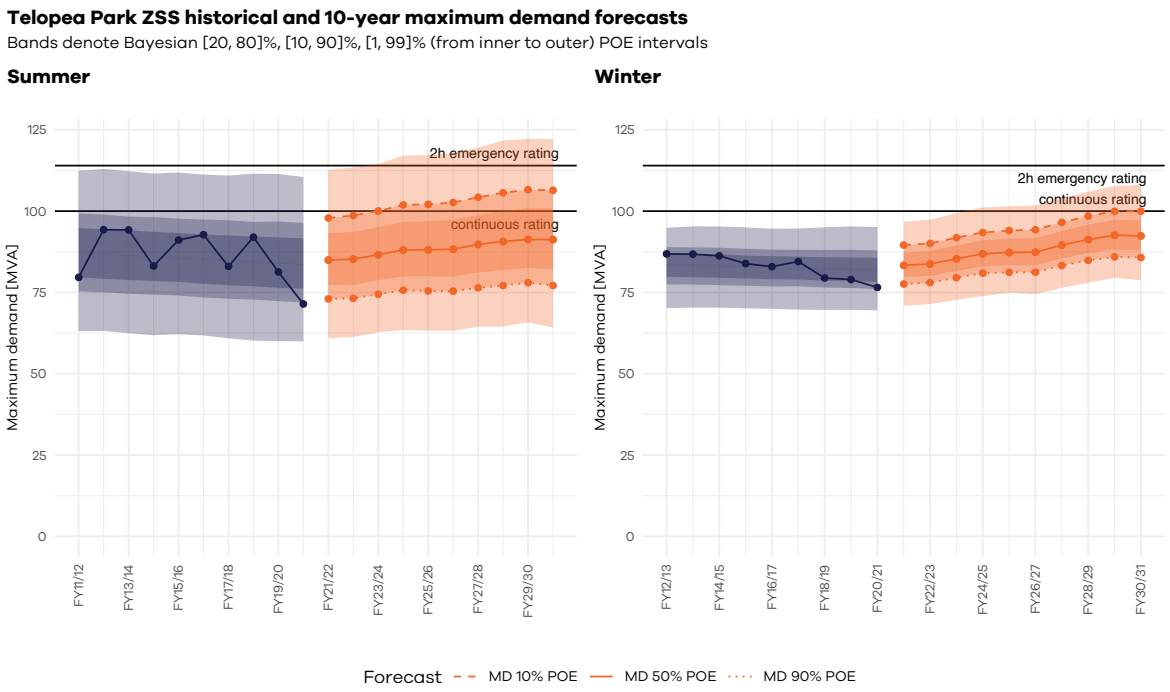


Table 29. Tennent Substation Historical Generation & Consumption Peaks

Year	Season	Generation Peak (MVA)	Consumption Peak (MVA)
2019	Summer	10.	2.5
2019	Winter	7.2	0.2
2020	Summer	9.9	0.1
2020	Winter	8.7	1.7
2021	Summer	10.1	1.6
2021	Winter	6.6	0.1

Tennent is a zone substation purpose built to connect to the large-scale Royalla solar farms. The generation peak is higher than the load peak. It is geographically removed from Canberra and there is no growth in either consumption or generation. For this reason, a forecast has been deemed unnecessary.

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

Theodore ZSS historical and 10-year maximum demand forecasts
Bands denote Bayesian [20, 80]%, [10, 90]%, [1, 99]% (from inner to outer) POE intervals

