evoenergy

Annual Planning Report 2022

Version 1.1 | Effective Date: 31.12.2022

December 2022

Document management

Version control

Date	Version	Description	Author
	1.0	Initial Draft	Rebecca Beasley
	1.1	Final Draft	Rebecca Beasley

Approval

Date	Name	Position	Signature
	Rebecca Beasley	Author	
	Leylann Hinch	Group Manager	
	Peter Billing	General Manager	

Evoenergy contact in relation to this report:

Planning & Future Networks
GPO Box 366
Canberra ACT 2601
Email: APR@evoenergy.com.au

Acknowledgement of Country

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

Featured artwork

"The Energy of Connection"
By Shaenice Allan

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

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 Distribution Network Service Provider in the Australian Capital Territory (ACT).

While care was taken in preparation of this report, to the maximum extent permitted by law, Evoenergy makes no representation or warranty (express or implied) as to the quality, currency, accuracy, reliability, or completeness of the information contained in this document, or its suitability for any intended purpose. Persons reading or accessing this report acknowledge and accept that Evoenergy (which, for the purposes of this disclaimer, is a reference to the ActewAGL Distribution partnership, the individual partners and their parent companies and includes all of its related bodies corporate, its officers, employees, contractors, agents and consultants, and those of its individual partners, their parent companies and related bodies corporate) shall have no liability (including liability to any person by reason of negligence or negligent misstatement) for any statements, opinions, information or matter (expressed or implied) arising out of, contained in, or derived from, or for any omissions from, the information in this report. This report contains certain predictions, estimates, and statements that reflect various assumptions. Those assumptions may or may not prove correct, may change over time, and depend upon a range of factors that are outside the control of Evoenergy.

Persons accessing this report should conduct their own inquiries to independently verify and check the quality, currency, accuracy, completeness, reliability and suitability of the information that this report contains and any reports or other information identified as having been used to prepare this report.

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 2023. 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.

Table of Contents

Annual Planning 1
List of Figures 5
List of Tables 7
Executive Summary 10
Transforming Our Business For The Future 10
Evoenergy Snapshot 11
Working With Stakeholders On Solutions 19
Chapter Overview 20
Chapter 1: Opportunities For Interested Parties 21
1.1 Engagement In Broad-Based Demand Management Programs 23
1.2 Engagement In A Targeted Initiative 23
1.3 Engagement In A Regulatory Investment Test 26
1.4 General Feedback And Suggestions 28
Chapter 2: About Evoenergy 29
2.1 Introduction 29
2.2 Evoenergy's Physical Environment 31
2.3 Regulatory Environment 34
2.4 Factors Impacting Future Network Development 35
Chapter 3: Asset Life Cycle Management 42
3.1 Asset Management Approach And Components 42
3.2 Network Planning Methodology 44
3.3 Risk Based Probabilistic Planning 44
3.4 Management Of Existing Assets 46
3.5 Asset Maintenance 48
3.6 Annual Planning Report (This Document) 48
Chapter 4: Network Performance 50
4.1 Network Reliability 50
4.2 Power Quality 52
Chapter 5: System Load And Energy Demand, And The Supply-Demand Balance 58
5.1 Introduction 58
5.2 System Demand 59
5.3 Zone Substation Load Forecasts 64
5.4 Load Transfer Capability 69
Chapter 6: Managing Existing Assets 71
6.1 Primary Systems 71
6.2 Secondary Systems 82
6.3 Information And Operational Technology 91
Chapter 7: System Planning 98
7.1 Network Planning - What Are The Main Challenges 98
7.1 Network planning - what are the main challenges 98
7.2 Joint Planning With Transgrid 99
7.3 Inter-Regional Impact of Projects & Relevant National Transmission Flow Path Developments 100
7.4 Urgent And Unforeseen Need 100
7.5 Planning Outcomes - Network Constraints And Limitations 100
7.6 Projects Currently In-Progress 105
7.7 Projects Completed 115
7.8 Proposed Network Developments 116

7.9 Constraints Requiring Detailed Technical Studies 131
7.10 Regulatory Investment Test 132
Chapter 8: Demand Management 133
8.1 Overview 133
8.2 Demand Management Challenges 133
8.3 Demand Management Initiatives 134
8.4 Demand Management Future 135
Chapter 9: Future Ways Of Working 137
9.1 Overview 137
9.2 Project Converge 137
9.3 Ginninderry Energy Pilot Project 138
9.4 Tariff Trials 139
9.5 Innovation Projects 140
Appendix A: Glossary of Terms 143
Appendix B: Network Physical Characteristics 145
Configuration Of The Evoenergy's Network 145
System Supply Security 146
Ratings Of Zone Substations And Transmission Lines 148
Appendix C: The Regulatory Framework And Operating Environment 160
Incentive Schemes 161
Appendix D: Asset Management System Certification 164
Appendix E: Demand Forecasts – Supplementary Information 165
Overview 165
Key Forecasting Terms As Applied By Evoenergy In This Report 166
Appendix F: Network Reliability Standards And Performance 184
Key Definitions 184
Reliability Strategy And Plan 187
Minimisation 188
Restoration 188
Appendix G: Power Quality Standards And Performance 189
Power Quality Standard And References 189
Power Quality Parameters 189
Appendix H: Network Technical Parameters And Systems 195
Key Network Systems 195
Key Network Technical Parameters 198

List of Figures

Figure 1	Summer And Winter Historical Demand And Forecast With Probability Of Exceedance Forecast (PoE)	12
Figure 2	Overview - Network Limitations Heat Map	16
Figure 3	Overview - Rooftop Photovoltaic Generation Heat Map	18
Figure 4	Four Paths Of Engagement	22
Figure 5	Process Overview - Projects Not Subject To Regulatory Investment Test	25
Figure 6	Process Overview - Projects Subject To Regulatory Investment Test	27
Figure 7	Evoenergy Within The Industry Supply Chain	30

Figure 8	Evoenergy's Transmission Network Dec 2022 - Geographic Representation	32
Figure 9	Evoenergy's Existing And Future Transmission Network - Schematic Representation	33
Figure 10	Utility Regulation Framework - Main Elements	34
Figure 11	Towards The Future Network	38
Figure 12	Asset Management And Network Planning - Overview Of Key Artefacts	43
Figure 13	Overview - Probabilistic Risk-Based Investment Decisions	45
Figure 14	Optimising Asset Retirement And Renewal - An Overview	47
Figure 15	Annual Planning Review - Outline Of The Process	49
Figure 16	SAIDI - Unplanned Interruptions Per Consumer (Minutes Per Consumer Per Year)	50
Figure 17	SAIFI - Unplanned Interruptions Per Consumer (Number Of Interruptions Per Consumer Per Year)	51
Figure 18	Power Quality Enquiries And Complaints By Financial Year	53
Figure 19	Power Quality Investigation (a) Triggers And (b) Outcomes For The 2021/22 Financial Year	53
Figure 20	PV Installed By Financial Year	54
Figure 21	Network Steady State Voltage Performance By Week	55
Figure 22	2022 Summer Maximum Demand Day Load Profiles	59
Figure 23	2022 Winter Maximum Demand Day Load Profiles	**59**
Figure 24	10-Year Whole-System Summer And Winter Maximum Demand Forecast	61
Figure 25	10-Year Whole-System Summer And Winter Maximum Demand Forecast	63
Figure 26	Gold Creek Substation 12-Year Forecast	64
Figure 27	Gilmore Substation 12-Year Forecast	65
Figure 28	East Lake Substation 12-Year Forecast	66
Figure 29	Belconnen Substation 12-Year Forecast	67
Figure 30	Woden Substation 12-Year Forecast	68
Figure 31	Fyshwick Zone Substation: Outdoor Wooden Pole Strung Busbars. Indoor 66kV Electromechanical Protection Relays	77
Figure 32	Fibre Optic Network - Northern ACT	85
Figure 33	Fibre Optic Network - Southern ACT	86
Figure 34	Representation of IEC 61850 substation compared to legacy scheme	88
Figure 35	Evoenergy's 132kV Transmission Lines And Proposed Molonglo Zone Substation Site	106
Figure 36	Causeway Switching Station	128
Figure 37	Causeway Switching Station - Proposed 132kV Cabling	129
Figure 38	Future (10 years) Transmission Network	130
Figure 39	Distribution of Domestic Rooftop Solar PV Installations Throughout the ACT	153
Figure 40	Seasons Across One Financial Year	167
Figure 41	Belconnen Substation 12-Year Summer And Winter Demand Forecast Chart	177
Figure 42	City East Substation 12-Year Summer And Winter Demand Forecast Chart	177
Figure 43	Civic Substation 12-Year Summer And Winter Demand Forecast Chart	178
Figure 44	East Lake Substation 12-Year Summer And Winter Demand Forecast Chart	178
Figure 45	Fyshwick Substation 3-Year Summer And Winter Demand Forecast Chart	179
Figure 46	Gilmore Substation 12-Year Summer And Winter Demand Forecast Chart	179
Figure 47	Gold Creek Substation 12-Year Summer And Winter Demand Forecast Chart	180
Figure 48	Latham Substation 12-Year Summer And Winter Demand Forecast Chart	180
Figure 49	Telopea Park Substation 12-Year Summer And Winter Demand Forecast Chart	181
Figure 50	Theodore Substation 12-Year Summer And Winter Demand Forecast Chart	182
Figure 51	Wanniassa Substation 12-Year Summer And Winter Demand Forecast Chart	182
Figure 52	Woden Substation 12-Year Summer And Winter Demand Forecast Chart	183

List of Tables

Table 1	Existing And Emerging Limitations Of The Transmission Network And Distribution Network	14
Table 2	Identified Retirements Of Major Assets	17
Table 3	10-Year Summer And Winter Maximum Demand (MW) Forecast	61
Table 4	10-Year Whole-System Day And Night Minimum Demand Forecast (MW)	63
Table 5	Load Transfer Capacity (MW) Between Evoenergy's Zone Substations In Summer	69
Table 6	Load Transfer Capacity (MW) Between Evoenergy's Zone Substations In Winter	70
Table 7	Asset Specific Plans (ASP)	72
Table 8	Completed Asset Replacement Program	75
Table 9	Identified Retirements Of Major Assets	76
Table 10	Identified Group Asset Retirements	79
Table 11	Secondary System Projects	90
Table 12	Summary Of Information Technology And Operation Technology Program	92
Table 13	Network Limitations	103
Table 14	Locations Where Constraints Are No Longer Applicable	105
Table 15	Forecast Load of Feeders Supplying the Molonglo Valley	106
Table 16	Supply To Whitlam Options Summary	108
Table 17	Supply To Denman Prospect Options Summary	109
Table 18	Supply To Dickson Options Summary	110
Table 19	Gold Creek Zone Substation Load Forecast	111
Table 20	Supply To Gold Creek Options Summary	111
Table 21	Supply To Pialligo Options Summary	113
Table 22	Supply To Canberra CBD West Options Summary	113
Table 23	Supply To Strathnairn Options Summary	116
Table 24	Supply To Donaldson Street, City, Options Summary	117
Table 25	Supply To Kingston Options Summary	118
Table 26	Supply To Lyneham Options Summary	119
Table 27	Supply To Woden/Phillip Options Summary	120
Table 28	Supply To Fairbairn South Options Summary	121
Table 29	Supply To Gungahlin Town Area Options Summary	122
Table 30	Supply To Hume West	123
Table 31	Supply To Fyshwick Dairy Road Options Summary	124
Table 32	Supply To CBD South - S 3 Parkes & S 37 City, Options Summary	125
Table 33	Supply To Tuggeranong Mixed Developments, Options Summary	126
Table 34	Nona Feeder Reliability Improvement Options Summary	127
Table 36	Electric Vehicle Based Innovation Projects	141
Table 37	Solar PV Based Innovation Projects	142
Table 37	Evoenergy Network Assets	148
Table 39	Evoenergy's Zone Substations	149
Table 40	Evoenergy Transmission Line Ratings	150
Table 41	PV Installations - Number of Enquiries, Number of Applications and Time to Process Applications; FY 2022 - 2023	151

Foreword

Our expanding electricity network provides essential electricity services to over 207,000 Canberran residents and businesses. The ACT's energy needs are growing and changing, and we know that innovative network planning is critical to ensure we continue to provide safe, reliable, and affordable electricity to the community.

The ACT Government's 2022 policy announcements: the 2022–30 Zero Emissions Vehicles (ZEVs) Strategy, and Powering Canberra: Our Pathway to Electrification, will drive the ACT's transition to full electrification at an accelerated pace and we must ensure our network is planned and managed accordingly. We are continuing to transform how we plan, build, and operate our network to support changing consumer expectations and support achievement of the ACT Government's net zero targets.

We have seen challenges in the energy sector this year including severe storm damage to the electricity network in Belconnen in January, and signals from the Australian Energy Market Operator (AEMO) in June that we were experiencing a lack of electricity reserves. These events have highlighted new opportunities and improvements in the way we serve our community—who are becoming more involved in all aspects of the energy system.

We continue to transform our network from providing a one-way flow, to facilitating bi-directional electricity to and from our customers. Customers are increasingly choosing how they want their electricity supplied and delivered with a growing number of options for producing, distributing, and storing electricity. We have seen an increased year on year uptake of solar panels (34%[1]), small-scale batteries (96%[2]) and electric vehicles (81%[3]) and we expect these increases to continue.

This year, we have undertaken community consultation for our 2024–29 Electricity Network regulatory proposal and Tariff Structure Statement. Our proposal sets out how much we need to spend in the coming five years to operate, maintain, and invest in our electricity network as we focus on balancing the need to prepare for the future with keeping costs as low as possible. From our community consultation we have heard that consumers want us to consider net zero emissions targets in our planning and that we invest in our network to ensure it is capable of meeting these needs.

This year, Evoenergy's annual planning report focuses on providing safe and reliable electricity supporting existing urban area development and electrification as our population continues to grow and we embark on the energy transition towards net zero emissions by 2045.

Peter Billing
Evoenergy General Manager

1 Based on increase in total installed panel size

2 Based on increase in total installed battery capacity for small-scale installations

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

Introducing Evoenergy

Evoenergy owns and operates electricity and gas networks and is licensed by the Independent Competition and Regulatory Commission (ICRC) to provide distribution, and connection services in the ACT. Evoenergy is a Distribution Network Service Provider registered with the Australian Energy Market Operator (AEMO). We are a regulated service provider subject to commonwealth and jurisdictional laws and statutory instruments including National Electricity Law (NEL), National Electricity Rules (NER), Utilities Act 2000, Utilities Technical Regulations Act, industry codes, technical codes, and regulations. The NER require Evoenergy to undertake annual planning review and prepare the Annual Planning Report. Our "poles and wires" network is supplied predominantly by power imported from interstate. There is an increasing amount of power generation embedded within Evoenergy's network with 64,250kVA of rooftop PV capacity 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 5.13.2 and Schedule 5.8 Distribution Annual Planning Report (DAPR).

"A sustainable business, energising our evolving community".

Executive Summary

Transforming Our Business For The Future

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

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

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

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

COVID-19 Operations

For most of 2022 Evoenergy has been working with special restrictions and precautions to manage the risk around COVID-19 and ensure our staff and the community are kept safe. For the first part of the year 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. Restrictions have been progressively rolled back, however Evoenergy continues to closely monitor the situation and is implementing measures as required. As the COVID-19 situation evolves and ACT restrictions begin to change Evoenergy will continue to adapt while ensuring safety and reliability are prioritised.

January 2022 Storm

The severe supercell storm that swept through north-western Canberra on Monday 3 January 2022 caused serious and extensive damage to Evoenergy's electricity network assets. Damage from the storm resulted in the loss of electricity supply for more than 21,000 of our customers in the Molonglo Valley, Belconnen, and Gungahlin.

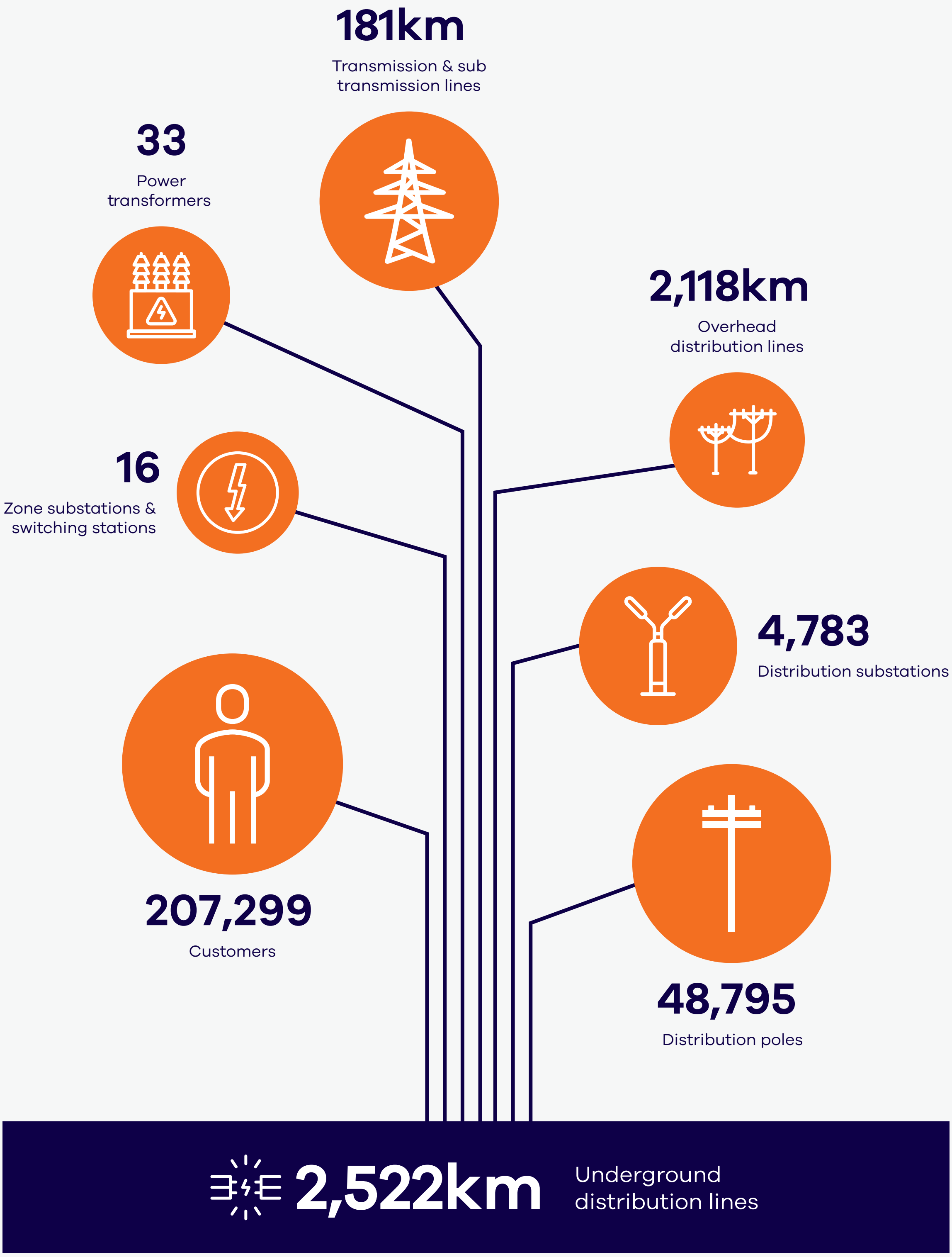
The scale of damage caused by this storm to our overhead electricity network was the largest since the damage of the 2003 bushfires.

In the first few hours and into the night, Evoenergy crews restored electricity supply to more than 18,000 customers. During the following six days, supply was gradually restored to all customers initially impacted, with the exception of a small number who required private contractors to repair internal damage.

The storm caused damage to more than 550 electrical assets. With the assistance of supplementary crews from Endeavour Energy, 190 service lines were replaced, 50 powerlines restrung, 20 cross arms, and 11 power poles replaced. Our focus during this time was working as quickly and safely as possible to return supply to our customers and replace damaged assets. The safety of our staff and the community is always our first priority.

The intensity and frequency of severe storm events are increasing, and we are committed to ensuring that we can adapt and respond effectively to our changing climate and environment. As part of Evoenergy's continuous improvement approach, a post January storm incident review was undertaken. Evoenergy has implemented a number of process improvements which will further improve how we scale up operations and support our customers during severe storm events.

Evoenergy Snapshot



Safety

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

POWERED BY **SAFETY**

System Level Demand

The second year of La Niña in 2022 led to a very mild summer season and a harsher winter season. This was reflected in the demand as we saw a significant decrease in summer electricity demand with a peak of 440MW (14% decrease from the 2021 peak summer demand), and a significant increase in winter demand to 685MW (9% increase on the 2021 peak winter demand). La Niña is expected to continue through summer of 2022/23.