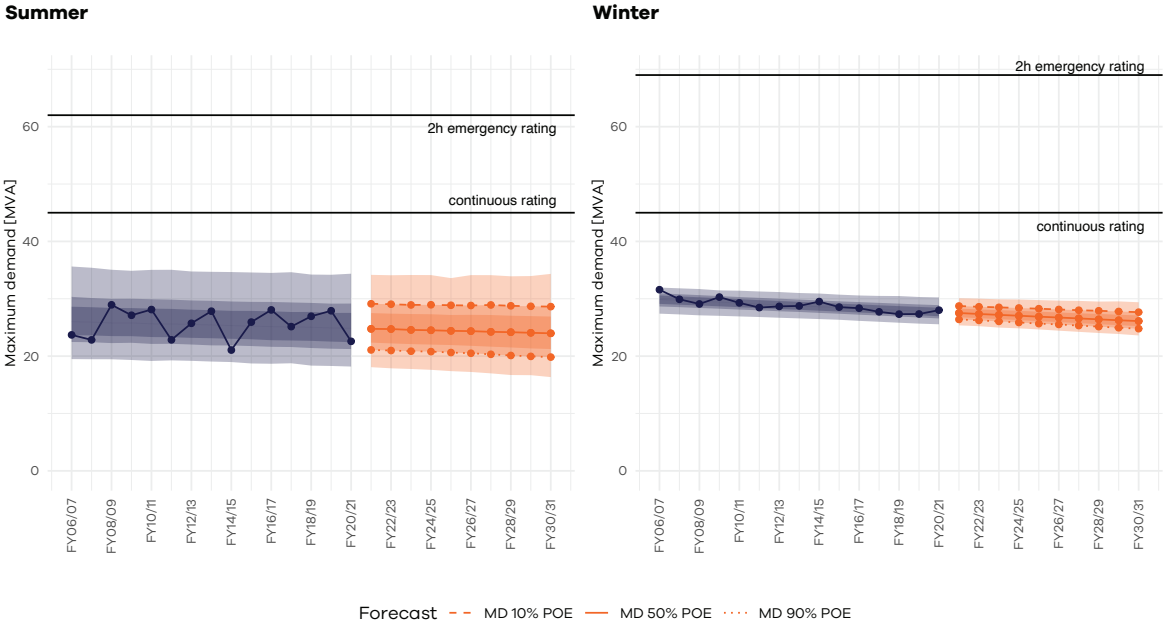


Figure 46. Wanniassa Substation 10-year summer and winter demand forecast chart

Wanniassa ZSS historical and 10-year maximum demand forecasts
Bands denote Bayesian [20, 80]%, [10, 90]%, [1, 99]% (from inner to outer) POE intervals

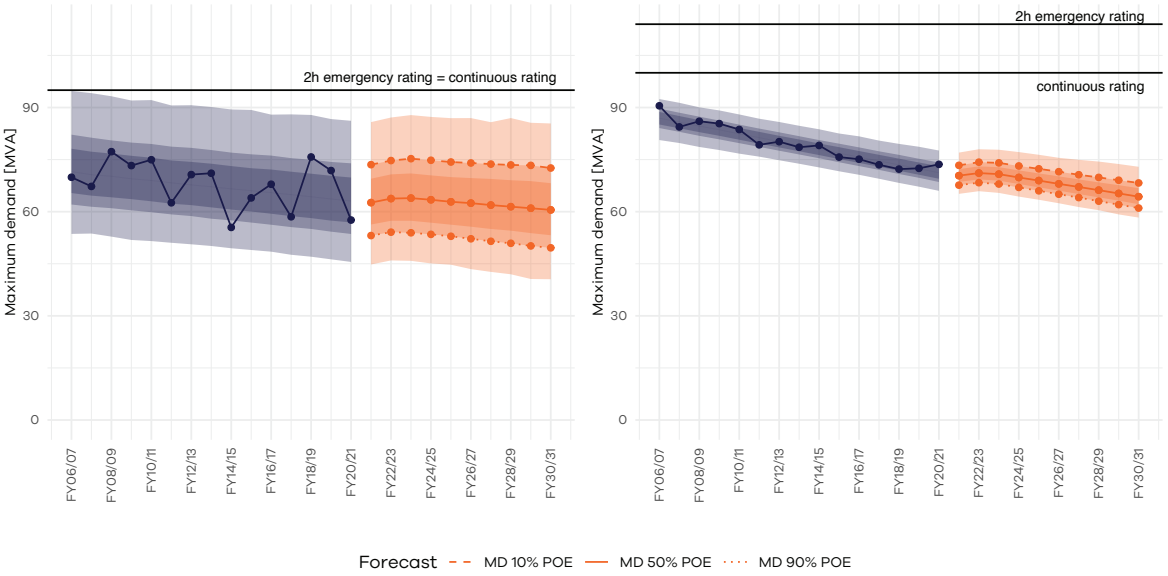
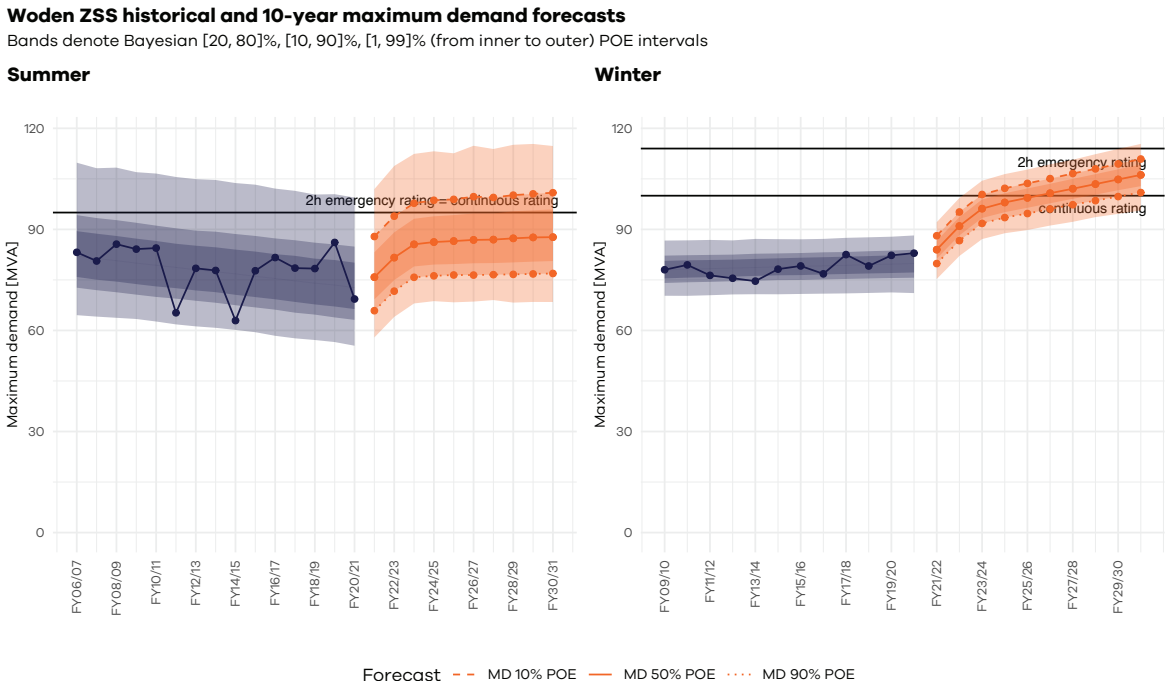


Figure 47. Woden Substation 10-year summer and winter demand forecast chart



Block Load Summary

This section provides a summary of block loads considered in forecasts by year and zone substation.

Table 30. Block Load Summary

Zone	2022 (MVA)		2023 (MVA)		2024 (MVA)		2025 (MVA)		2026 (MVA)		2027 (MVA)		2028 (MVA)		2029 (MVA)		2030 (MVA)		2031 (MVA)	
	Su	Wi	Su	Wi	Su	Wi	Su	Wi	Su	Wi	Su	Wi	Su	Wi	Su	Wi	Su	Wi	Su	Wi
Belconnen	1.1	1.2	0.97	1.1	0.8	0.85	1.2	1.2	0	0	0	0	0	0	0	0	0	0	0	0
City East	5.1	4.3	4	3.9	2.7	2.7	1.4	1.2	1.3	0.95	0.48		0.48		0.38		0.45	0.13	0.18	
Civic	3.3	3.1	3.6	3.5	4.3	3.7	1.6	1.6	0.73	0.93	1.8	1.9	0.96	1.1	0.95	1.1	0.67	0.77	0.7	0.8
East Lake	3.1	2.9	1.5	1.3	2.35	2.4	2.6	2.7	2.4	2.4	1.35	1.4	1.2	1.2	1	1	1	1	1	1
Fyshwick	2.4	2.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gilmore	2.4	1.9	0	0	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	1.4	1.4	1.6	1.6	0.8	0.8	0	0	0	0
Gold Creek	0.8	0.64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Latham	0.6	0.8	0.6	0.8	0.6	0.8	0.96	1.2	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8
SYSTEM	9	9	11.4	11.4	2.8	2.8	0.2	0.2	6.6	6.6	6.4	6.4	6.5	6.5	6.6	6.6	6.5	6.5	0.5	0.5
Telopea	1.8	1.8	0.64	0.68	1.8	1.8	1.8	1.7	0.6	0.55	0.4	0.35	1.8	2.4	1.4	1.9	1.2	1.5	0	0
Wanniassa	0.15	0.2	1.8	1.9	0.72	0.85	0.15	0.2	0.15	0.2	0.15	0.2	0.15	0.2	0.15	0.2	0.15	0.2	0.15	0.2
Woden	3.6	4	6.5	6.8	4.6	5	1.4	1.7	0.9	1.2	0.9	1.2	0.9	1.2	0.9	1.2	0.9	1.2	0.9	1.2