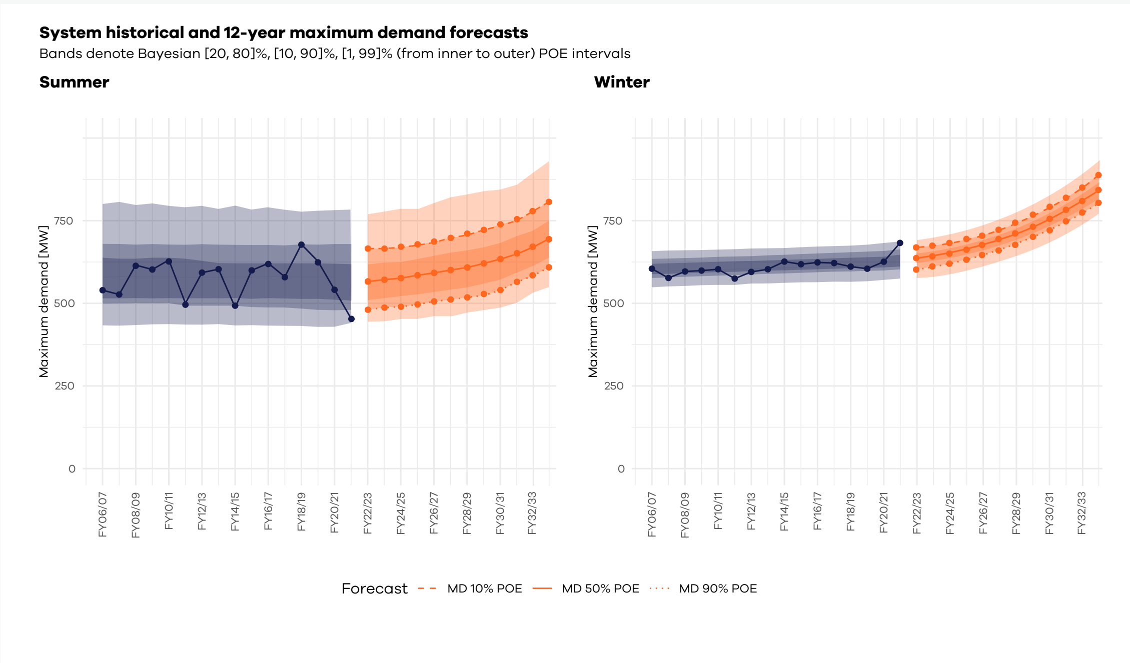
The 2022 forecast peak demand for network-delivered energy shows significant growth over the next decade in both summer and winter peak demand over the next ten years. This increase is primarily due to net-zero driven growth in electric vehicle charging, and electrification of the gas network, as well as population growth and large data centre connections in the region.

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

These trends are illustrated in the following historical and 10-year maximum demand forecast 2022.

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.

Figure 1. Summer And Winter Historical Demand And Forecast With Probability Of Exceedance Forecast (PoE)



The Net Zero Transition And Shift In Energy Sources

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

Evoenergy has undertaken detailed modelling to understand the potential impacts of NZE by 2045 for the Evoenergy energy networks in the ACT. This dynamic, strategic tool will enable future planning to prudently prepare and incrementally progress a consumer-centric, net zero transition roadmap prioritising safety, sustainability, and security, balanced against reliability, and affordability. Evoenergy will continue to collaborate with key stakeholders including the ACT Government and the community through the energy transition as we work towards a net zero future.

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

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

Localised Constraints

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

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

Molonglo Valley Demand Constraints

In 2020 Evoenergy completed a Regulatory Investment Test for Distribution (RIT-D) process for constraints in the Molonglo Valley due to significant growth as a result of new greenfield residential developments. As part of this process Evoenergy identified that a non-network solution, such as a network scale battery, could be used to defer the required construction of a zone substation. Evoenergy is currently working with a proponent to implement a battery energy storage system (BESS) at the site of the future Molonglo Zone Substation. This solution is planned to be operational by winter 2023.

Gold Creek Demand Constraints

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

Overview Of Constraints

Table 1. Existing And Emerging Limitations Of The Transmission Network And Distribution Network

Location	Network element	Limitation	RIT-D	MVA required	Consult	Decision	Required	Estimated cost***	Project reference
Molonglo Valley	Zone Substation & Feeders	Capacity	Yes	4.5	Dec-19	Jun-20	Feb-22	$30.5m	7.6.1
Whitlam	Feeder	Capacity	No	15.8	Jun-21^	Oct-21	Sep-22	$1.3m	7.6.2
Denman Prospect	Feeder	Capacity	No	8.9	Feb-22	May-22	Apr-22	$1.8m	7.6.3
Dickson - Dooring St	Feeder	Capacity	No	4.1	Dec-19^	Jun-20	Feb-22	$3.8m	7.6.4
Gold Creek Zone	Zone Substation	Capacity / Reliability	Yes	-	Dec-22	Feb-23	Apr-25	$8.6m	7.6.5
Fyshwick	Feeder	Capacity	No	40	Jun-21	Dec-21	Dec-23	$5.5m	7.6.6
Pialligo	Feeder	Capacity	No	8	Dec-21^	Mar-22	Jun-23	$4.8m	7.6.7
CBD West	Feeder	Capacity	No	5.6	Dec-22	Mar-23	Apr-24	$3.7m	7.6.8
Gilmore	Zone Substation	Capacity / Reliability	No	-	Dec-21	Apr-22	Oct-23	$2.5m	7.6.9
Strathnairn	Feeder	Capacity	No	3.4	Dec-22	Mar-23	Mar-25	$2.1m	7.8.1
City - Donaldson	Feeder	Capacity	No	1.4	Dec-22	Jun-23	Apr-25	$3.4m	7.8.2
Kingston^^	Feeder	Capacity	No	-	Dec-25	Jun-26	Apr-28	$1.0m	7.8.3
Lyneham	Feeder	Capacity	No	2.1	Dec-25	Jun-26	Apr-28	$5.3m	7.8.4
Woden/Phillip	Feeder	Capacity	No	3.9	Dec-22	Mar-23	Apr-25	$4.1m	7.8.5
Fairbairn South^^	Feeder	Capacity	No	-	Dec-26	Jun-27	Apr-29	$1.6m	7.8.6
Gungahlin Town Centre	Feeder	Capacity	No	4.9	Dec-23	Jun-24	Apr-26	$5.2m	7.8.7
Hume West	Feeder	Capacity	No	1.1	Dec-24	Jun-25	Apr-27	$2.3m	7.8.8
Fyshwick Dairy Road	Feeder	Capacity	No	6.8	Dec-23	Jun-24	Apr-26	$0.7m	7.8.9
CBD South	Feeder	Capacity	No	0.1	Dec-24	Jun-25	Mar-27	$5.0m	7.8.10
Greenway	Feeder	Capacity	No	0.9	Dec-22	Mar-23	Mar-24	$2.8m	7.8.11
North Canberra	Transmission	Voltage	No	-	Jun-23	Dec-23	Jun-25	TBC	7.9.1
Gold Creek Zone	Zone Substation	Voltage	No	-	Dec-22	Jun-23	Jun-25	TBC	7.9.7
Ginninderry^^	Zone Substation & Feeders	Capacity	Yes	-	Dec-23	Jun-24	Sep-27	$28.6m	7.9.2

***** 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

^^ Constraint forecast beyond 2027 planning horizon

Table 1. Existing And Emerging Limitations Of The Transmission Network And Distribution Network

Location	Network element	Limitation	RIT-D	MVA required	Consult	Decision	Required	Estimated cost***	Project reference
Belconnen Zone	Zone Substation	Capacity / Reliability	Yes			2029-34 period			7.9.3
Mitchell	Zone Substation & Feeders	Capacity	Yes			2029-34 period			7.9.4
Curtin	Zone Substation & Feeders	Capacity	Yes			2029-34 period			7.9.5
East Lake Zone	Zone Substation	Capacity / Reliability	Yes			2029-34 period			7.9.6
Various Net Zero Feeders	Feeders	Capacity	TBC			Pending additional analysis			7.9.8

***** 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

^^ Constraint forecast beyond 2027 planning horizon

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

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

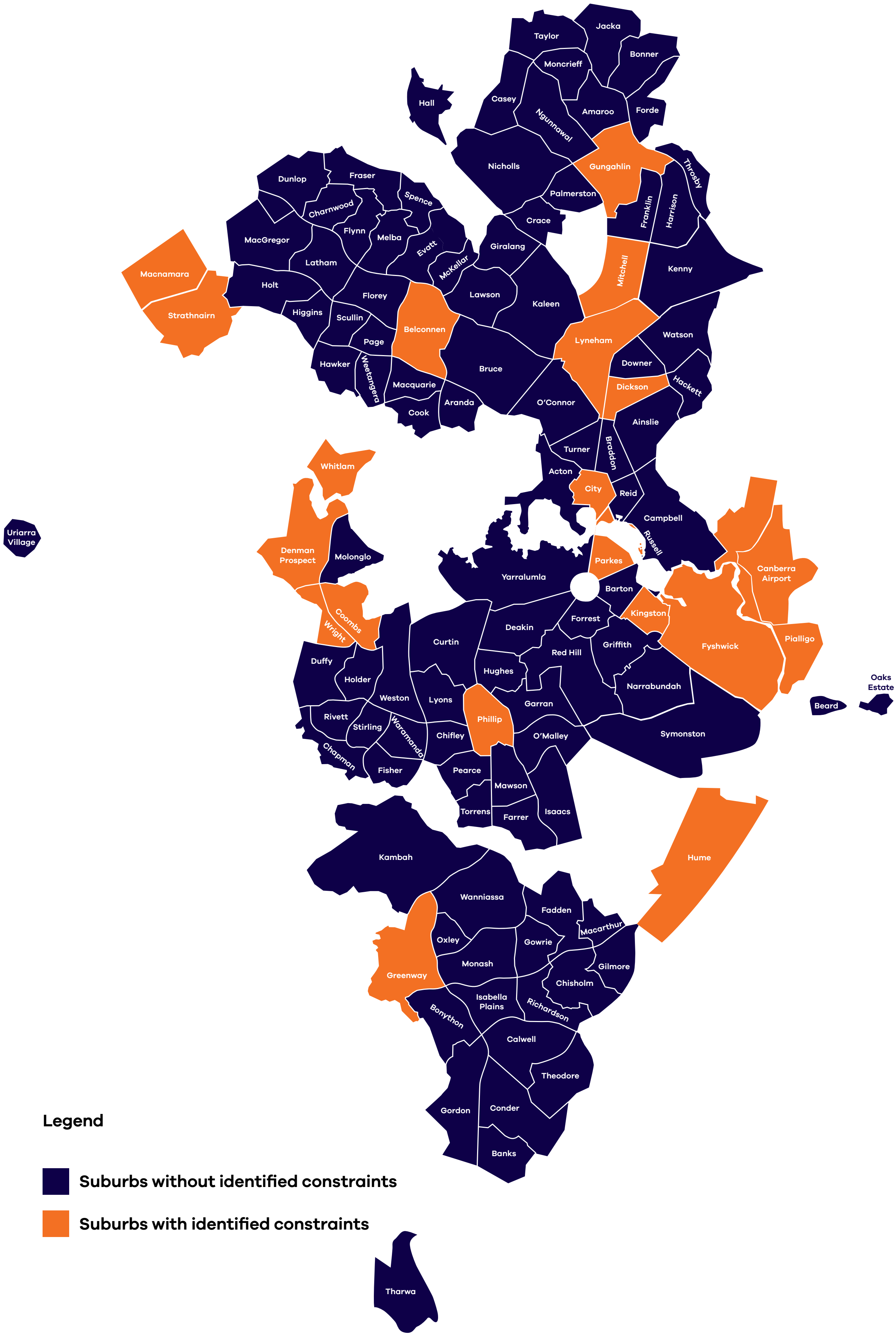
In addition to these localised capacity constraints, the make-up of electricity demand is changing in the ACT; specifically around consumers driving localised growth in electricity demand, where electricity is sourced, and the impact that is having on network utilisation and performance.

Load growth has been primarily driven by:

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

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

Figure 2. Overview – Network Limitations Heat Map



Network Performance

Evoenergy continues to focus on the management of existing assets taking into account asset performance and risks relating to asset condition, age and criticality. Our annual planning review process identified a need for several major asset retirements over the 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	132kV Circuit Breaker	Asset condition & performance	No	$0.35m	N/A	Mar 2020 complete	Jun 2021 complete
Fyshwick Zone Substation	66kV Assets	Asset condition & performance	No	$2.1m	Jun 2021 complete	Dec 2021 complete	Jun 2024
Latham Zone Substation	Substation Switchboard	Asset condition & performance	No	$3.1m	Dec 2022	Jun 2023	Jun 2025
Wanniassa Zone Substation	Substation Switchboard	Asset condition & performance	No	$3.1m	Dec 2022	Jun 2023	Jun 2026
Telopea Zone Substation	Power Transformer[4]	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 amongst its peers in Australia. We are subject to the Australian Energy Regulator's (AER) reliability performance targets for unplanned outages and local jurisdictional ACT reliability targets for planned and unplanned outages. Our current strategic intent is to maintain reliability performance within the existing regulatory targets and ensure we comply with our license conditions. Our plan to address key reliability challenges is to develop a more responsive network through investment in people, process and technology, embed risk-based asset management and incorporate best practice vegetation management.

Power Quality - Voltage Regulation

One of the most important planning considerations affecting forecast demand is the gradual shift from electricity generated and transmitted outside the ACT to embedded generation within the ACT, and unprecedented growth in "in front of the meter" and "behind the meter" generation. Forty-three (43) MW of large-scale solar generation is currently embedded in the ACT network. There is continued strong growth in rooftop photovoltaic generation with around 28% of all detached or semi-detached residential dwellings in the ACT now with photovoltaic installations. Over the 2021/22 financial year rooftop photovoltaic generation increased by 64.25MW, which was the highest annual increase on record, with total embedded generation capacity now approximately 254MW[5].

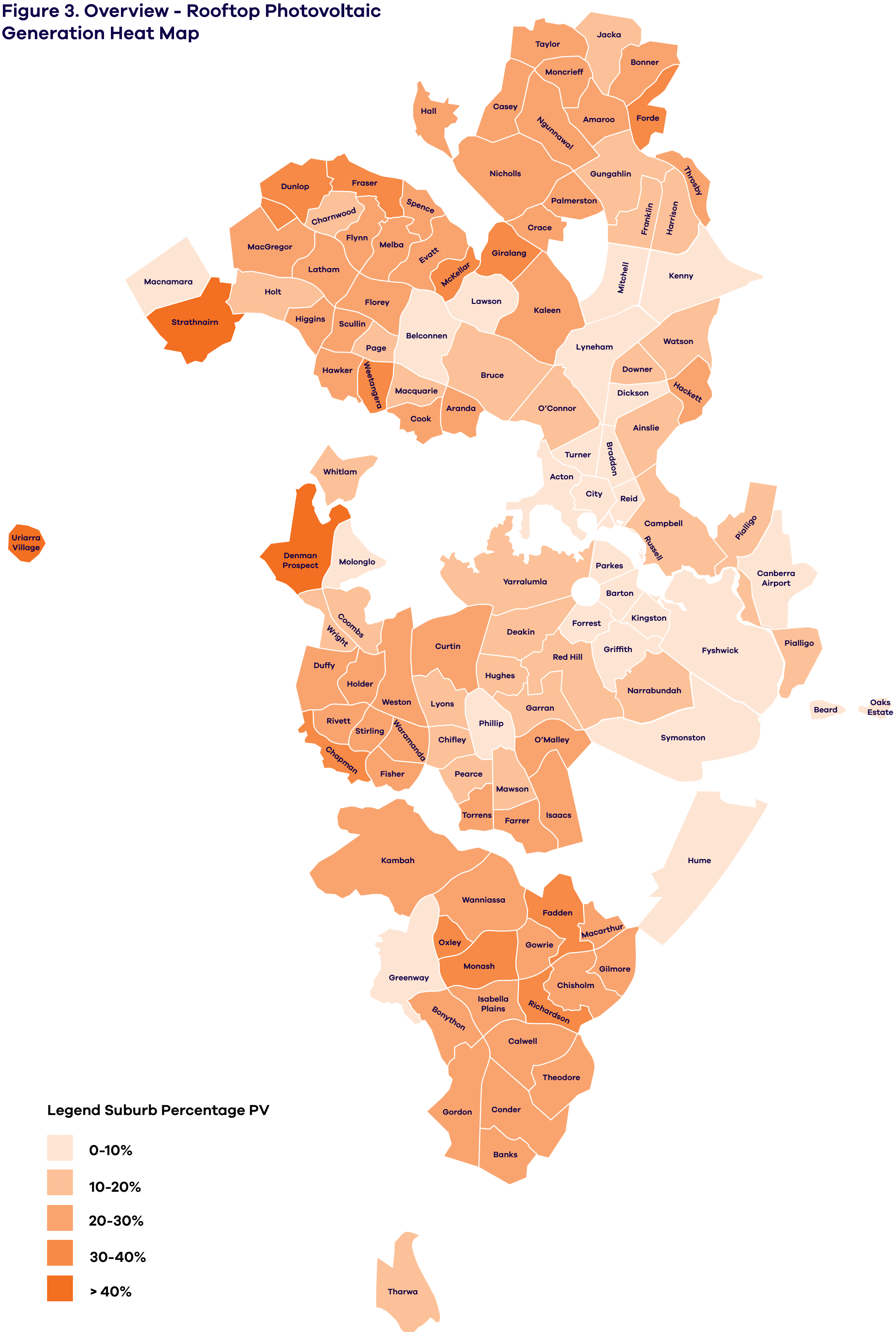
This presents a key challenge for Evoenergy as this increase in embedded generation creates two-way energy flows and potential over-voltages in some locations. The voltage regulation limitations usually occur in the locations where the penetration of photovoltaics is high, which may lead to power quality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

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

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

5 Based on recorded total panel size.

Figure 3. Overview - Rooftop Photovoltaic Generation Heat Map



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 in the Gold Creek Zone area which cannot be managed by the current zone transformer tap changing arrangement into the future. Evoenergy is currently assessing options including:

1. Replacing the power transformers with ones which have a greater tapping range
2. Install mechanically switched shunt reactors
3. Install power electronics solutions such as STATCOM or TCR devices
4. Seek non-network solution to manage reactive power such as network or community scale batteries, systemic reactive set point control of photovoltaic (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.

A technical study is currently underway which will inform the preferred solution and subsequent implementation project.

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 which are required go through the RIT process will have analysis performed to determine if there may be a preferred non-network solution to the constraint. The findings of this analysis are published in a non-network options report which is publicly available on the Evoenergy website and communicated to our Demand Management Register[6] 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

In 2021, we 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 operates in the National Electricity Market (NEM) through an aggregator.

Additionally, further systems have been planned in Greenfield suburbs of the ACT such as Jacka, proposed by the Suburban Land Agency (SLA)[7].

This is in addition to 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 the local energy policy directorates and other stakeholders to understand the impact of the ACT Governments' commitment towards investing in 250MW of BESS units supported by $100 million of government funding. The ACT Government battery scheme is being rolled out in three streams for transmission-scale batteries, batteries at government sites and distribution level batteries (suburb level). 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 energy consumers in the ACT.

6 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

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

Chapter 5:

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

Chapter 6:

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

Chapter 7:

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

Chapter 8:

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

Chapter 9:

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

Appendices:

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

Chapter 1: Opportunities For Interested Parties

Evoenergy is operating in a rapidly evolving energy environment. We are experiencing changes in technology, consumption patterns, consumer 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[8] 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 conducted according to our Stakeholder Engagement Strategy. For specific consultation matters additional plans or programs may be developed.

The Evoenergy Stakeholder Engagement Strategy[9] is available on the Evoenergy website. 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.

8 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.

9 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 meaningful 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.

1.1.1 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.

1.1.2 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.

1.1.3 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.

1.2.1 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 2022 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.

1.2.2 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.

1.2.3 How To Participate

Interested parties can register for targeted programs on the Evoenergy website. There are no obligations on your part if you register[10]. 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 5** provides a process overview including Evoenergy stakeholder engagement through demand side engagement strategy.