Note: **Su** is Summer, and **Wi** is Winter

Appendix F: Network reliability standards and performance

Key definitions

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

Network reliability standards (set by the Australian Energy Regulator and jurisdictional technical regulator), the performance and the key reliability measures are outlined in the following sections:

Australian Energy Regulator Reliability Targets

The purpose of the Service Target Performance Incentive Scheme (STPIS) is to provide an incentive to maintain existing supply reliability to consumers, and to implement improvements to match consmers' value of supply reliability. The scheme includes financial incentives or penalties based on improvement or deterioration in network performance compared to past benchmarks. The scheme currently applies to unplanned supply interruptions.

The determination by AER for Evoenergy in April 2019 applied the STPIS scheme to the 2019-24 regulatory control period. In each year, the incentives and penalties are capped at 5% of the annual Evoenergy allowance.

STPIS targets are set by the AER for the five-year regulatory control period. The targets set by AER for 2019-24 are in Table 31. The targets apply to unplanned supply interruptions only.

Table 31. STPIS Reliability Performance Targets for Unplanned Outages:

Year	2019-24
Unplanned SAIDI I[33]	
Urban	32.524
Short Rural	35.056
Whole Network (weighted average)	33.366
Unplanned SAIFI[34]	
Urban	0.565
Short Rural	0.591
Whole Network (weighted average)	0.574

Jurisdictional Regulator Reliability Targets

The ACT Utilities (Technical Regulation) Act requires Evoenergy to comply with the relevant technical codes. The reliability targets specified in the Electricity Distribution Supply Standards Code are shown in Table 32. The ACT targets apply to planned and unplanned supply interruptions. Table 33 below includes full set of actual reliability performance figures for planned and unplanned outages.

Table 32. 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

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

[34] 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 33 provides the historical reliability performance statistics for Evoenergy's network. The table includes SAIDI and SAIFI figures for the rural network, urban network, and the whole of the network from the year 2015 onwards. The planned and unplanned outages are set out against jurisdictional and STPIS reliability targets.

Table 33. 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**	**2019-20**	**2020-21**
SAIDI									
Whole Network Overall	91 (ICRC)	74.01	83.74	91 (ICRC)	88.49	92.53	**91 (ICRC)**	81.70	82.04
Whole Network Planned	-	38.89	44.21	-	57.05	41.54	**-**	33.32	39.87
Whole Network Unplanned	-	35.12	39.53	-	31.44	34.94	**-**	34.81	37.79
Urban Unplanned	31.912 (AER)	35.73	42.74	30.32 (AER)	29.81	33.19	**32.524 (AER)**	29.32	31.78
Short Rural Unplanned	49.32 (AER)	30.25	39.11	46.86 (AER)	34.11	36.58	**35.056 (AER)**	46.63	57.35
SAIFI									
Whole Network Overall	1.2 (ICRC)	0.86	0.902	1.2 (ICRC)	0.7	0.95	**1.2 (ICRC)**	0.715	0.745
Whole Network Planned	-	0.185	0.212	-	0.2	0.19	**-**	0.167	0.205
Whole Network Unplanned	-	0.675	0.69	-	0.49	0.63	**-**	0.489	0.523
Urban Unplanned	0.616 (AER)	0.682	0.669	0.585 (AER)	0.45	0.60	**0.565 (AER)**	0.445	0.462
Short Rural Unplanned	0.942 (AER)	0.616	0.852	0.895 (AER)	0.56	0.60	**0.591 (AER)**	0.586	0.723
CAIDI									
Whole Network Overall	74.6 (ICRC)	86.06	92.84	74.6 (ICRC)	126.41	96.92	**74.6 (ICRC)**	114.33	110.10
Whole Network Planned	-	210.22	208.54	-	285.25	215.58	**-**	199.31	194.62
Whole Network Unplanned	-	52.03	57.29	-	64.16	55.09	**-**	71.19	72.1
Urban Unplanned	-	52.39	63.89	-	66.24	55.18	**-**	78.22	68.80
Short Rural Unplanned	-	49.11	45.90	-	60.91	60.92	**-**	79.57	79.31

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 consumers. Evoenergy's network reliability strategy and plan consider the following tactics to manage our network reliability for consumers.

Prevention

Minimise asset failures

Asset failures often result in an unplanned outage for consumers. Reducing the number of asset failures can reduce unplanned outages for consumers and improve network reliability. An objective of Evoenergy's asset maintenance programs is to optimise asset life-cycle and reduce asset failures in the network through assets inspection, maintenance, refurbishment and replacement by applying risk-based methods

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 through regular inspections and tree clearing around overhead power lines.

Reduce third party damage

Damage to Evoenergy's network by other parties may cause unplanned supply outages to consumers. For example, damage to our network may be caused 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) platform to mitigate damage to our network caused by other parties.

Decommission legacy assets

Removing unreliable assets from the network, removes potential 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 cause consumer outages.

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 value of energy at risk or unserved energy. The value is derived from the probability of supply interruptions and the value of energy to consumers.

Dispatch Distributed Energy Resources (DER)

During peak demand, generation, transmission or distribution networks cannot always meet peak demand events particularly in case of asset outages. When these events occur, load shedding (disconnection of consumers) may be required to maintain the stability and reliability of the grid. At the national level, load shedding events are directed by AEMO. Any events resulting in the ACT distribution network constraints are managed by Evoenergy.

Controlled dispatch of Distributed Energy Resources (DER) including batteries can reduce the likelihood of load shedding events by reducing demand during peak periods. This approach may reduce unplanned outages for consumers and reduce the likelihood of AEMO or Evoenergy load shedding.

Maximise availability for PV generators

The number of low voltage (LV) photovoltaic (PV) generators is increasing, challenging LV network voltage regulation capability limits. These generators operate within a prescribed voltage standard and if the voltage drifts outside the range, the generator must disconnect from the network, until the voltage is within the tolerance limits. Although the network is available for consumers to receive electricity, their generator may experience 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 consumers. For example, primary and secondary asset maintenance strategies are aligned so that one planned outage is required to maintain as many assets in a single outage as practicable.

Minimisation

Auto-reclosers

Many overhead network faults are transient. Auto-reclosers are switchgear designed to isolate faults when they occur, then attempt to restore supply automatically if the fault is intermittent. Reclosers can reduce the number of consumers impacted by faults and a number of sustained faults.

Diversify network outage risk

Diversifying network outage risk refers to network design which limits the number of consumers affected by a single fault on the network. Evoenergy's asset management planning does this by analysing feeder outage rates, optimising the number of consumers connected to feeders, design and installation of network protective devices and catering for credible network contingencies.

Restoration

Fault Location, Isolation & Service Restoration (FLISR)

Evoenergy's 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 consumers. Automated FLISR is a collection of tools including switchgear with remote control and indication, integrated with the centralised Advanced Distribution Management System (ADMS). Current fleet of switchgear with remote control and indication is currently being reviewed for compatibility with an automated FLISR system.

Remote network indication & control

Some overhead and underground switchgear is installed with remote indication and control capability. Remote control allows Evoenergy's 24-hour control centre to respond to faults by enabling faster identification and isolation of faulty sections of the network and quicker restoration of supply to consumers who are connected to healthy sections. The restoration can take place, before crews are dispatched on-site.

Maintain asset availability to enable fast restoration

When assets fail and an outage occurs, supply is often restored to consumers by isolating the failed section of network and restoring supply from an adjacent "healthy" part of the network. The 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 consumer 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 seek to identify network defects with high reliability risk to prioritise 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 the information provided in Chapter 4. This appendix provides additional information in relation to power quality in addition to the information provided in Chapter 4.