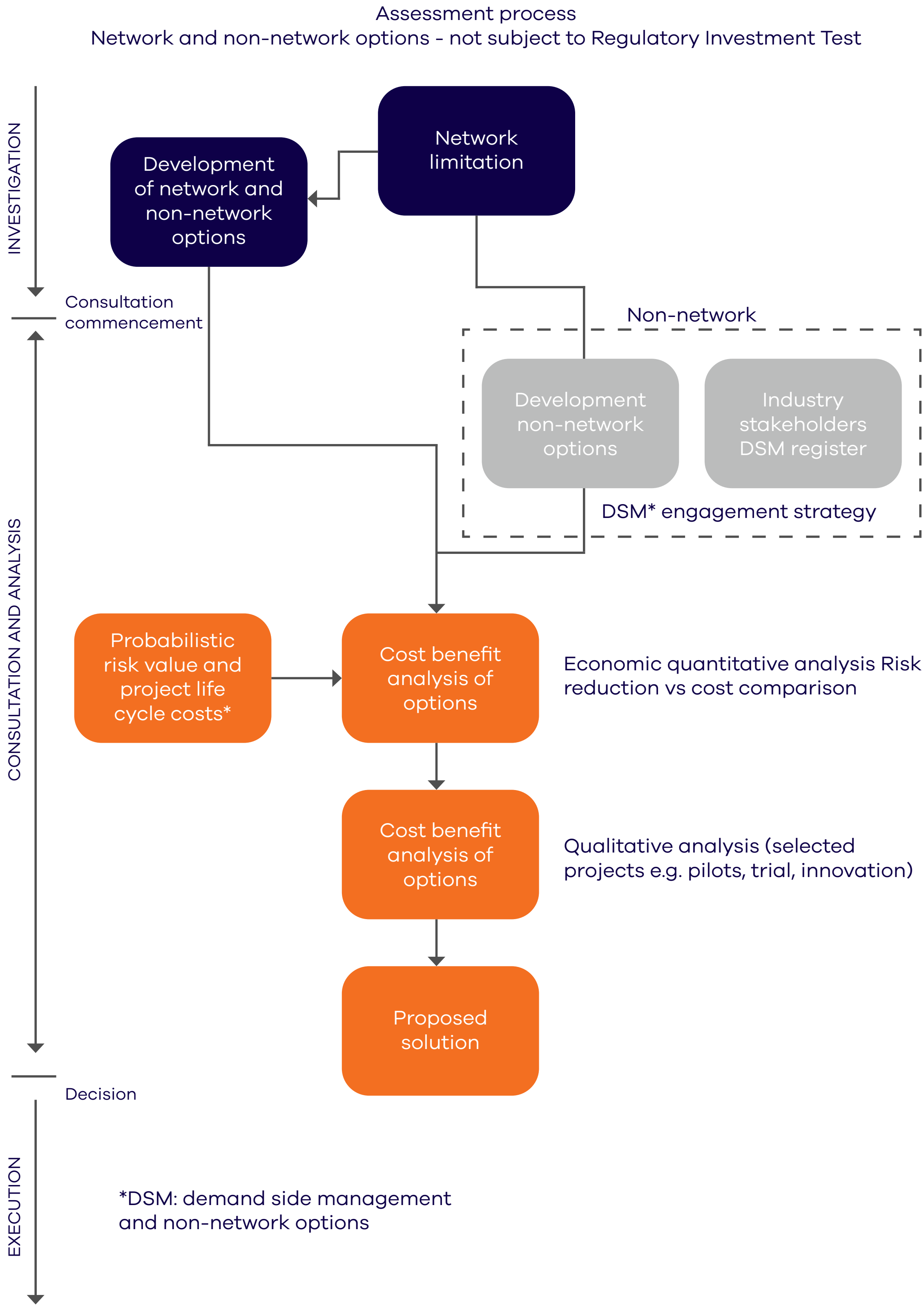
Our RFP will explain the network limitation, the timeline for resolution and possible solutions. The RFP will indicate what investment, capital contribution or incentive we are prepared to provide to external parties to resolve the issue.

Distribution and Transmission projects above $6 million are subject to mandatory Regulatory Investments Test[11] (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.

10 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

11 Projects above $6 million are subject to Regulatory Investment Tests.

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



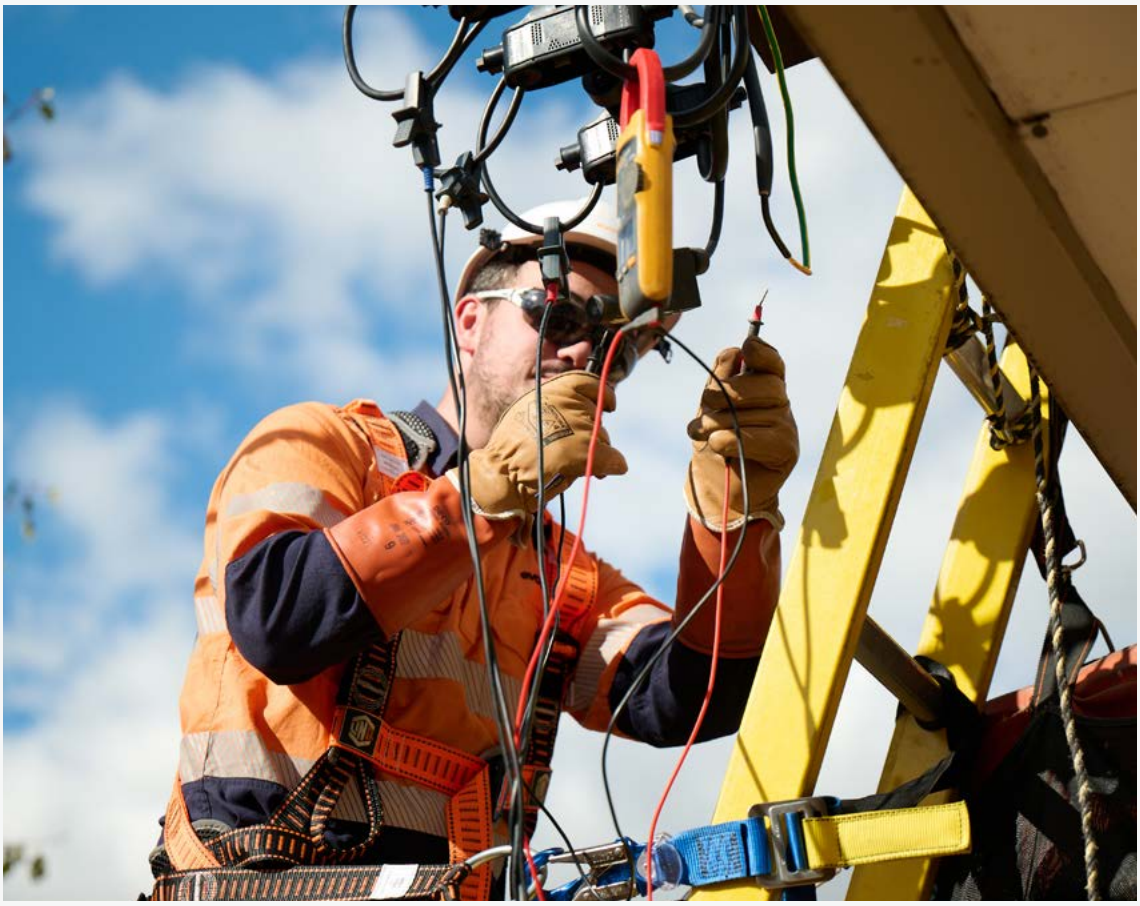
1.3 Engagement In A Regulatory Investment Test

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.

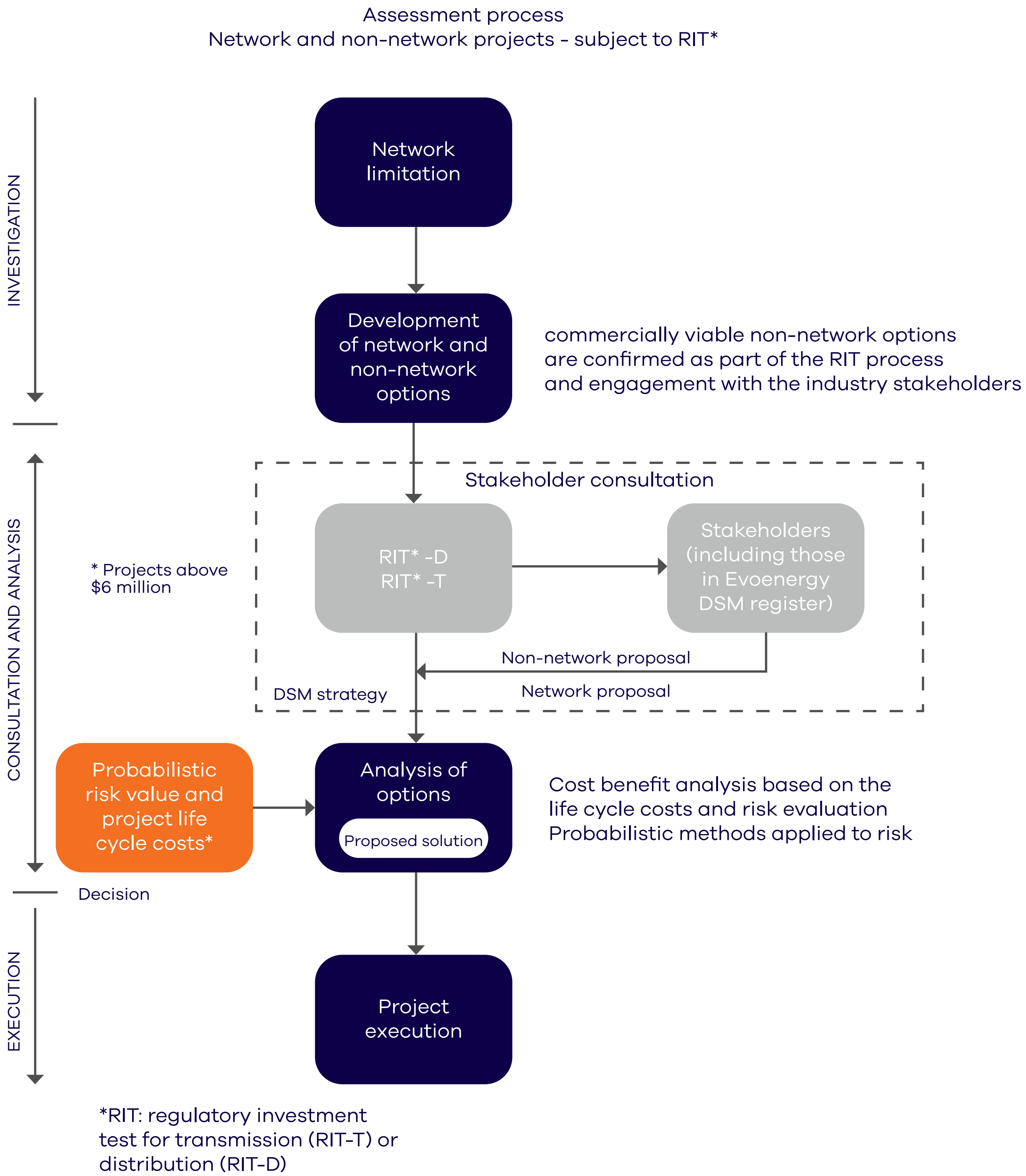
As part of the RIT process Evoenergy is required to publish a non-network options report (NNOR) detailing the analysis of the viability of non-network options when compared with the proposed network option(s). If it is determined that a non-network solution is potentially viable, Evoenergy can use the 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[12].



12 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 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.

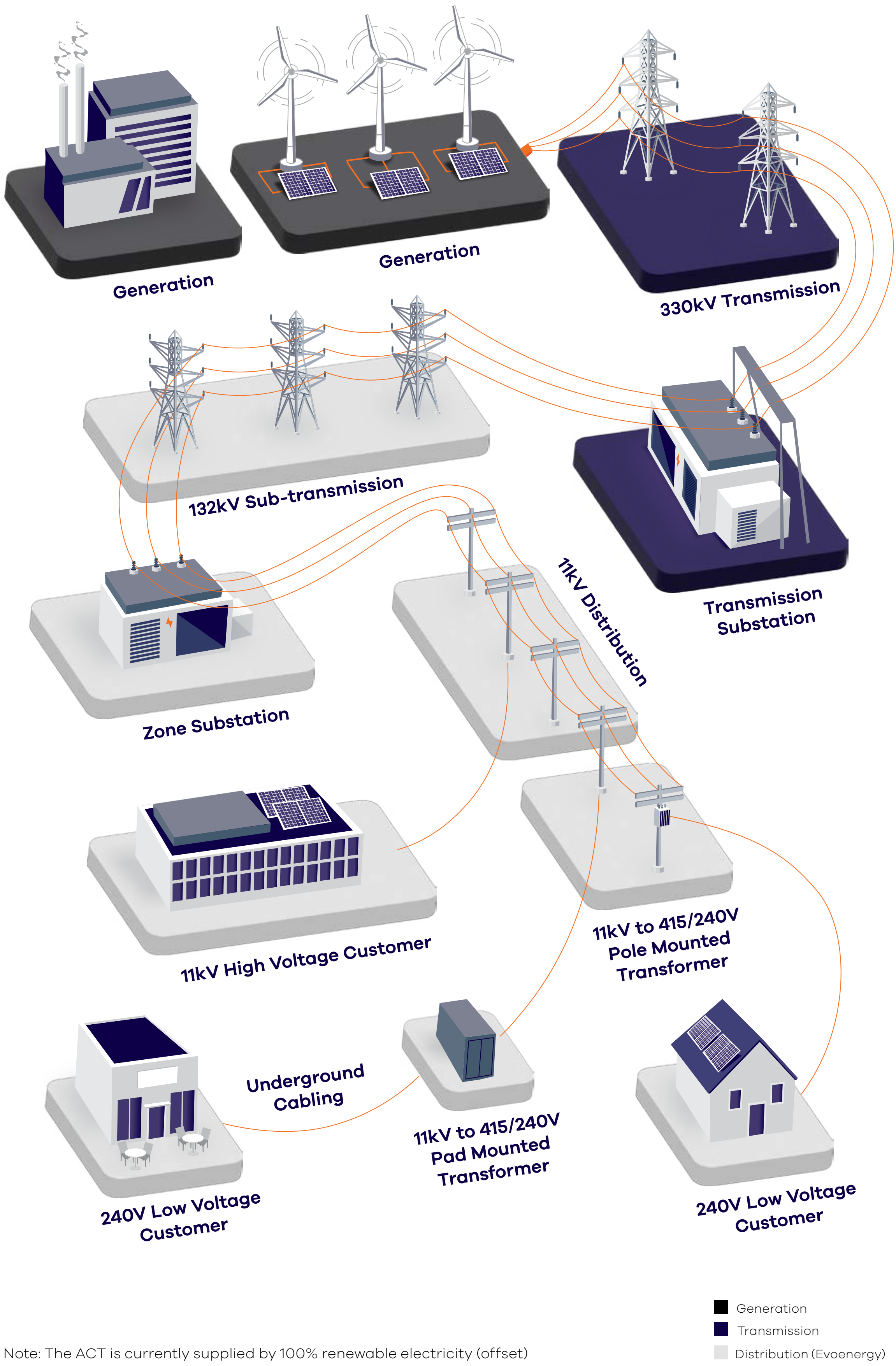
2.1 Introduction

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 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 7** 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 powerlines and other infrastructure used to distribute electricity through the network to your home or business. Evoenergy undertakes electricity network maintenance, connects new energy consumers, plans, and constructs new infrastructure and provides emergency responses.

Figure 7. Evoenergy Within The Energy Delivery Chain



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

2.2 Evoenergy's Physical Environment

Evoenergy provides electricity services over an area of 2,358 square kilometres to 207,299 electricity consumers as of 30 June 2022, within the ACT. It also supplies electricity to around 90 consumers in New South Wales.

Evoenergy owns and operates the electricity network which includes 188 kilometres of transmission lines, sixteen 132kV/11kV zone substations and switching stations, around 4780 distribution substations and over 4,138 km of distribution lines. More detailed statistical information on the network asset numbers is provided in **Table 38**.

Figure 8 and **Figure 9** 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 2022.

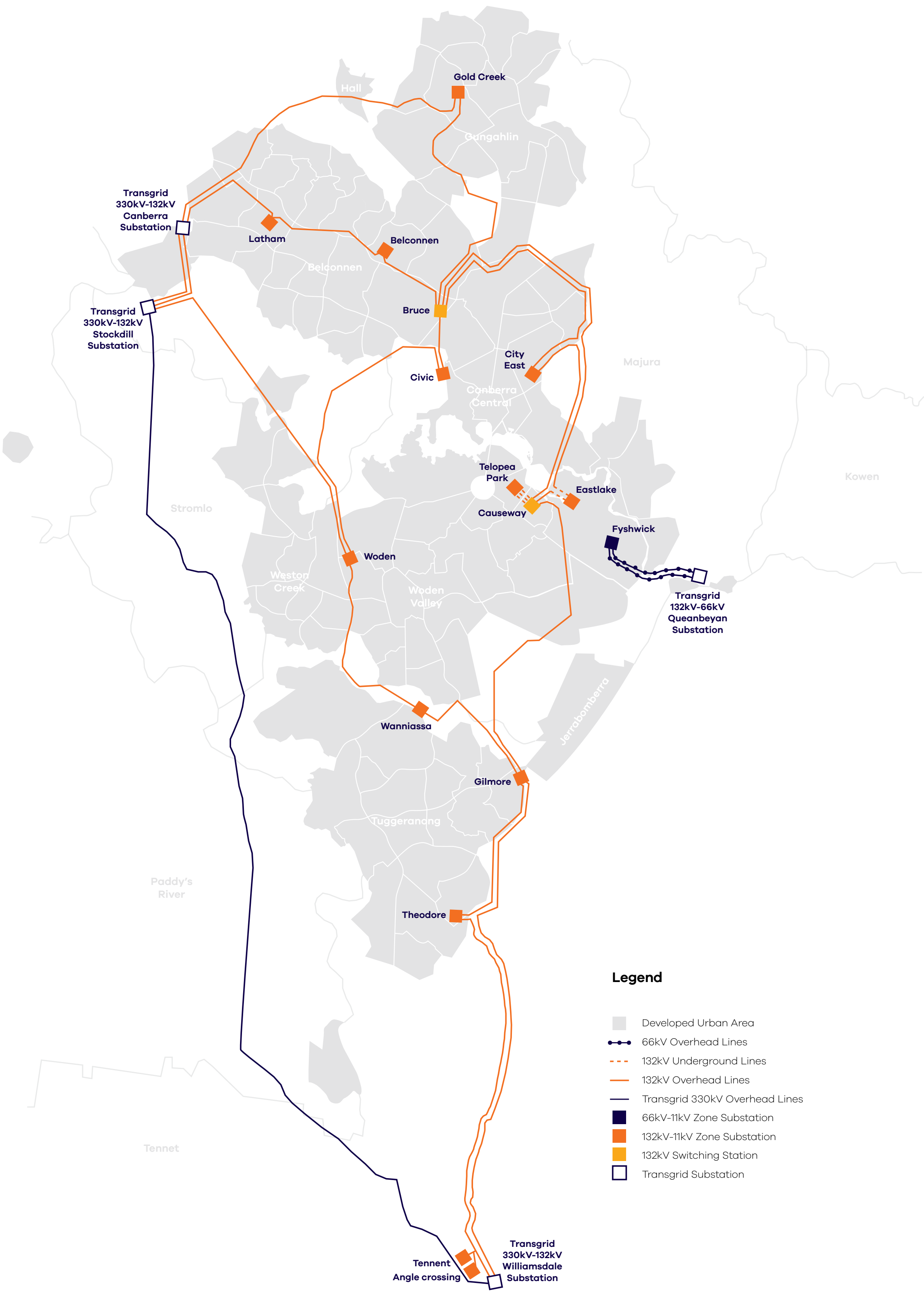
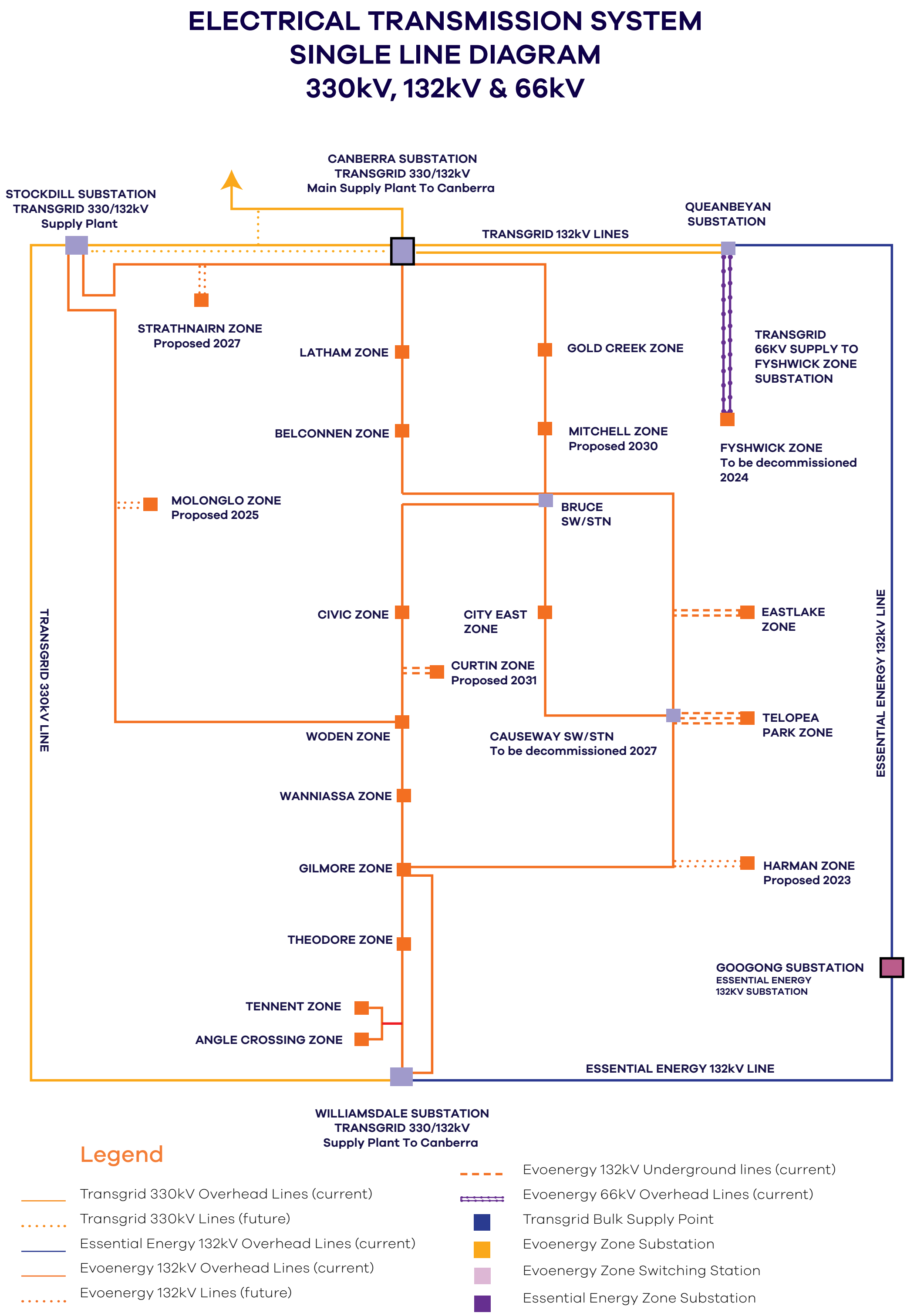


Figure 9 below depicts existing and future Evoenergy's transmission network and Transgrid's 330kV lines connecting Evoenergy's network through four bulk supply points (Canberra Substation, Stockdill Substation, Williamsdale Substation and Queanbeyan Substation) to the New South Wales transmission network. All the components marked for 132kV, 66kV and 11kV 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 330kV 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.