The appendix includes the following commentary:

- An overview of the main standards, guidelines and other technical requirements relating to power quality
- Description of key power quality parameters and requirements
- Summary of power quality issues related to embedded generation

Power quality standard and references

Schedule 5.1 of the NER lists the *Network System Standards* that are to be achieved by Network Service Providers (NSPs). Evoenergy's 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 consumers' premises must be supplied and maintained within regulation limits to ensure correct operation of appliances and safety to equipment and personnel. Exceeding the upper voltage limit may result in insulation breakdown and subsequent equipment damage, whilst operating below the lower limit impacts on power quality and could cause fuses to blow due to higher current.

Steady state phase-neutral low voltage at the consumer's point of supply is maintained at 230 V +10%/-6% in accordance with Australian Standards AS/NZS 60038 and AS 61000.3.100. Steady state voltage at the consumer's point of supply is measured to ensure the V1%, V99% and V50%, (phase-to-neutral and phase-to-phase).

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) 253 Volts (Phase-to-Neutral Maximum)
	-	392 Volts (Phase-to-Phase Minimum) 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% of the nominal supply voltage. However small magnitude changes occurring at certain frequencies can give rise to an effect known as flicker. Voltage fluctuations may cause spurious tripping of relays, interference with communications equipment, and may trip electronic equipment.

Flicker is usually consumer-generated due to the following:

1. Frequent starting of induction motors – mainly the direct online starting of induction motors.
2. Electric welders.
3. Arc furnaces.

Evoenergy responds to a consumer report of flicker by installing a mobile power quality analyser. Evoenergy either advises the consumer if the flicker is due to its operations, or rectifies if caused by Evoenergy's equipment.

Maximum permissible voltage flicker levels are specified in TR IEC 61000.3.7:2012.

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 consecutive 10-minute periods.

Voltage flicker levels for different voltage levels

Planning levels for flicker in MV, HV & EHV systems		
	MV	HV / EHV
P_{st}	0.9	0.8
P_{lt}	0.7	0.6

Voltage Dips

Voltage dips are typically caused by events such as lightning or faults on adjacent feeders, or are generated by equipment located within consumers' premises (e.g. induction motor starting). Dips caused by faults on adjacent feeders can propagate throughout the network, affecting consumers' supply voltage on all feeders at the zone substation. Although only consumers on the faulted feeder experience an interruption, many experience the reflected voltage sags generated by the fault.

Evoenergy monitors voltage dips as part of its proactive power quality monitoring program. Evoenergy uses its SCADA system and protection records to analyse events and uses its mobile power quality analysers to assist in the analysis and rectification of voltage dips. Evoenergy shall use the implementation of numerical protection devices and the ADMS to further reduce the overall number of voltage dips on the network. Evoenergy proposes to review fault switching and investigate the use of auto-reclosers, sectionalises and fault passage indication devices to reduce fault switching.

Voltage Dip Voltage Tolerances[35]

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.

maintenance programs designed to avoid excessive switch contact arcing.

[35] ACT Electricity Distribution Supply Standards Code

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:

1. Inadequate earthing (high earth resistance or open circuit earth) at substations.
2. 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.

Act Electricity Distribution Technical Standards Code prescribes voltage difference between neutral and earth is < 10 V steady state (5-minute average) at the point of supply.

Voltage difference between neutral to earth limits[36]

Voltage Difference Between Neutral to Earth
< 10 Volts (5 minute average at the point of supply)

Voltage unbalance

Voltage unbalance typically results from:

- Unbalanced phase impedances.
- Unbalanced phase loadings.
- Interaction between phases (induced voltages) on overhead lines.

Unbalanced voltages can result in high neutral currents which introduce the potential for high neutral to earth voltage difference, and the generation of negative sequence voltages that can damage three-phase induction motors.

Evoenergy manages voltage unbalance within the required limits through appropriate design practices and transformer procurement specifications. Evoenergy uses its mobile power quality analysers and quality of supply survey procedures to identify and rectify voltage unbalance. This is supported 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*.

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.