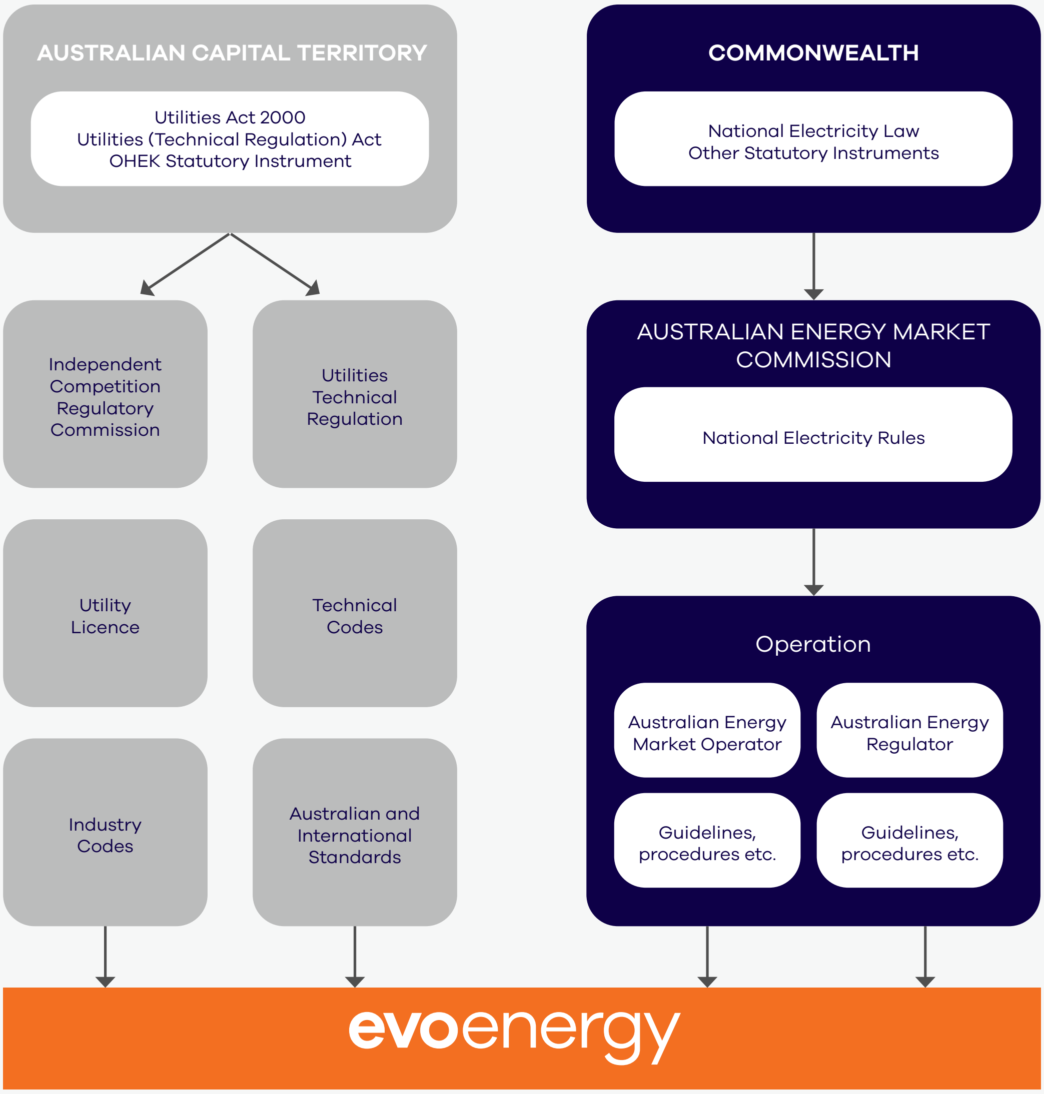
The way we plan our network is consistent with a range of obligations and regulatory instruments which support the National Electricity Objective (NEO):

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

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

Figure 10. Utility Regulation Framework – Main Elements



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

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

2.4 Factors Impacting Future Network Development

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

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

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

There are over 30,000 solar installations in the ACT, over 3,500 battery installations and the number of electric vehicles is on the rise demonstrating how forward thinking Canberran's are. The practical decisions Evoenergy makes in the short term to realise our energy vision are going to be essential to enable a smooth, affordable and equitable net zero transition by 2045. We continue to look at every aspect of how we operate and maintain our energy networks as well as monitoring external factors so we can plan the required future network development while keeping the safety of our people and the community at the centre of everything we do.

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

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

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

2.4.1 Government policies and long term context

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

Across the ACT network, 43MW of large-scale solar generation is currently embedded and there is around 30MW of new solar generation under consideration. The growth in rooftop photovoltaic generation continued last year with 64.25MW of additional capacity installed. Around a quarter of residential dwellings in the ACT have rooftop solar (PV) installations. The installed capacity of residential installations has increased by just over 34% the 2021/22 financial year. 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 Government energy policies point to the continuation of this trend. In 2022 the ACT Government announced full electrification as the pathway for the ACT to achieve net zero greenhouse gas emissions by 2045. Other Government policy includes the 100% renewable energy target, achieved in 2020 and which has been extended in perpetuity into the future. The 2019 government renewable auctions mandated provision of network batteries as part of the offer. The perpetual 100% renewable energy target means that future increases in energy consumption will have to be matched by additional renewable generation. The rapid uptake of distributed generation in the ACT is expected to continue. Consequently, Evoenergy predicts an increase in power quality challenges and electricity demand due to decarbonisation, gas substitution and electric vehicles.

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 64%. Most future transport scenarios, including whole electric, hydrogen and hybrid vehicles point to the likely increases in electrical energy requirements from the network. This report does not factor the impact of 2045 target which at the time of preparation of the report was subject to Government consultation.

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

2.4.2 Planning For Our Future Network

Evoenergy responds to the changing energy industry landscape. Energy consumers are embracing new technologies and increasingly taking control of their own energy generation, storage and usage. Power flows are becoming two-way, based on generation and demand patterns, and Evoenergy is evolving from a traditional DNSP to a Distributed System Operator (DSO). Evoenergy's strategic planning focus is to develop and operate the transmission and distribution networks effectively and efficiently catering 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 an overview of the changing business environment influenced by our key stakeholders.

Figure 11. Towards The Future Network

On-grid residential customers

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

Off-grid customers

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

Developers

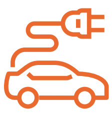
Increasing number of estates with compulsory renewable generation and battery storage. Estates requiring only limited support from the electricity network.

Government

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

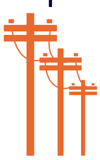
Commercial Customers

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



Zero emission vehicle owners

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



Demand management sector

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

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.

The ACT has the highest rate of EV sales of any state (83 EVs per 10,000 new car sales)[13]. 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**.

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.

2.4.3 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 whole of Evoenergy's system, zone substations and specific distribution system parts experiencing capacity constraints. Demand for electricity is driven by a number of factors including population growth, economic activity, energy efficiency, consumer consumption patterns, new commercial and residential developments and larger point loads. 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.

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

2.4.3.1 Evoenergy Observations And Findings:

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

2.4.4 Factors Impacting Reliability

The reliability of the supply is measured though the 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).

2.4.4.1 Evoenergy Observations And Findings:

Benchmark data on unplanned outages in Australian DNSPs reveals that Evoenergy holds one of the best records for network reliability amongst its peers in Australia[14]. Evoenergy's current strategic intent is to maintain reliability performance within the existing regulatory targets and ensure we comply with our license conditions.

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

14 AER 2022 Electricity network performance report 2022- https://www.aer.gov.au/networks-pipelines/electricity-network-performance-report-2022

2.4.5 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.

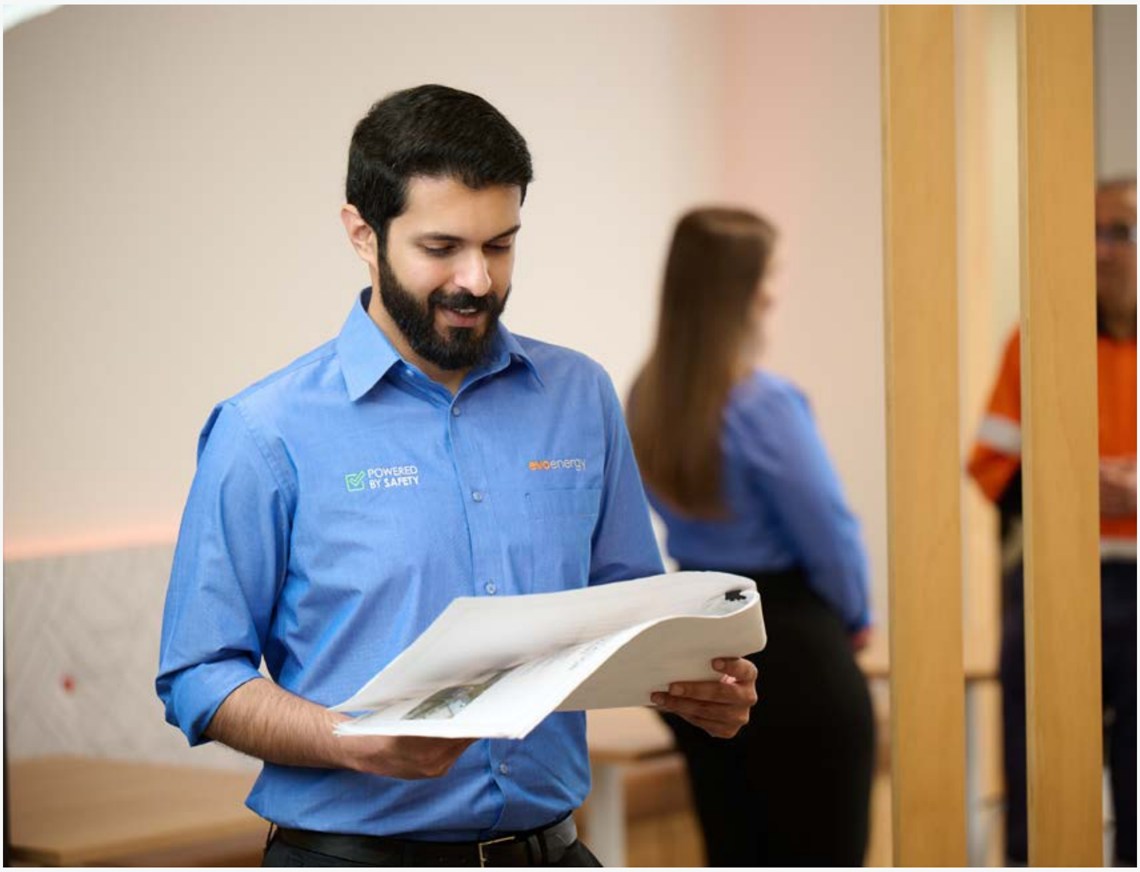
Distributed energy resources such as photovoltaics have a potential to impact power quality and reliability.

2.4.6 Evoenergy Observations And Findings:

Currently for Evoenergy, main power quality initiatives focus on the impact of the solar photovoltaic (PV) 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 low consumption, the reverse power flow may increase voltage levels beyond the normal operating range. Higher voltages may cause automatic disconnection from the network of PV installations. These 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 high-quality electricity supply.

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

The key characteristics of Evoenergy asset management approach include:

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

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. Evoenergy's ISO 55001 certification can be found in Appendix D.

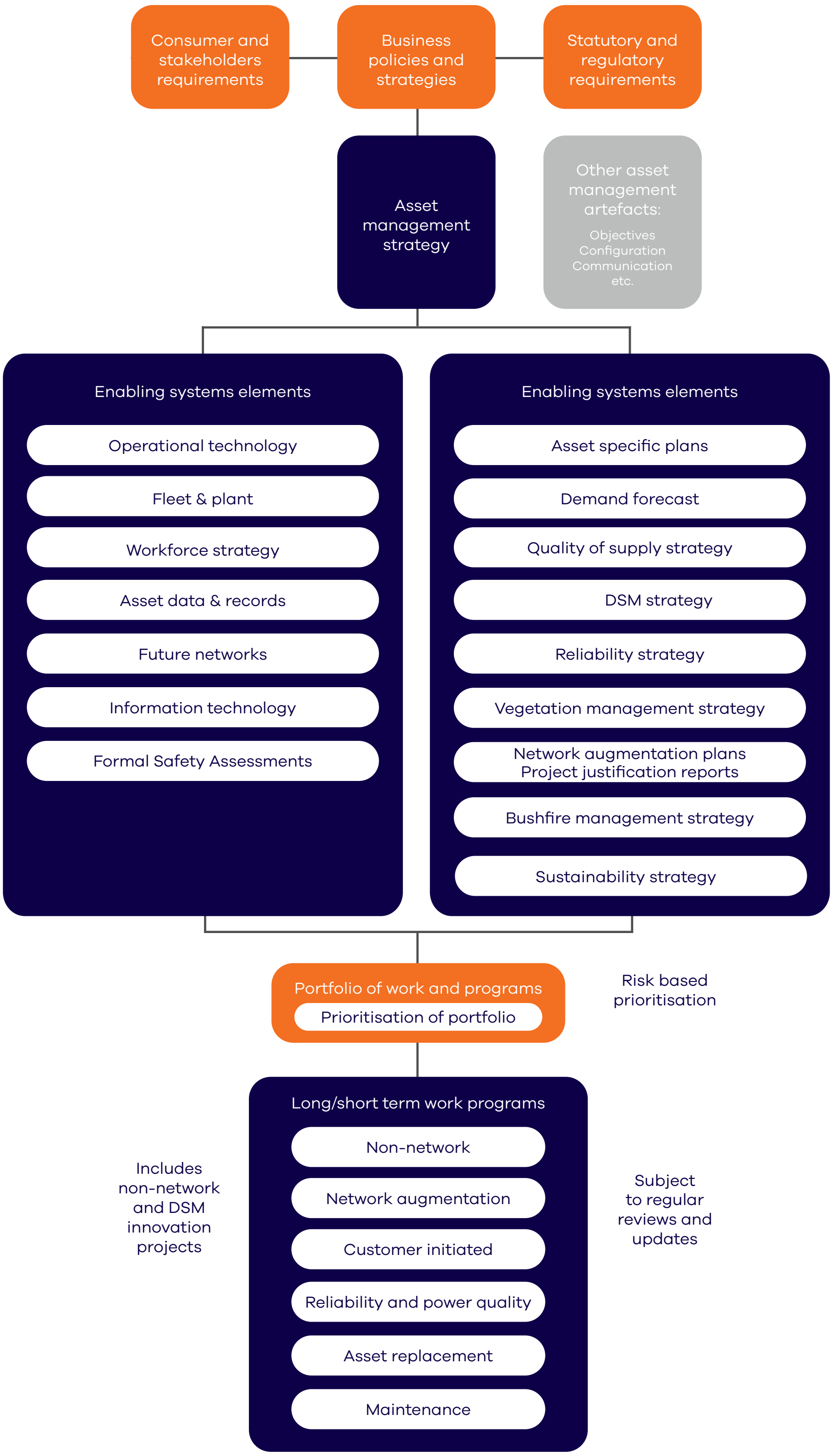
3.1 Asset Management Approach And Components

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

- Development of network investment and maintenance programs through a bottom-up analysis of network and asset needs including safety, performance, load growth, security, asset health, and criticality.
- Exploration of demand management and non-network solutions through engagement with the consumers and industry stakeholders.
- Application of rigorous probabilistic risk assessment methods to operational risk analysis and network investments.
- Application of Reliability Centred Maintenance (RCM) methodology to the development of asset maintenance programs in accordance with asset performance, health, and criticality.
- Optimising programs across asset categories by using a risk-based top-down review to achieve the desired level of risk mitigation at least cost.

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

Figure 12. Asset management and network planning – overview of key artefacts



3.2 Network Planning Methodology

Evoenergy applies its network planning process to address existing and emerging network limitations and performance issues. The primary objective of network planning is to ensure sufficient security, quality, and reliability of supply at the lowest possible cost. Evoenergy's network planning processes 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.

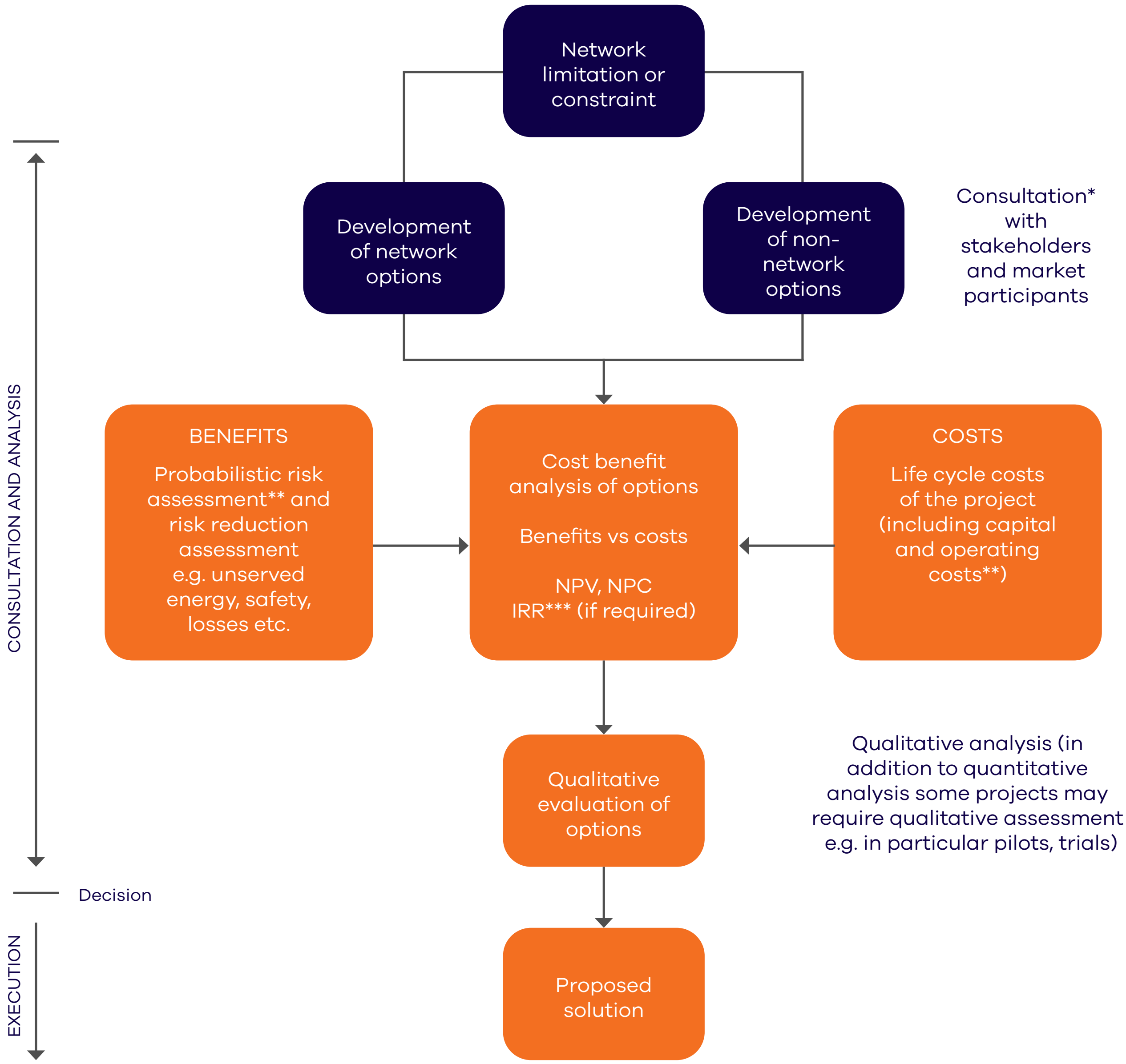
As a starting point, deterministic methodology is used to identify parts of the network where demand may exceed supply capacity. The network is designed with a limited redundant capacity margin in the critical parts of the network to cater for credible contingency events. This deterministic methodology 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[15].

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 has developed an 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[16].

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

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 outputs from the process are Asset Specific Plans (ASPs) for all network asset classes and groups. The ASPs include planned asset retirement, renewal, and maintenance. ASPs 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.

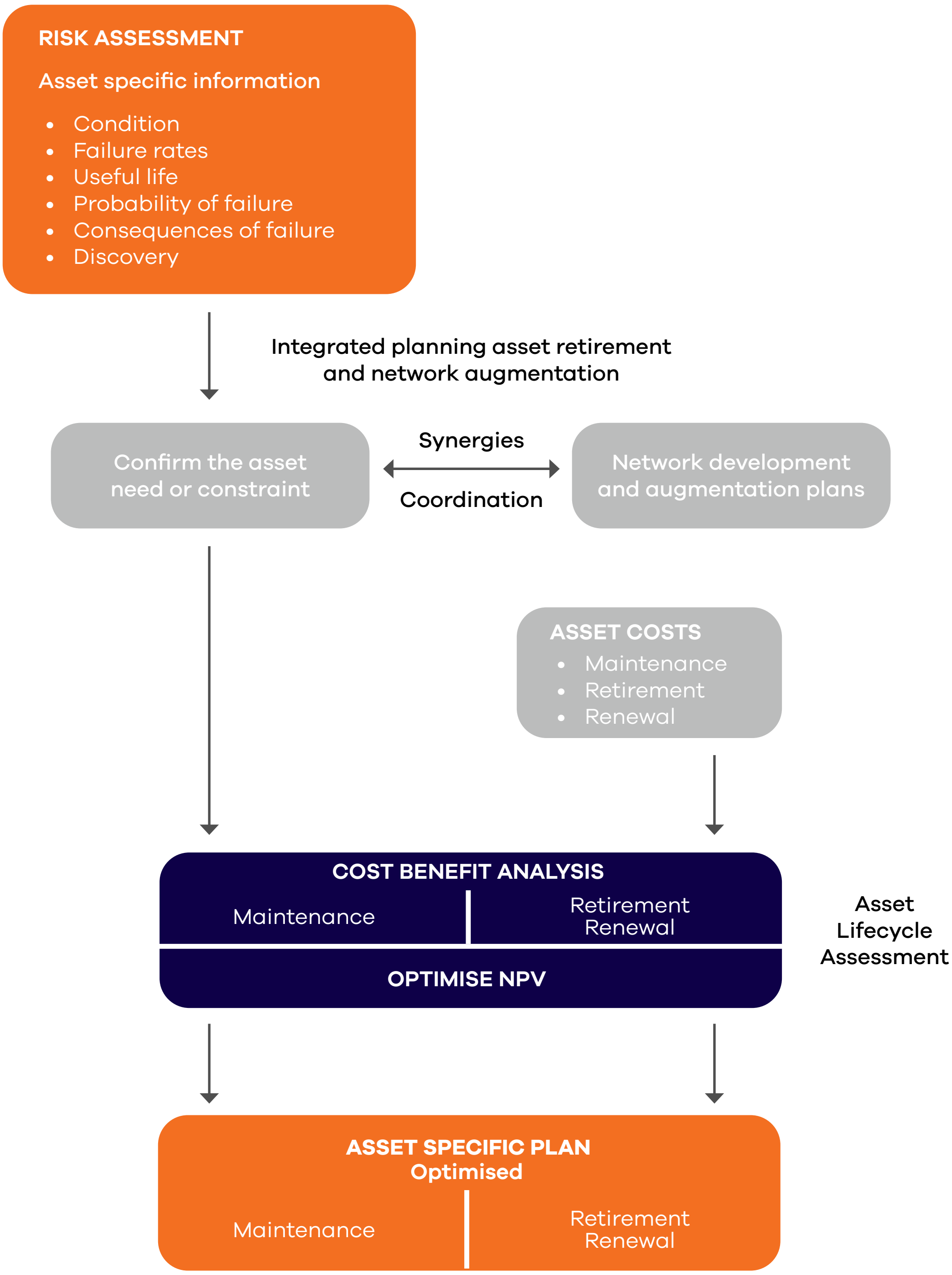
Chapter 6 discusses outcomes of the planning review for the asset retirement and renewal.

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

15 VCR values are sourced from: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability

16 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 reliability centred maintenance. The governing factor in reliability centred maintenance analysis is the impact of a functional failure at the equipment level dependent on the criticality of the asset.

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

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

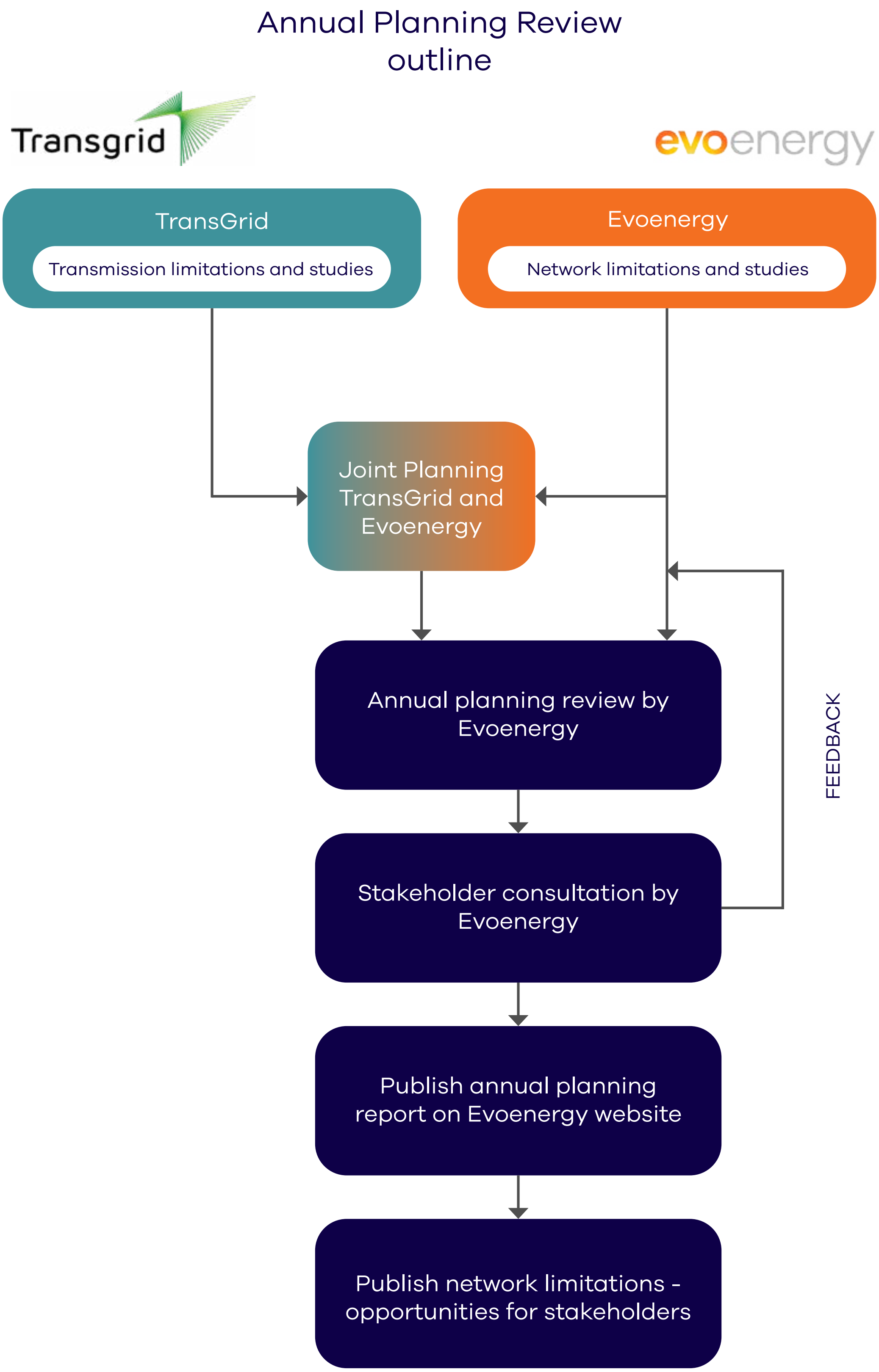
3.6 Annual Planning Report (This Document)

Evoenergy documents the approach and outcomes of network planning in its APR. The prioritised solutions are rolled into the network asset management and development programs and are periodically reviewed and updated. The report's planning horizon is five years for the distribution 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 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 energy consumers in terms of availability and quality of supply.

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

4.1 Network Reliability

Network reliability performance is measured by the frequency and duration of supply interruptions to 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)

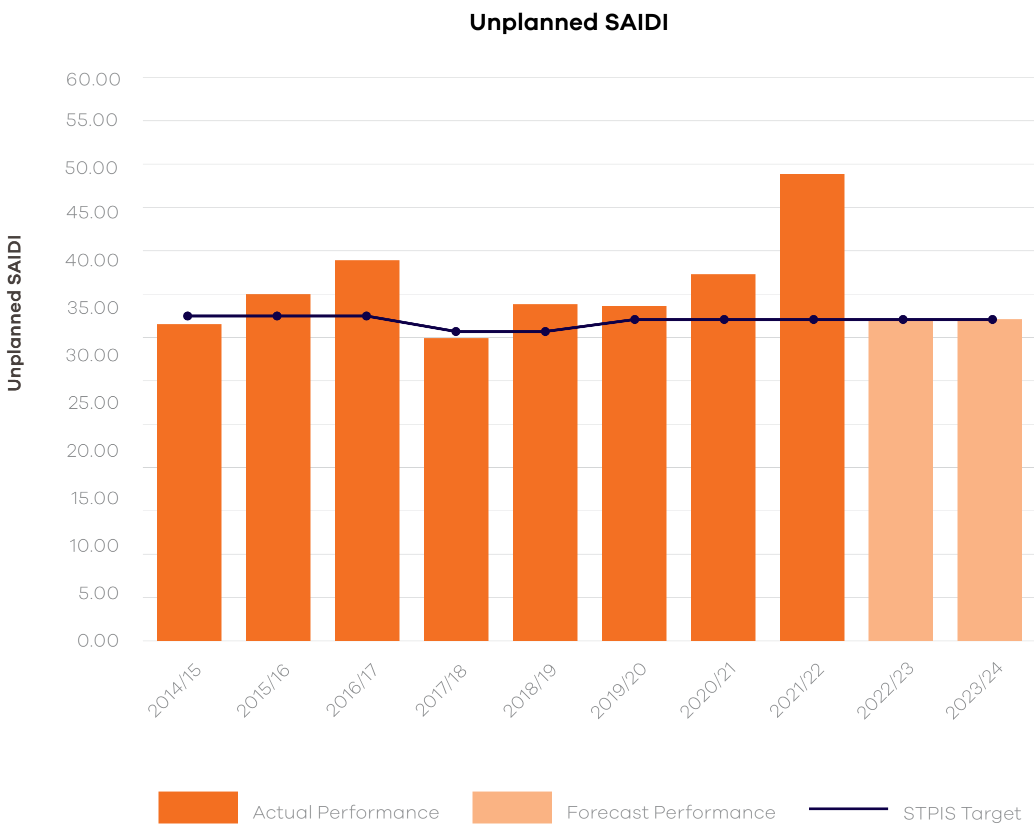
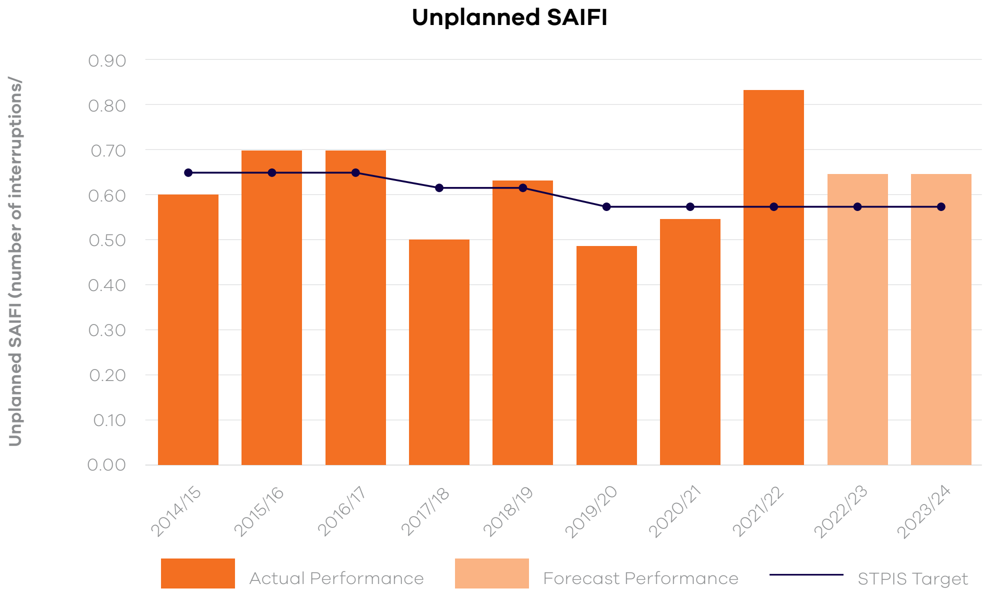


Figure 17. SAIFI- Unplanned Interruptions Per Customer (Number Of Interruptions Per Customer Per Year)



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

4.1.1 Reliability – What Are The Main Challenges

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

4.1.1.1 Outage Cause Attribution

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

4.1.1.2 Environmental Variability

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

4.1.1.3 Project Delivery

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

4.1.1.4 Defect Management

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

4.1.2 Reliability – What We Have Achieved In The Last Year

Evoenergy's network reliability improvement initiatives implement economically feasible options to maintain or improve network performance for consumers. Our reliability initiatives have focused on the fast and safe restoration of supply. In 2021/22 we installed remote controlled automatic reclosers on five (5) overhead feeders and load break switches on one (1) overhead feeder to minimise consumers affected by faults and reduce supply restoration time to consumers on healthy sections.

4.1.3 Reliability – Planning Outcomes

4.1.3.1 Reliability Strategy And Tactics

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

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

Appendix F contains more detail on these policies.

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

- Installing remote controlled automatic reclosers and load break switches on our overhead network to minimise consumers affected by faults and reduce the duration of outages for consumers on healthy sections. In 2022/23 this program is planned on five (5) overhead feeders.
- Installation of remote-control switchgear with fault indication on underground networks to reduce the duration of outages. In 2022/23 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.

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

4.2 Power Quality

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

Power quality issues manifest themselves in voltage, current or frequency 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 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.

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

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

4.2.1 Power Quality – What Are The Main Challenges?

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

In the 2021/2022 financial year, Evoenergy received 183 enquiries (inclusive of 61 enquiries relating to electric shocks, which only occasionally result in verified power quality issues) from customers relating to quality of supply. There is a long-term trend of rising engagement between customers and Evoenergy regarding quality of supply.

The most prevalent trigger for customers to make an enquiry in the 2021/2022 financial year was overvoltage, and in approximately half of all investigations that were triggered, a power quality issue was able to be validated.

Figure 18: Power Quality Enquiries And Complaints By Financial Year

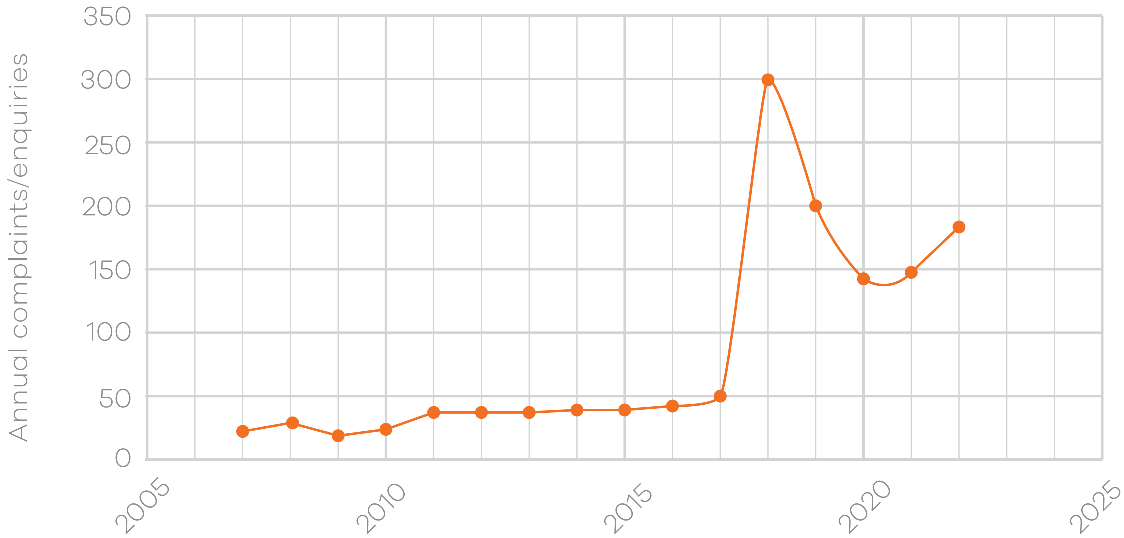
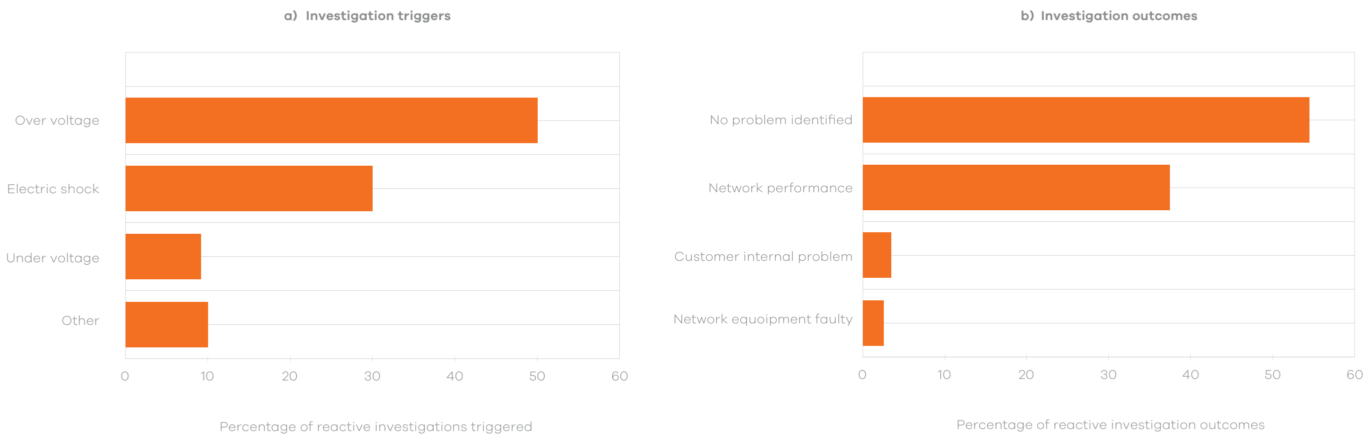


Figure 19: Power Quality Investigation (a) Triggers And (b) Outcomes For The 2021/2022 Financial Year

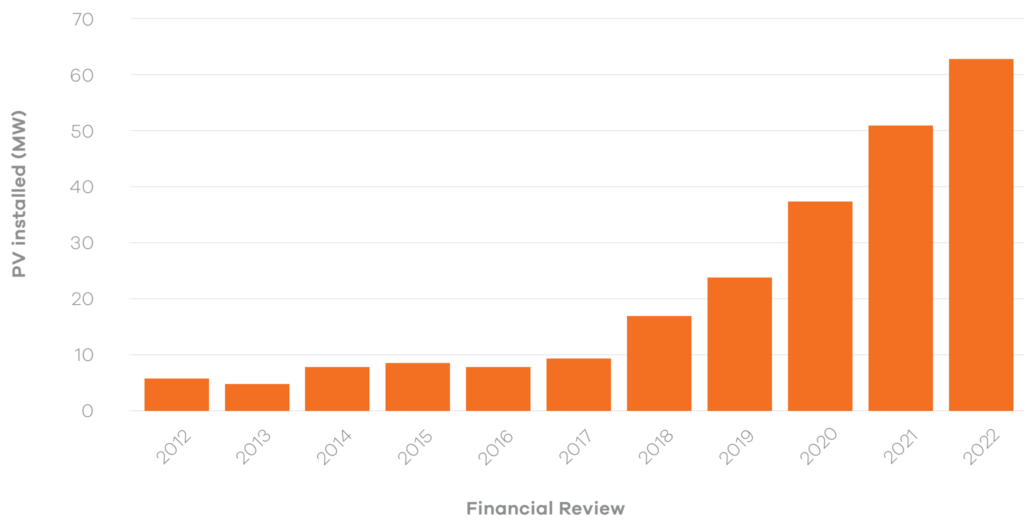


Evoenergy is experiencing increasing voltage regulation challenges in the low voltage network. The majority of these challenges relate to increasing penetration of distributed PV generation, particularly rooftop photovoltaics, which are being installed on the Evoenergy network at an accelerating rate. These challenges can be exacerbated by the presence of other distributed energy resources such as residential battery energy storage systems and electric vehicle chargers.

Where voltages are high as a result of concentrated penetration of distributed PV generation, some parts of the low voltage network are increasingly subject to reversed power flows. Evoenergy has determined that hosting capacity limits for PV generation will be increasingly challenged in the future in various network locations. **Section 4.2.3** highlights Evoenergy current practices and new initiatives that are/will be deployed to resolve voltage regulation issues.

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

Figure 20: PV installed By Financial Year



4.2.1.1 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 330kV 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 330kV Substation from 136kV to regulate at nominal 132kV. 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.