[36] Electricity Distribution Supply Standards Code

Harmonics

Harmonics are usually consumer-generated. Non-linear loads such as industrial equipment (e.g. arc welders), variable speed drives, uninterruptible power supplies, some types of lighting, and office equipment, are all sources of harmonic currents. Harmonic currents flowing in transformers cause an increase in the copper (resistive) losses and iron (magnetising) losses. Harmonic distortion can cause the supply voltage waveform to depart from sinusoidal in a repetitive manner. This can affect the operation of computer equipment, create noise on radio and television receivers, and cause vibration in induction motors.

Evoenergy responds to consumer requests to measure and analyse harmonic levels. Evoenergy uses its mobile power quality analysers and undertakes harmonic monitoring as part of its power quality surveys.

Consumers must ensure that harmonic distortion caused by their equipment does not exceed the limits prescribed in AS/NZS 61000 parts 3.2, 3.4, 3.12 and TR IEC 61000.3.6.2012.

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. The replacement of synchronous generation with asynchronous generation reduces the fault current and can lead to a "weak" system. 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 may cause high voltage on the distribution network so output from DC/AC inverters will need to be strictly adhered to.

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, that is 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 trialling 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 flywheel 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 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 under-performing protection relays that have reached the end of their economic life. Old electro-mechanical and static/electronic protection devices are being progressively replaced with modern numerical relays.

- All new or replacement protection systems will include the following:
- All protection devices will be multifunctional numerical control devices (IEDs) compliant with *IEC 61850 and DNP3 standards*.
- IEDs shall use *DNP3 or IEC 61850* protocol for SCADA communications to RTUs.
- Protection and automation functions will be implemented in IEDs.
- Duplicate protection devices shall be installed in 132 kV zone substation applications as required by the NER.
- Main and backup protection devices shall be installed in 11 kV zone substation applications.

Network voltage regulation

The Evoenergy network is supplied from TransGrid's bulk supply substations at Canberra, 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.).

Evoenergy has installed TNSP metering on the 11 kV group circuit breakers at all 132/11 kV zone substations. In addition to providing metering functions to AEMO, these meters provide accurate voltage measurements and other power quality information to the ADMS in real time.

Evoenergy monitors steady state voltage levels and responds to consumer complaints where required. Evoenergy is considering the application of smart metering technology to further ensure compliance of steady state voltage levels.

Network fault level and protection

Fault level is defined in terms of fault current (kA). The fault current is the maximum current that would flow at that point in the network should a short circuit fault occur. Major equipment elements such as circuit breakers, switchgear, cables, and busbars are specified to withstand the maximum possible fault level. This equipment is designed to withstand the thermal and mechanical stresses experienced due to the high currents in short circuit conditions.

Fault level is also an indication of a power system's strength. Higher fault current levels are typically found in a strong power system, while lower fault current levels indicate a weaker power system. A strong power system exhibits better voltage control in response to a system disturbance, whereas a weak power system is more susceptible to voltage instability or collapse. For example, connection points with higher fault levels experience less voltage flicker during load switching compared with those that have lower fault levels. System strength is a measure of the ability of a power system to remain stable under normal conditions and to return to a steady state condition following a system disturbance.

High voltage overhead lines that are insufficiently fault rated may cause the conductors to clash, sag below minimum ground clearance, or even break when subjected to a fault current. Such situations can occur when network augmentations such as the construction of a new zone substation increase the fault levels in the distribution network.

Conversely increasing amounts of power electronic converter generation (e.g. PV generation) connected to the network, replacing synchronous generation, serves to reduce fault levels and consequently reduce system strength.

Evoenergy specifies new 11 kV equipment to be capable of withstanding 25 kA three-phase short circuit fault current. Maximum 11 kV fault level on the network has been calculated at approximately 12.2 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 consumers or even potential equipment damage.

The National Electricity Rules S5.1.10 requires network operators to have a proportion of their load available for shedding by under-frequency relays. This is required to arrest the collapse of the national grid in the event of a major contingency that results in a sudden large deficiency of generation, such as could occur due to tripping of several generating units or tripping of transmission interconnectors. NSPs in consultation with AEMO must ensure that 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:

1. Inadequate sizing of the earth conductor relative to the maximum fault current.
2. High impedance between the earth conductor and the mass of earth (true earth).

Under such conditions the passage of the fault current through the inadequate earth connection will result in a voltage increase on the earth connection for the duration of the fault. This condition can present risk of electric shock to a person who may be standing on "true earth" but is in contact with the inadequately earthed device. It can also result in damage to sensitive equipment.

Evoenergy complies with earth potential rise requirements by basing its network designs on reference publications[37]. 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 is developing a set of guides and standards relating to earthing design, construction, and testing.

[37] ENA EG-0 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

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 180,000 revenue meters installed at consumer premises. The main purpose of conventional meters is to measure a consumption of electricity. The meters are being managed in accordance with Evoenergy's metering asset management plan. In 2017 a set of regulatory reforms under the Power of Choice banner expanded contestability to the installation of all consumer 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 measuring of energy consumption. The latest generation of meters include functionality which can provide additional information to consumers on their energy consumption, assist with network operation and provide additional data in relation to power quality.

Evoenergy is 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.

Key network technical parameters

Electromagnetic fields (EMF)

Electromagnetic fields are a key design consideration for bare electrical conductors such as overhead lines and bus-work, particularly those which operate at high voltage. For conductors with an earth shield, such as underground cables, the fields are encapsulated within the cable and do not present external hazards.

Electromagnetic fields incorporate both electric fields resulting from the voltage on conductors and 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)[38] 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.

[38] http://www.ena.asn.au/sites/default/files/emf_handbook_2016

Inductive interference

Inductive interference refers to the ability of the magnetic fields generated by current flowing in typically overhead line conductors, to cause interference with other electromagnetic radiation such as radio, television and communication signals.

Evoenergy shall continue to undertake routine maintenance programs to ensure all equipment is in good working condition, in particular all HV and LV overhead lines, to ensure that inductive interference is within the limits specified in Australian Standard AS 2344:2016 Tables 1 and 2 (limits of radiated radio disturbance from overhead AC power lines and high voltage equipment).

Direct current (DC) component

A high DC component of the neutral voltage can cause damage to electronic devices and impact on the correct operation of protective devices. It can also lead to an increase in losses and result in heating within electrical and electronic equipment.

Evoenergy ensures that consumer's inverters connected to the network adhere to the relevant standards and regulatory requirements.

Evoenergy publishes on its website the "Requirements for Connection of Embedded Generators up to 5 MW to the Evoenergy Distribution Network "document. This includes the requirement that inverters must comply with the requirements of the Clean Energy Council (CEC) and Australian Standard AS/NZS 4777 (Grid connection of energy systems via inverters).

Power factor

Power factor relates to the relationship between real and reactive power. In an alternating current (AC) system the in-phase portions of voltage and current waveforms produce "active" or real power which is the capacity of the electricity system to perform work. The out of phase portions of voltage and current waveforms produce "reactive" power. The combination of active and reactive power is termed apparent power. A low or poor power factor will result in inefficiency due to high apparent power loading with a low real power delivery.

Evoenergy monitors power factor as part of its programmed proactive and reactive monitoring of the network. Evoenergy uses the ADMS to identify areas of the network that may be experiencing power factor issues. Metering data is also used to identify installations with power factor outside acceptable limits.

Consumers can gain significant benefits by improving the power factor at their premises. These benefits include reduced electricity costs, increased plant load capacity and utilisation, and better voltage regulation. Improvement of power factor is usually achieved by the installation of capacitors.

Evoenergy requires that the power factor at the point of common coupling between Evoenergy's network and the consumer's installation 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 Clause 3.6.3, Evoenergy is required to calculate and publish annually the distribution loss factors on its network. Publishing of the loss factors improves transparency of the network loss performance to retailers and consumers. Evoenergy calculates distribution loss factors for both site-specific consumers (embedded generators with output greater than 10 MW and load consumers with maximum demand greater than 10 MW or 40 GWhs consumption) and average DLFs for non-site-specific consumers. 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[39], and Evoenergy's published DLFs can be found on AEMO's website[40].

[39] https://www.evoenergy.com.au/-/media/evoenergy/about-us/evoenergy-loss-factor-methodology.pdf

[40] https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/loss_factors_and_regional_boundaries/2021-22/distribution-loss-factors-for-the-2021-22-financial-year.pdf?la=en

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