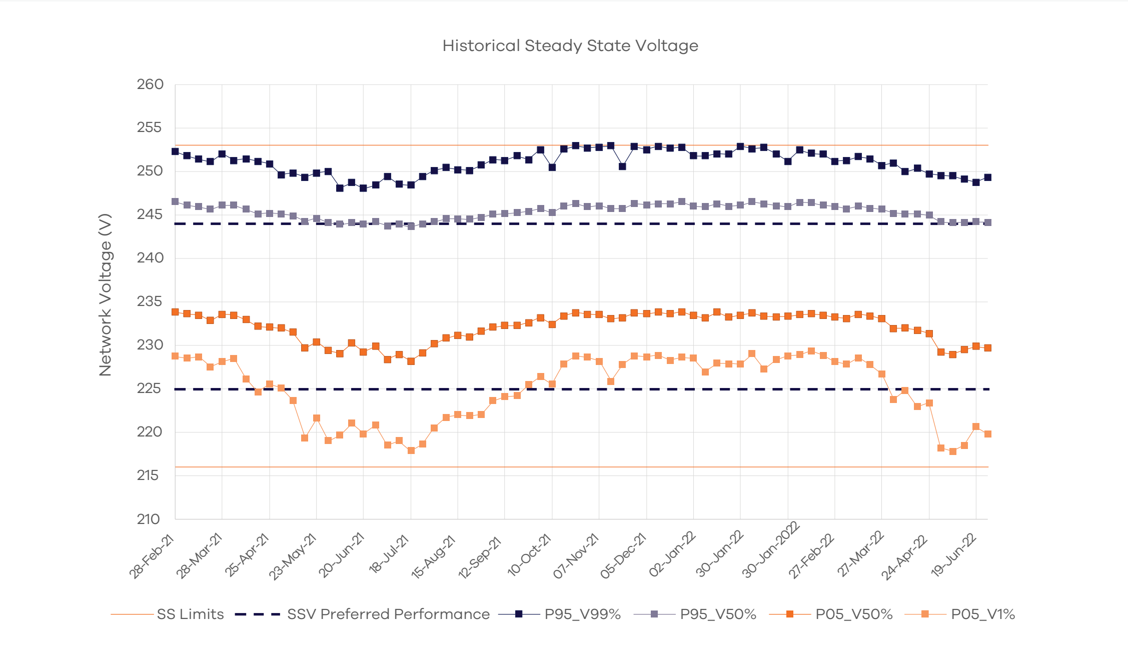
Evoenergy is currently undertaking a detailed technical study of both the power quality issues at the Gold Creek Zone Substation as well as the interaction with capacity constraints in the area. This will lead into a likely RIT-D for the Zone Substation. As part of these investigations the solutions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

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

4.2.2.1 Proactive Monitoring

Evoenergy's proactive program monitors the network steady state voltage (SSV) through analysis of power quality measurements sourced from third-party fixed monitoring assets, with performance displayed in **Figure 21**. As expected, there is considerable seasonal voltage variation which reflects both the seasonal variances in customer behaviour/demand and seasonal variances in DER performance characteristics.

Figure 21: Network Steady State Voltage Performance By Week



4.2.2.2 Resolution Of Enquiries

Evoenergy received 122 enquiries and complaints in relation to potential power quality issues during this financial year. Of these, 46 enquiries and complaints were substantiated as a power quality issue following investigation, with the most prevalent issue being over voltage.

This result is not unexpected with increased generation from solar PV and low loading during the warmer months of this reporting period. Most of these overvoltage issues were rectified through adjustment of the tap settings on the relevant distribution transformer.

4.2.2.3 Community Outreach

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

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

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

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

4.2.2.4 Power Quality Compliance Audit Survey and Benchmarking

Evoenergy participated in national benchmarking with respect to power quality performance, carried out by the University of Wollongong. This benchmark revealed that 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.

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 voltage regulation, unbalance and harmonics.

4.2.3 Power Quality – Planning Outcomes

Over 2021/2022, Evoenergy updated its Quality of Supply Strategy to address contemporary challenges for the network and drafted a Quality of Supply Operations Plan to support its operationalisation.

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

4.2.3.1 Proactive Monitoring

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

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

4.2.3.2 Smart Metering Data

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.

4.2.3.3 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.

4.2.3.4 PQCA National Survey and Benchmarking

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

4.2.3.5 Power Quality Issues And Complaints

Evoenergy investigates all instances of identified power quality issues and power quality enquiries and 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.

4.2.3.6 Standards

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

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

4.2.3.7 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**.

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.

5.1.1 Act Government Energy Policies

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

Evoenergy has a strategic initiative for ongoing modelling of a zero emissions future. The initiative aims to work with key stakeholders to inform prudent planning for a comprehensive and practical zero emissions road map.

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

5.2 System Demand

5.2.1 Historical Demand

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

- Summer maximum demand is weather dependent. For example, summer 2012, 2015 and 2022 maximum demands fell below 500MW due to mild weather conditions. The 2019 maximum demand rose above 650MW due to persistent widespread heat, exceptional heatwaves, and below-average rainfall.
- The highest historical summer peak in real power was 657MW (2018/19) and the highest winter demand was this past year of 685MW (2022). This winter peak was a new whole of network maximum demand record.
- The historical winter maximum demand has generally been less variable than summer maximum demand. This is largely due to less variability in weather conditions.
- The hottest day of Summary 2021-22 was recorded on Sunday 2nd January 2022 where it reached 33.5°C. This did not coincide with the peak summer demand. The peak summer demand was 440MW and this occurred on Wednesday 16th of February 2022 at 5:45 pm (AEDST) after a few moderately hot days. It was a mild and wet summer compared to previous years.
- In the 2021-22 winter period was especially harsh. The coldest night was Tuesday 19th July 2022 where a low of –6.7°C was reached. The peak winter demand of 685MW occurred at 6:30pm (AEST) on Tuesday 7th June 2022 which had a maximum temperature of 9.8°C after several weeks of cold weather.
- In comparison to 2021, actual summer maximum demand showed close a 14% decrease and actual winter maximum demand a 9% increase. Winter maximum demand was over the POE10 while summer maximum demand was below POE90. This indicates that the 2022 maximum demand for both summer and winter was an approximately a 1 in 10 year event.

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

Figure 22. 2022 Summer Maximum Demand Day Load Profiles. (Peak day: 2022-02-16)

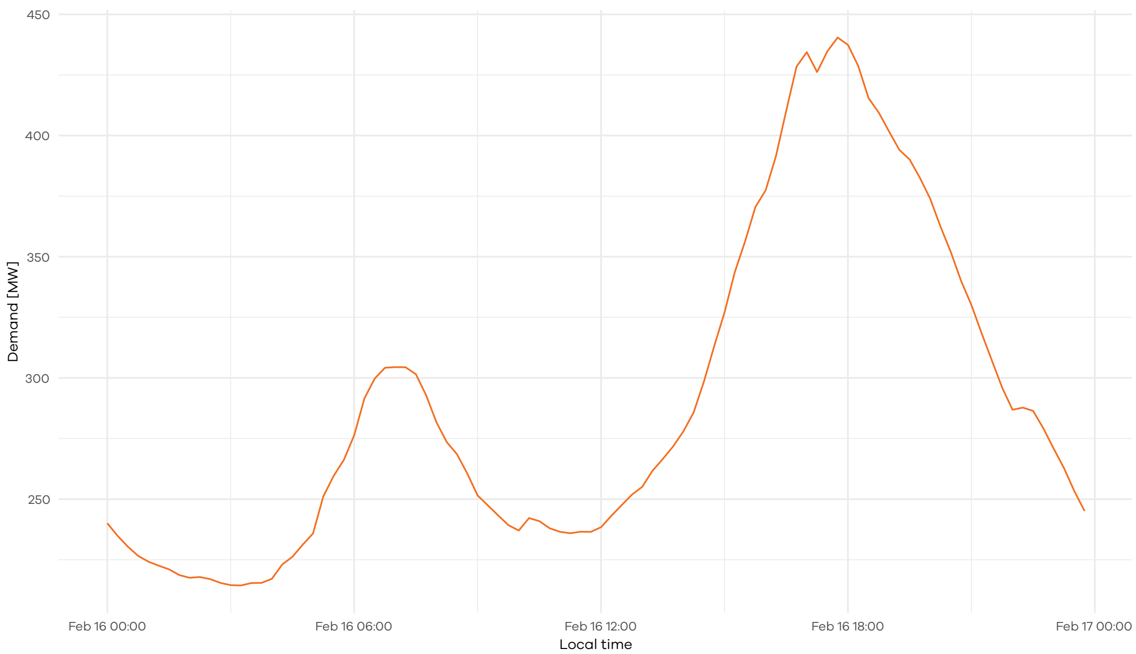
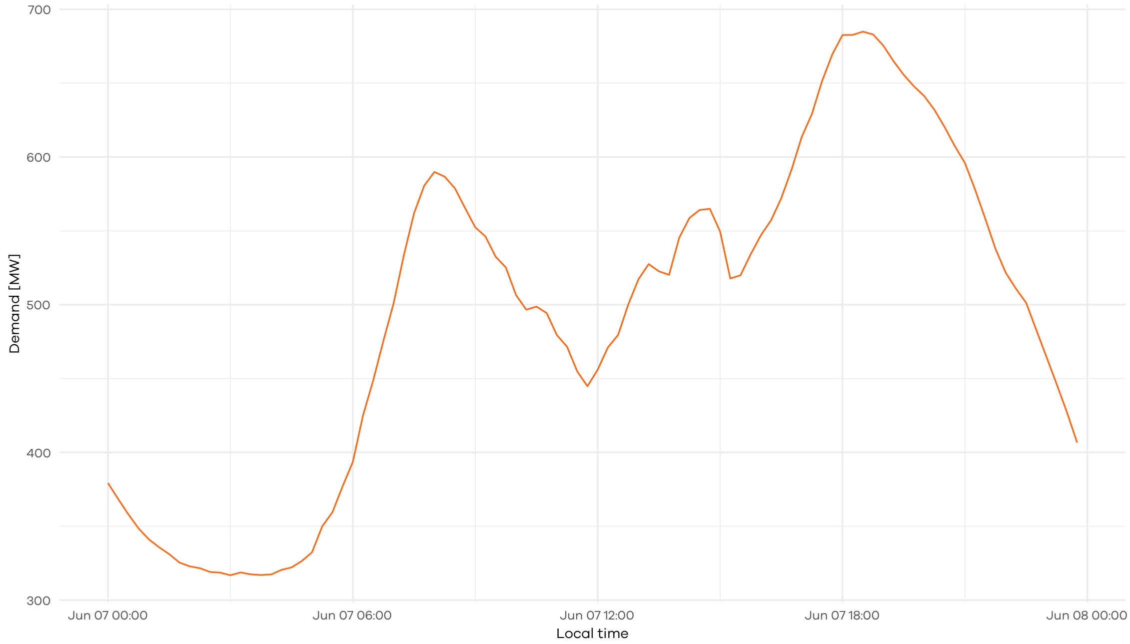


Figure 23. 2022 Winter Maximum Demand Day Load Profiles. (Peak Day: 2022-06-07)



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 2023–32 are presented in **Figure 24**.

There is a forecast increase in demand which exceeds the trend from historical data. One factor is the predicted significant increases in data centre 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. Another factor is the predicted increase in load from the charging of electric vehicles as numbers increase in the ACT.

5.2.2.1 System Forecast

10-year forecasts based on historical system data estimate a change in peak summer demand of 12MW per annum and a change in peak winter demand of 19MW per annum.

Based on forecast 2023[17] peak demand values, this corresponds to an expected change of +16% over the next 10 years in peak summer demand, and +23% 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.

17 2023 forecasts were used this year instead of 2022 actuals as the actuals for both summer and winter were outside one in ten-year events which skewed the comparisons

Figure 24. 12-Year Whole-System Summer And Winter Maximum Demand Forecast.

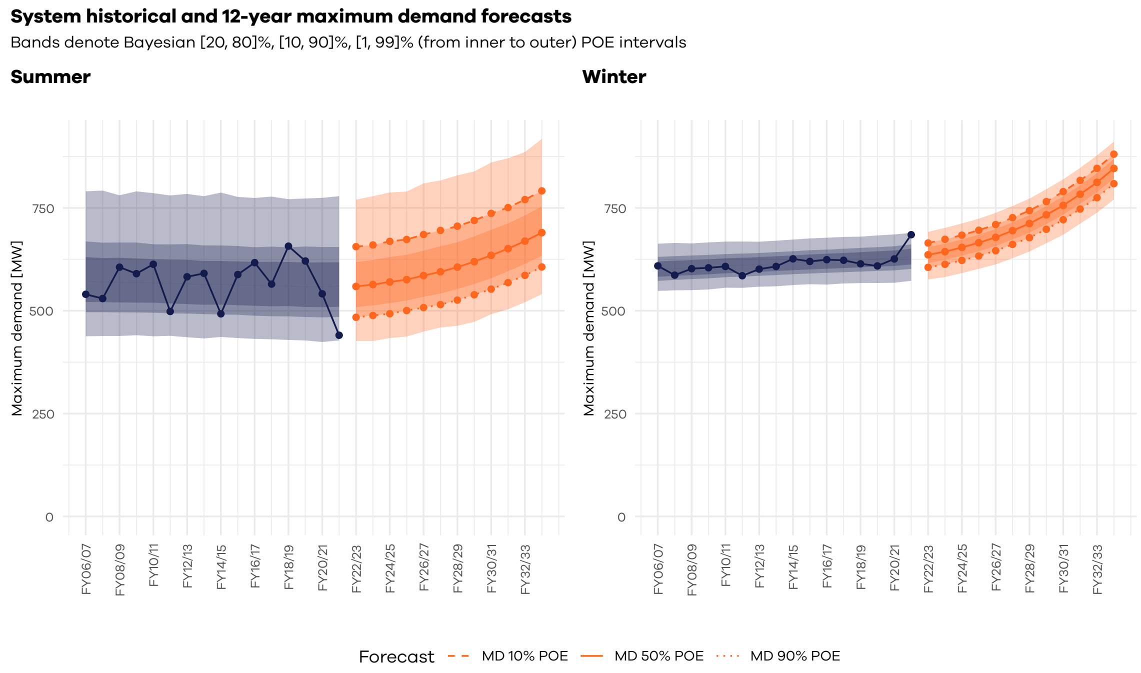


Table 3 provides summer and winter forecast demand (MW) numerical values for three probability of exceedance levels to complement **Figure 24**.

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

Year	Summer			Winter		
	POE90	POE50	POE10	POE90	POE50	POE10
2023	484	559	656	606	636	665
2024	488	564	660	613	644	674
2025	493	570	669	622	654	684
2026	500	576	673	633	665	696
2027	508	586	685	646	678	710
2028	515	595	695	661	695	726
2029	526	606	706	678	712	743
2030	539	619	719	698	733	765
2031	553	635	737	721	756	790
2032	568	651	751	747	783	817

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 24**.
- Winter maximum demand is forecast to significantly grow over the next 10 years and this is expected be accelerated as we see the likely impacts of higher uptake of electric vehicles and transition away from gas.
- Summer maximum demand is also forecast to grow significantly over the next 10 years although less than winter. This difference is primarily due to the lesser impact of electric vehicle and gas transition growth on the summer peak when compared to the winter peak.

5.2.3 System Summer And Winter Minimum Demand Forecast

In AEMO's 2022 Electricity Statement of Opportunities[18] (ESOO) it is forecast that short term (0-5 years) minimum operational demand across the NEM, including in NSW (which contains the ACT) rapidly declines because forecast uptake of distributed PV grows faster than projected underlying demand. The forecast minimum operational demand in 2022-23 is higher in all regions than in the 2021 ESOO, due to higher projections for electrification and increased operation from large industrial loads.

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 charging, battery capacity changes, and electrification have a greater impact on the changes in minimum demand.

Figure 25 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[19]. 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 64.25MW 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 13 years (-5, +31).

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.

18 AEMO 2022 Electricity Statement of Opportunities available here: https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2022/2022-electricity-statement-of-opportunities.pdf?la=en

19 Day/night separation is in agreement with AEMO's new point forecasting methodology.

Figure 25. 10-Year Whole-System Summer And Winter Minimum Demand Forecast.

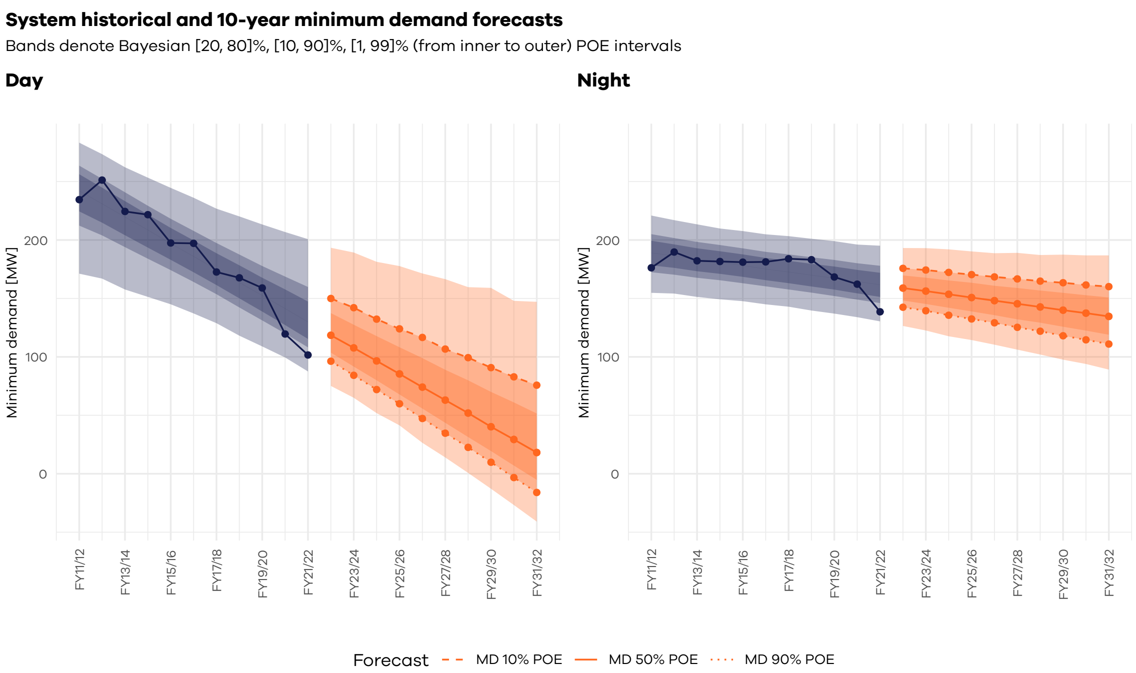


Table 4 provides minimum demand (MW) numerical values to complement the minimum forecast **Figure 25.**

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

Year	Day			Night		
	POE90	POE50	POE10	POE90	POE50	POE10
2023	96	118	150	142	159	176
2024	84	108	142	139	156	174
2025	72	97	132	136	154	172
2026	60	85	124	132	151	170
2027	47	74	117	129	148	168
2028	35	63	107	125	145	167
2029	23	52	99	122	143	165
2030	10	40	91	118	140	163
2031	-3	29	83	115	137	162
2032	-16	18	76	111	135	160

For the 2022 Annual Planning Report Evoenergy has extended our forecasting to include export forecasting at the system and zone substation level. Evoenergy does not expect any constraints to occur at a zone substation or system level due to export volumes.

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

5.3 Zone Substation Load Forecasts

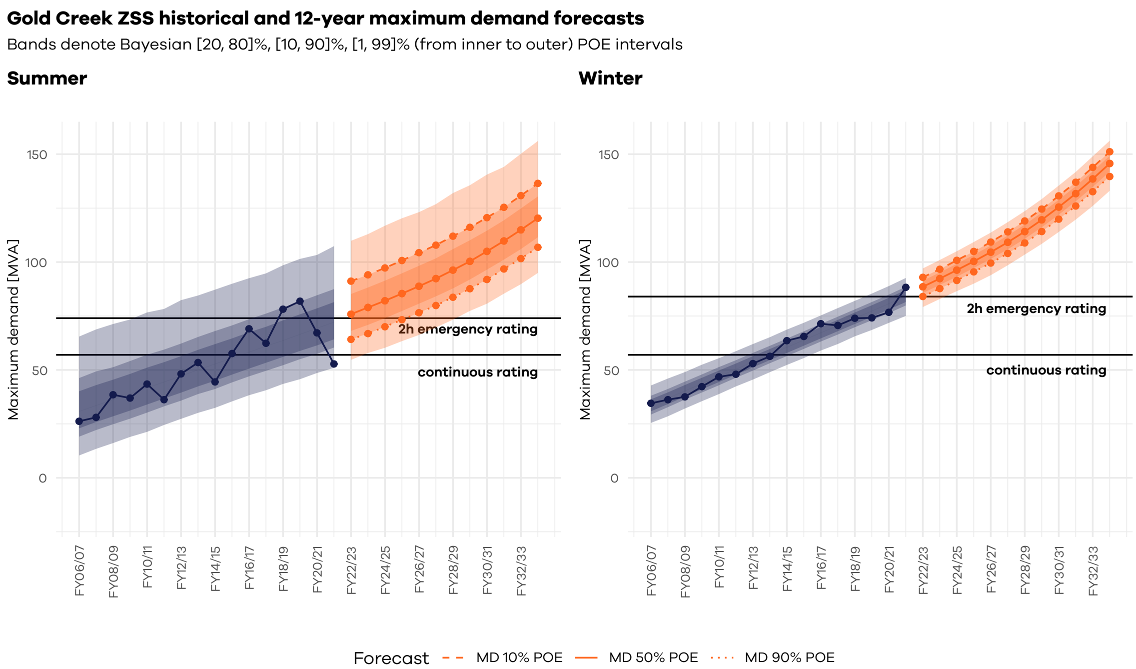
This section provides the highlights of the zone substation demand forecast. The figures below show summer and winter ten year forecast for selected zone substations shown against substation two-hour emergency rating. **Appendix E** contains the full set of forecast graphs and figures for zone substations.

5.3.1 Gold Creek Substation

Zone Substation Limitation

Updated forecasts indicate that the winter 50% POE forecast is expected to continue to exceed two-hour emergency ratings on an ongoing basis. Evoenergy has published the non-network options report for this constraint as part of a RIT-D process. See **Section 7.6.5** for more detail.

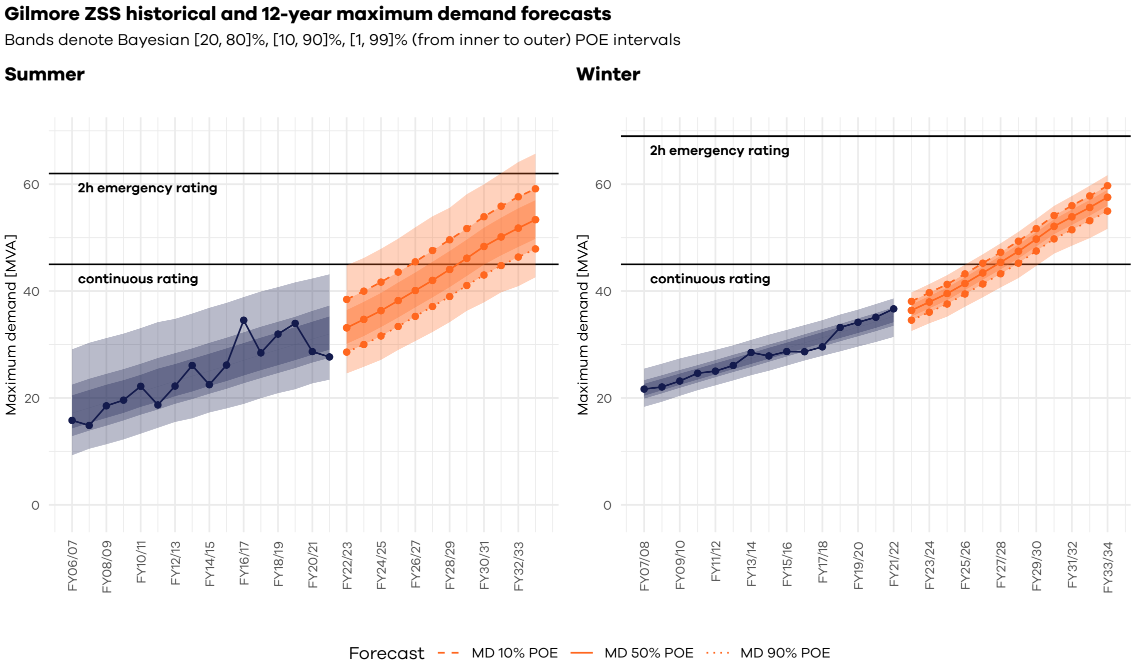
Figure 25. Gold Creek Substation 12-year forecast.



5.3.2 Gilmore Substation

Gilmore Zone Substation (ZSS) forecast (**Figure 27**) is expected to have significant load growth in the next 10 years due to the expansion of commercial load in the Hume area, primarily the data centres. It is forecast that the demand will exceed the continuous rating late in the 2024-29 regulatory period. This additional load along with the aged assets in the zone substation and the requirement for additional 11kV circuit breakers due to customer redundancy requirements have triggered work at this zone substation. Please see **Sections 7.6.9** and **6.1.4.6** for further detail.

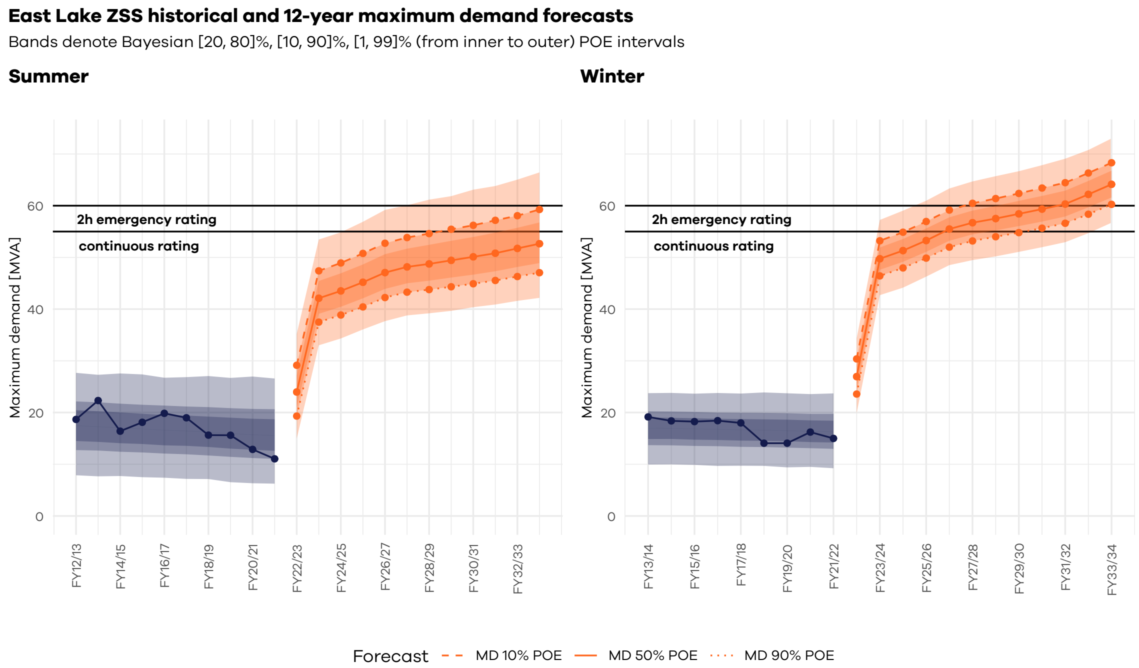
Figure 27. Gilmore Substation 12-year forecast



5.3.3 East Lake Substation

In the forecast shown in **Figure 28** we see a steep increase in demand at East Lake Zone Substation. The primary driver for this steep jump is the transfer of all load currently on Fyshwick Zone Substation to East Lake Zone Substation to enable the decommissioning of Fyshwick Zone Substation. Please see **Section 6.1.4.2** and **7.6.6** for further detail. The other driver of load growth in this area is the increase in commercial load from consumers in the Fyshwick, Causeway and Canberra Airport areas, in particular data centres. It is not anticipated that additional augmentation of East Lake Zone Substation may be required within the 10-year planning horizon.

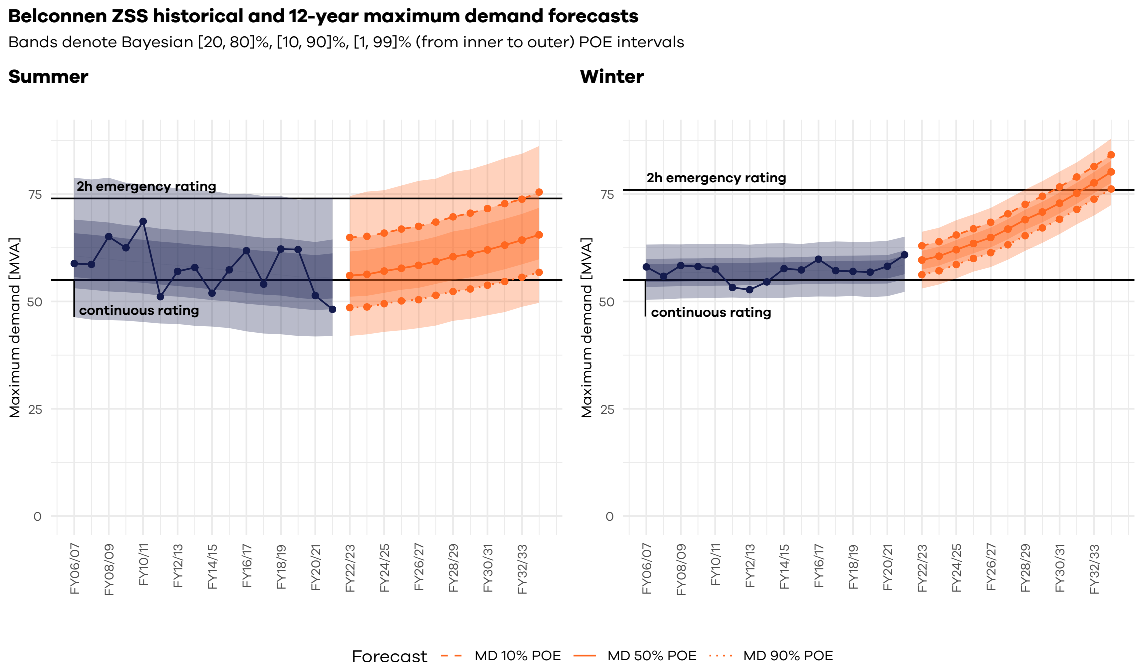
Figure 28. East Lake Substation 12-Year Forecast



5.3.4 Belconnen Substation

Belconnen Zone Substation has been consistently operating above the continuous rating during both the summer and winter peak demand periods for several years. Despite this there is minimal load growth expected during the 10-year planning horizon so it is not forecast that the zone substation will operate above the emergency 2-hour rating. For this reason, Belconnen Zone Substation may require an additional transformer in the 2029-2034 regulatory period. This potential constraint will be monitored. For further detail please see **Section 7.9.3**.

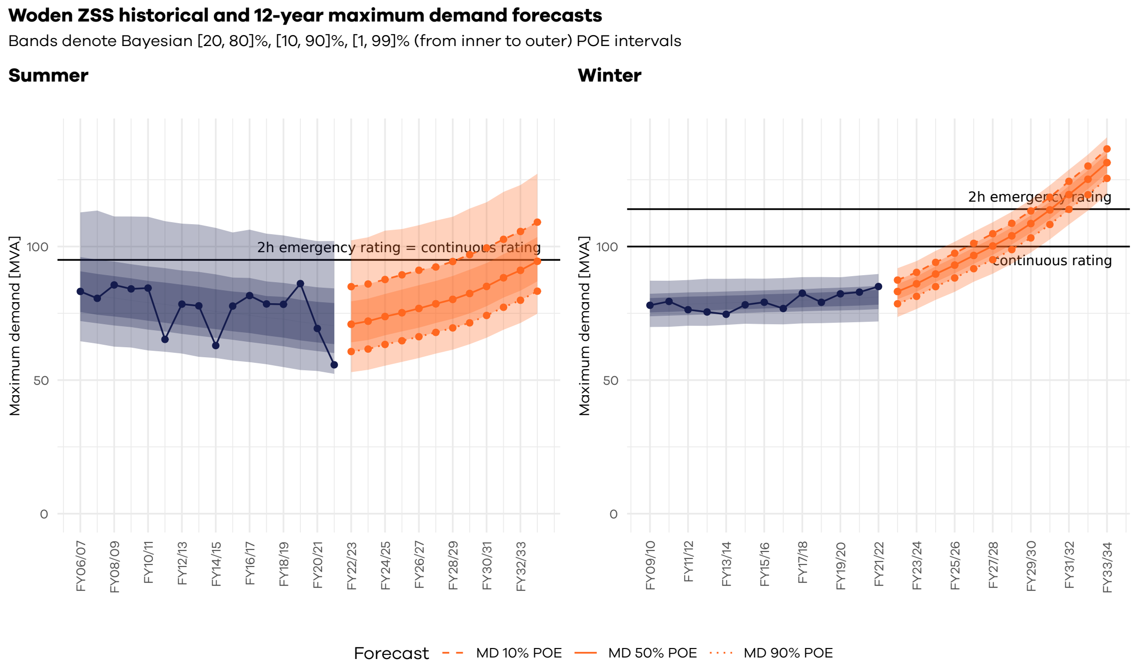
Figure 29. Belconnen Substation 12-Year Forecast



5.3.5 Woden Substation

There is significant load growth expected in the area currently supplied by Woden Zone Substation due to significant redevelopment and urban intensification in the Woden Town Centre areas as well as major residential development in the Molonglo Valley. The growth in the Molonglo Valley will initially be supplied by the proposed Molonglo battery and then the Molonglo Zone Substation. For further detail on this project and the associated RIT-D please see **Section 7.6.1**. The growth in the Woden Town Centre is expected to cause constraints in the 2029-2034 regulatory period and Evoenergy has proposed a potential new zone substation in the South of Canberra. Please see **Section 7.9.5** for further detail.

Figure 30. Woden Substation 12-Year Forecast



5.4 Load Transfer Capability

Table 5 and **Table 6** show the load transfer capability (MW) between Evoenergy's Zone Substations. Transfer capability is calculated based on spare capacity of zone substation transformers and spare capacity of interconnecting 11kV 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		To												
		Belconnen	City East	Civic	East Lake	Fyshwick	Gilmore	Gold Creek	Latham	Telopea Park	Tennent	Theodore	Wanniassa	Woden
From	Belconnen		1.9	6.1				9.7	2.1					
	City East			19.7	1.3					9.5				
	Civic	3.3	14.1					3.6	1.2	7.1				
	East Lake		0.2							2.7				
	Fyshwick		0.2		6.1		0.3			1.9				
	Gilmore											3.5	14.0	
	Gold Creek	3.4		2.7					2.2					
	Latham	11.5		2.1				0.4						
	Telopea Park		11.2	11.1	3.7		0.9						4.0	8.3
	Tennent												3.0	
	Theodore						6.8						5.9	
	Wanniassa						10.3			0.7		8.7		13.2
	Woden			1.1						1.1			12.6	

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		5.6	10.5					4.3					
	City East	0.8		23.6	2.2					13.8				
	Civic	6.0	19.2						1.9	18.9				
	East Lake		1.1							5.1				
	Fyshwick		1.1		12.2		1.1			2.5				
	Gilmore									0.4		3.5	17.7	
	Gold Creek	5.5		2.7					2.9					
	Latham	15.1		5.2										
	Telopea Park		14.3	11.7	5.5		2.3						4.8	11.9
	Tennent													
	Theodore						6.8						7.5	
	Wanniassa						12.5			1.9		9.8		15.6
	Woden			1.9						3.3			18.0	

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 plans 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**	**48,708**	**35**
	Concrete Pole	11,631	23
	Fibreglass Pole	4,321	9
	Timber Pole	26,685	48
	Steel Pole	5,901	21
	Stobie Pole	354	76
Pole Substations	**Total**	**1,384**	**38**
	Pole Substation	1,384	38
Overhead Lines and Pole Hardware	**Total**	**2118 km**	**53**
	Overhead HV Conductors	968 km	52
	Overhead LV Conductors	1,149 km	54
Overhead Switchgear & Automation	**Total**	**8,063**	**51**
	Gas Switch	123	9
	HV Link	1,510	34
	Surge Diverter	2,741	101
	Fault Passage Indicator	595	7
	Drop-out Fuse	1,598	32
	Auto-Recloser	47	14
	Air Break Switch	1,516	41
	Load Break Switch	6	26
Overhead Service Conductors	Total	1,149 km	31
	Overhead Service Cable	1,149 km	31

Table 7. Asset Specific Plans (ASP)

Asset Specific Plan (ASP)	Asset Group(s)	Asset Qty	Average Age
Distribution Underground Network			
Distribution LV Switch board Assembly	**Total**	**N/A**	**N/A**
	LV Circuit Breaker	1,196	30
	LV Switchboard	3,183	27
Underground LV Cables	**Total**	**3,658 km**	**30**
	Underground Service Cable	2,116 km	29
	Underground LV Cable	1,542 km	31
LV Pillars	**Total**	**18,443**	**31**
	LV Pillar	14,917	26
	Point of Entry Cubicle	3,526	53
Earthing	**Total**	**26,901**	**30**
	Distribution Pole Earthing	14,635	23
	Ground Substation Earthing	3,769	30
	Overhead Substation Earthing	1,385	38
	Overhead Switch Earthing	1,691	38
	Underground to Overhead Connection Earthing	4,436	43
	Transmission Line Earthing	1,126	39
Distribution Substation/ Switching Station Sites	**Total**	**3,770**	**30**
	Padmount Substation	2,539	29
	HV Switching Station	357	35
	Chamber Substation	504	28
	Stockade Substation	6	36
	Kiosk Substation	364	35
Distribution HV Switchboard Assembly	**Total**	**N/A**	**N/A**
	HV Circuit Breaker	592	19
	HV Switchboard	12	25
Ground Mounted Transformers	**Total**	**3,891**	**30**
	Ground Transformer	3,891	30
Underground HV Cables	**Total**	**N/A**	**N/A**
	Underground HV Cable	1,673 km	65
	Underground HV Feeder	242	58
Ring Main Units	**Total**	**3,958**	**26**
	Ring Main Unit	3,958	26
HV & LV Pits	**Total**	**553**	**-**
	HV & LV Underground Pit	553	-

Table 7. Asset Specific Plans (ASP)

Asset Specific Plan (ASP)	Asset Group(s)	Asset Qty	Average Age
Zone Substations			
132kV & 66kV Air Insulated Switchgear	**Total**	**569**	**34**
	132kV & 66kV Circuit Breakers	39	40
	132kV & 66kV Current Transformers	144	28
	132kV & 66kV Isolators	149	39
	132kV & 66kV Voltage Transformers	89	31
	132kV & 66kV Earth Switches	37	37
	132kV Surge Diverters	111	35
Zone 11 kV Switchboard Assembly	**Total**	**458**	**33**
	11kV Oil Circuit Breakers	129	44
	11kV Vacuum Circuit Breakers	243	26
	11kV 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

Table 7. Asset Specific Plans (ASP)

Asset Specific Plan (ASP)	Asset Group(s)	Asset Qty	Average Age
Zone Substations			
Overhead Transmission Lines	**Total**	**1,525**	**34**
	Concrete Pole	893	29
	Timber Pole	424	44
	Steel Tower	200	47
	Steele Pole	8	3
Overhead Transmission Lines	**Total**	**183 km**	**41**
	Overhead conductors	183 km	41
Underground Transmission Lines	**Total**	**6.1 km**	**17**
	Underground cables	6.1 km	17

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	7
Poles	Replace Pole	207
Pole Substations	Replace Single Pole Substation	3
	Replace Two Pole Substation	2
Distribution Underground Network		
Distribution Substations / Switching Station Sites	Replace Padmount	4
HV Switchboard Assembly	Replace HV Distribution Circuit Breaker	1
	Replace HV Switchboard	1
LV Pillars	Replace Pillar	61
LV Switchboard Assembly	Replace Capstan Link LV Board	2
	Replace LV Pit	1
LV Pit	Replace LV Pit	12
HV Ring Main Unit	Replace RMU	6
Underground HV Cables	Replace HV Cable Termination	22
Underground LV Cables	Replace LV Pothead	8
	Replace Service Pothead	2
	Replace LV Underground Cable	1
	Replace LV Underground Cable Termination	11
	Replace LV Underground CONSAC Cable	5

6.1.4 Asset Retirement - Planning Outcomes

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

6.1.4.1 Retirements of major assets

Table 9 below summarises review outcomes which relate to 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	132kV 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 2025
Wanniassa Zone Substation	Substation Switchboard	Asset condition & performance	No	$3.1m	Dec 2022	Jun 2023	Jun 2026
Telopea Zone Substation	Power Transformer[20]	Asset condition & performance	No	$2.7m	Mar 2021 complete	Jun 2021 complete	Jun 2022

20 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.

6.1.4.2 Decommissioning Of Fyshwick Zone Substation 66kV Assets

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

Primary assets at and supplying Fyshwick Zone Substation are at the end of their economic lives. The two 66kV 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 66kV 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 66kV 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 66kV protection relays are also at the end of their economic lives and a risk assessment has shown a high risk of mal-operation which has significant reliability impacts.

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

A project is underway to decommissioning the 66kV assets at Fyshwick and supply the 11kV from express feeders from East Lake zone substation. See section 7.6.6 for further detail on this project.

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

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

6.1.4.3 Latham Zone Substation Switchboard Replacement

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

This 11kV switchgear is increasing in risk to Evoenergy, our 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 11kV switchboard at Latham Zone Substation with modern equivalent at an estimated cost of $3.1 million in the period 2024-29. The second Latham 11kV switchboard is planned to be replaced in the period 2029-34.

6.1.4.4 Wanniassa Zone Substation Switchboard Replacement

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

This 11kV switchgear is increasing in risk to Evoenergy, our 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 11kV switchboard at Wanniassa Zone Substation with modern equivalent at an estimated cost of $3.1 million in the period 2024-29. The second Wanniassa 11kV switchboard is planned to be replaced in the period 2029-34.

6.1.4.5 Wanniassa Distribution Line Underground Cable

This project is no longer applicable. The previously reported Reid Feeder replacement project will not proceed in FY24. The performance of this feeder has been monitored over the last three years and has not experienced any further failures. Due to the improved reliability of the feeder, the funds allocated to this project have been re-directed to higher risk works across the network.

6.1.4.6 Provisional 132kV 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 6.2.9**.

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 has procured a new power transformer to be installed at Telopea Park Zone Substation. The existing Telopea Park transformer will be relocated to Gilmore Zone Substation to feed upcoming generators and growing data centres in Hume. Commissioning of the new Power Transformer was completed in November 2022.

6.1.4.7 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.

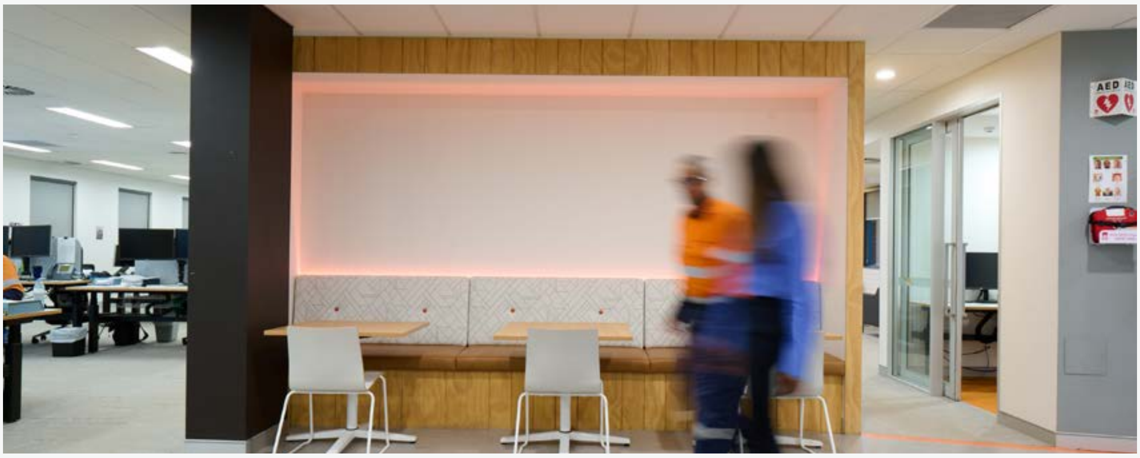
Although most asset retirements require replacement, the option to decommission the asset is also assessed. Evoenergy has been successful at decommissioning assets which have reached retirement by augmenting the network with non-like-for-like solutions at a lesser cost. For example, distribution substations 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)	2023		2024		2025		2026		2027		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[1]	2	0.78	2	0.78	2	0.78	2	0.78	2	0.78	10	7.8
Distribution LV Switchboard Assembly[1]	4	0.8	3	0.6	2	0.2	2	0.2	2	0.2	13	2
Distribution Substation/ Switching Station Sites	6	1.2	6	1.2	8	1.8	10	2	12	12.4	32	6.4
LV Pillars	40	0.27	40	0.27	40	0.27	40	0.27	40	0.27	200	2.7
UG HV Cables[2]			0.5	0.25	0.5	0.25	0.5	0.25	0.5	0.25	2	1
UG LV Cables[3]			0.5	0.43	0.5	0.43	0.5	0.43	0.5	0.43	2	1.72
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	20	1.02	20	1.02	25	1.21	81	5.29
Pole Substations	8	0.4	8	0.4	9	0.51	9	0.51	9	0.51	43	2.33
Poles	285	4.55	285	4.55	310	4.949	358	4.715	414	6.609	1652	25.373

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.

6.1.5.1 Overhead Lines and Pole Hardware

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

6.1.5.2 Overhead Switchgear and Automation

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

6.1.5.3 Pole Substations

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

6.1.5.4 Poles

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

6.1.6 Distribution Ground Network

6.1.6.1 Distribution LV Switchboard Assembly

Distribution LV switchboard 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. Next it will target the old LV Boards containing exposed live components and certain types of circuit breakers that have known operational and maintenance issues. Some of them also containing asbestos.

An inspection program conducted 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 the substation will inform the priorities for the Evoenergy kiosk/padmount substation replacement program.

6.1.6.2 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 old legacy HV or LV 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 or repaired. For LV, the switchboards that have Capstan Links, exposed live components and aged components such as solid 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.

6.1.6.3 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. This is now possible to be achieved through the newly rolled out configurable LV pillar. The LV Pillars that have been prioritised for replacement include Henley Pillars and Pregnant Columns.

6.1.6.4 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 leading to high voltages at customer premises. 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.

6.1.6.5 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 Covered 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 life 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. Attempts have been made to conduct condition assessment mainly using on-line partial discharge (PD) testing with limited success. Monetised risk and failure data 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 10** summarises identified retirement of assets above $200,000. **Table 11** identifies programs for grouped small asset renewals and replacements.

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

6.1.9 Vegetation Management

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

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

Vegetation coming into contact with overhead powerlines 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 given their obsolescence
- The need to replace old damaged and failing pilot cables used for 11kV feeder unit protection and SCADA communications
- The need for increased speed, capacity, and reach of the telecommunication systems to support our operations
- Increased SCADA data requirements for effective management of DER in the low voltage network
- Protecting secondary assets from cyber security threats.

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

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

SCADA is also increasingly being installed on a distribution substation level within both Chamber and Padmount distribution substations. This is primarily driven by the need for additional monitoring and control on a LV network level to effectively manage the challenges of increased embedded generation penetration, connection of residential batteries and charging of electrical vehicles. Evoenergy currently has SCADA monitoring at around 10% of distribution substations with the aim to increase this to 20% over the next few years. Recent technological developments in low-cost retrofittable SCADA monitors have provided the capability to efficiently incorporate SCADA within older substations in older ACT suburbs. Additional details on Evoenergy's distribution substation monitoring program can be found in **Section 6.2.5**.

6.2.3 Protection

Protection assets are located within Evoenergy zone substations, switching stations, and distribution substations, and are used to isolate faults with electrical equipment, 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 2023-27 protection renewal program includes the following:

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

6.2.4 Telecommunication Systems

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

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

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

- Upgrading our 132kV 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.

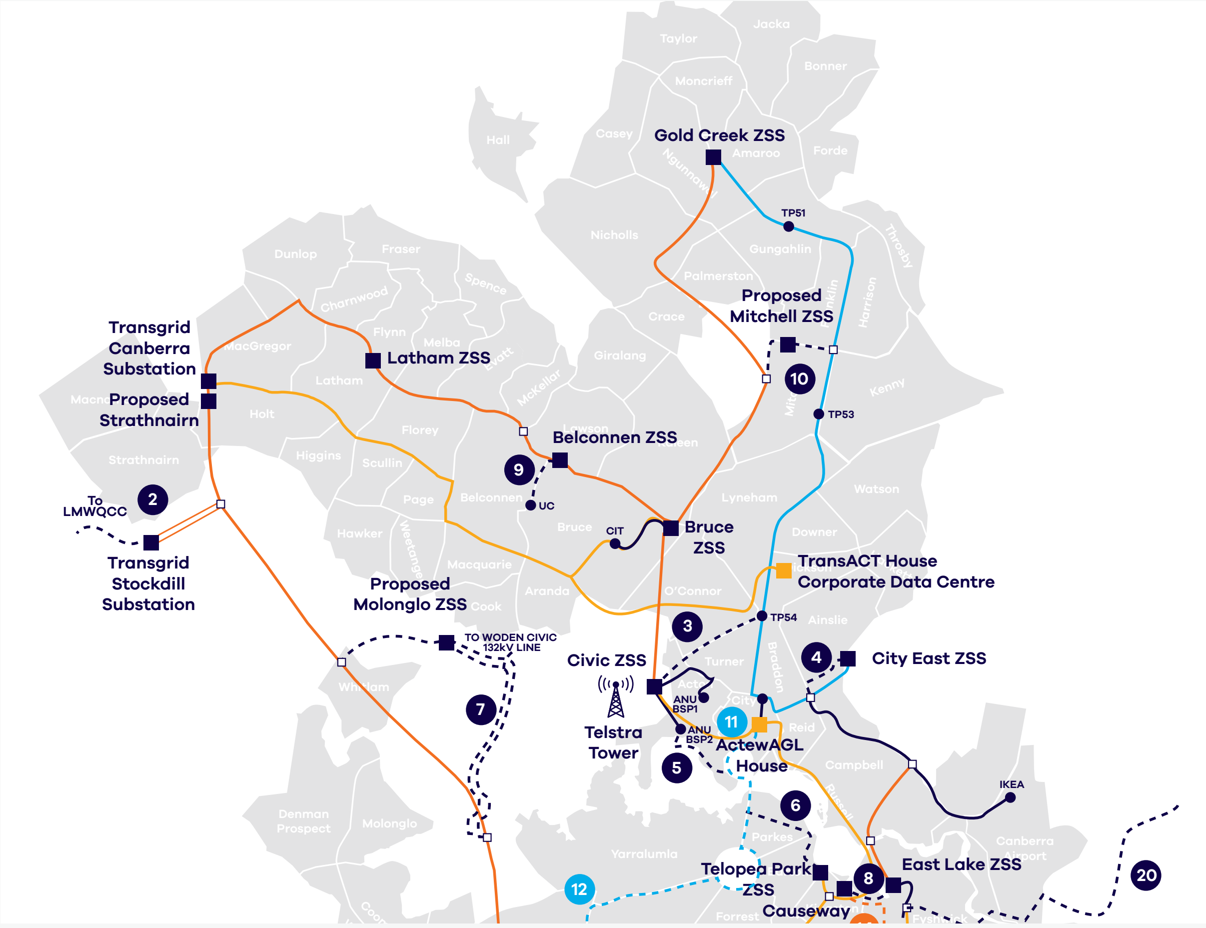
Other telecommunications upgrade programs include:

- Replacement of aging copper pilot cables with Optical Fibre cables. Pilot cables are used for 11kV feeder protection and SCADA communications. This is necessary for providing safety and reliability in the 11kV 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 32 and Figure 33 show current and proposed communications network projects as follows:

- Current UG Fibre Projects
  - **2.** Stockdill-LMWQCC Fibre
  - **3.** Dooring Feeder Fibre
- Upcoming UG Fibre Projects
  - **4**. City East Redundancy Fibre
  - **15**.GDC-LDK Fibre
  - **16**.Fyshwick Express Feeders Fibre
- Proposed UG Fibre Projects
  - **5.** ANU-Nishi Fibre
  - **6.** Kings Av to National Library Fibre
  - **7.** Molonglo ZSS UG 132kV line & Fibre
  - **8.** Causeway Decommissioning UG 132kV line & Fibre
  - **9.** Belconnen-UC Fibre
  - **10**. Mitchell ZSS UG 132kV line & Fibre
  - **19**. Wanniassa-Woden Bus Interchange UG Fibre
  - **20**. Eastlake-Airport UG Fibre
  - **21.** Civic-CBD UG Fibre
- Proposed Light Rail UG Fibre Projects
  - **11**. Stage 2A City-Commonwealth Av
  - **12**. Stage 2B Commonwealth Av – Woden
- Upcoming OPGW Fibre Projects
  - **13**. Canberra Av 132kV line (dual)
  - **14**. Gilmore-Causeway Line (extension Canberra Av to Causeway)
- Proposed OPGW Fibre Projects
  - **18**. Woden-Wanniassa 132kV line replacement & Fibre

Figure 32. Fibre optic network – Northern ACT



Legend

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

Current UG Fibre Projects

- 2 Stockdill-LMWQCC Fibre
- 3 Dooring Feeder Fibre

Upcoming UG Fibre Projects

- 4 City East Redundancy Fibre

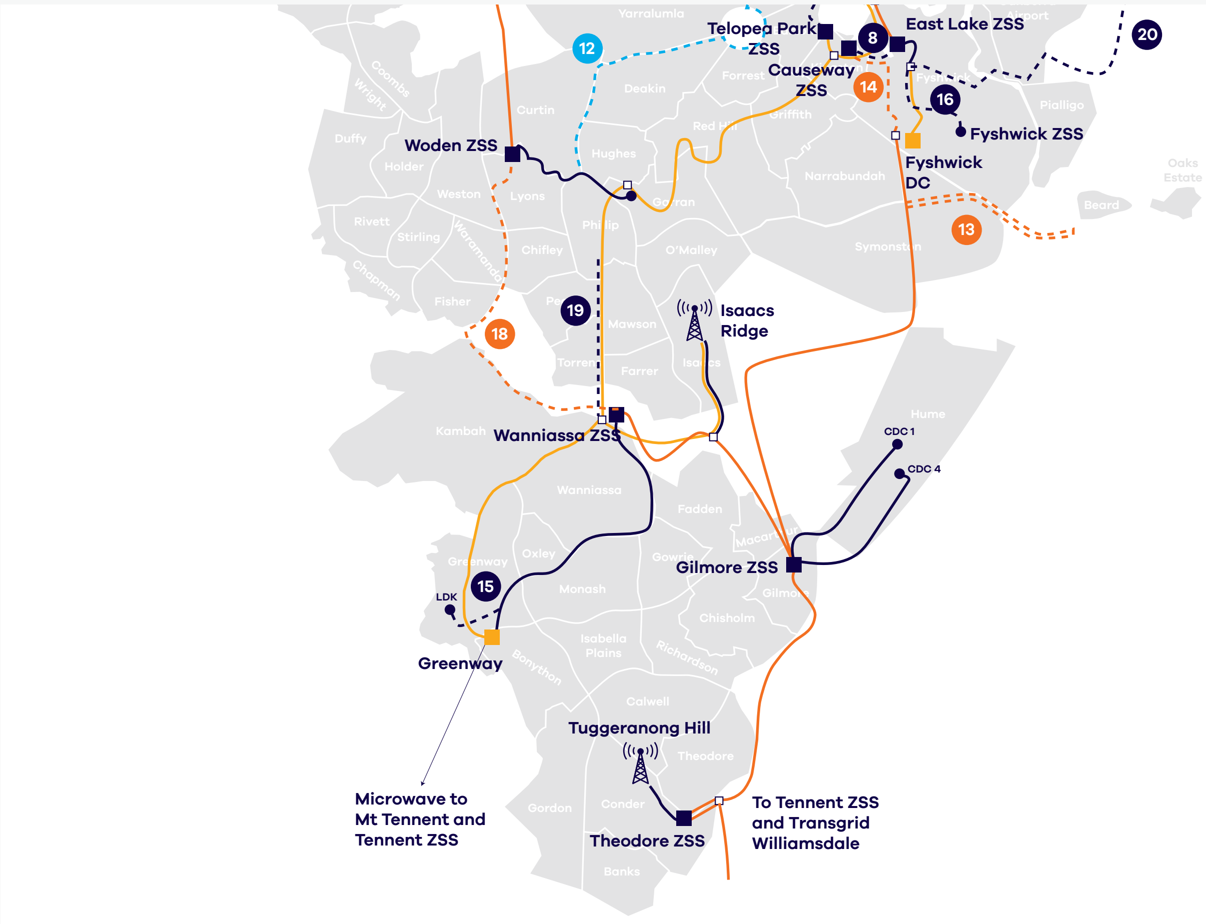
Proposed UG Fibre Projects

- 5 ANU-Nishi Fibre
- 6 Kings Av to National Library Fibre
- 7 Molonglo ZSS UG 132kV line & Fibre
- 9 Belconnen-UC Fibre
- 10 Mitchell ZSS UG 132kV line & Fibre
- 20 Eastlake-Airport UG Fibre
- 21 Civic-CBD UG Fibre

Proposed Light Rail UG Fibre Projects

- 11 Stage 2A City-Commonwealth Av
- 12 Stage 2B Commonwealth Av - Woden

Figure 33. Fibre optic network – Southern ACT



Legend

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

Upcoming UG Fibre Projects

15 GDC-LDK Fibre

16 Fyshwick Express Feeders

Proposed UG Fibre Projects

8 Causeway Decommissioning UG 132kV line & Fibre

19 Wanniassa-Woden Bus Interchange UG Fibre

20 Eastlake-Airport UG Fibre

Proposed Light Rail UG Fibre Projects

12 Stage 2B Commonwealth Av – Woden

Upcoming OPGW Fibre Projects

13 Canberra Av 132kV line (dual)

14 Gilmore-Causeway Line (extension Canberra Av to Causeway)

Proposed OPGW Fibre Projects

18 Woden-Wanniassa 132kV line replacement & Fibre

6.2.5 Distribution Substation Monitoring

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

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

6.2.6 Substation Automation Systems - IEC 61850

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

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

Safety Benefits

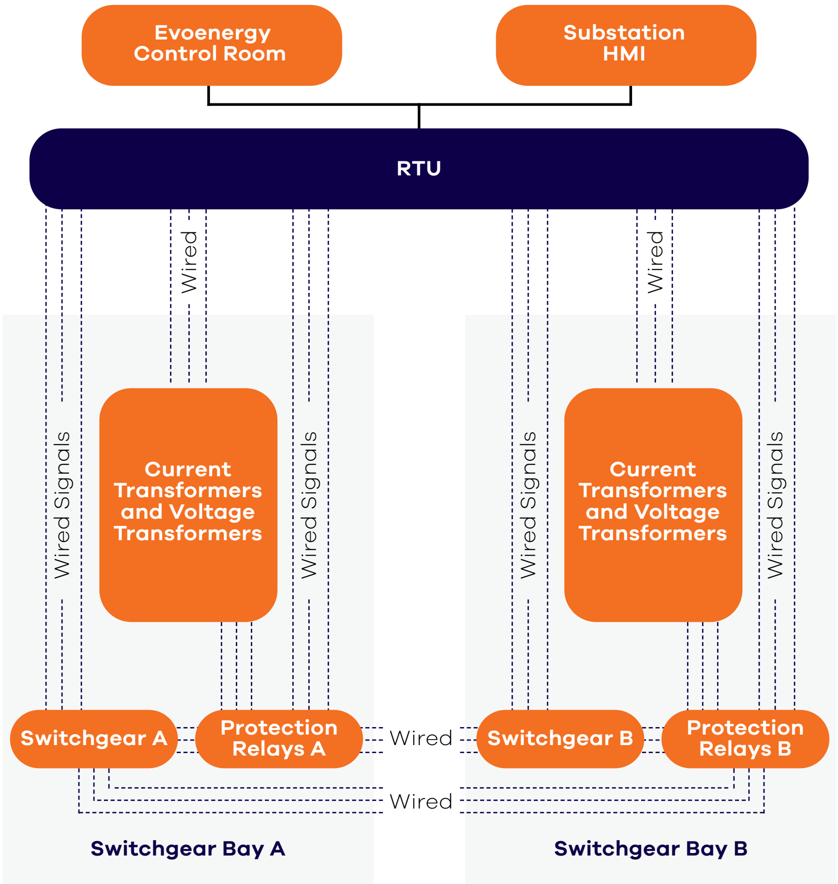
- Reduced requirement for DC wiring in protection panels. Communication between IEDs (Intelligent Electronic Devices) within the substation utilise fibre optic ethernet networks rather than hardwiring
- Increased visibility and reporting on communications and overall system health
- Additional controls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

Financial Benefits

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

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

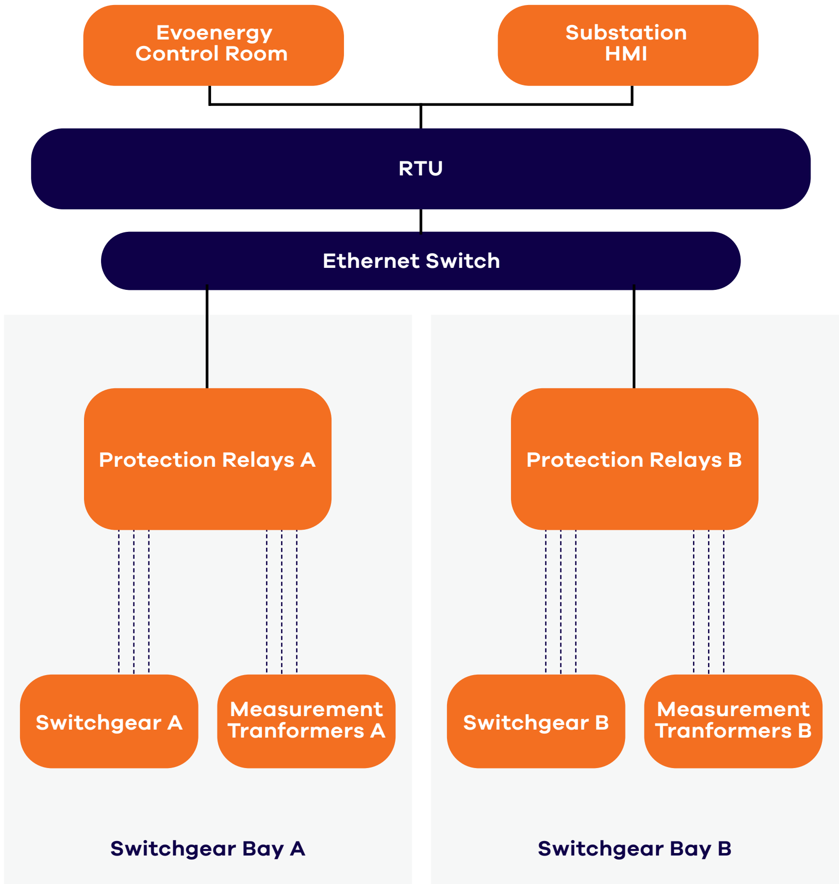
Figure 34. Representation of IEC 61850 substation compared to legacy scheme



Legacy Scheme

Extensive substation wiring:

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



Digital Substation Utilising IEC 61850

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

6.2.7 Advanced Fault Detection and Auto-Reclosing Schemes

Electricity distribution networks inherently involve bushfire risk to the environment and the community. Evoenergy is trialling a new type of switchgear primarily to reduce the risk of bushfires. Our bushfire management plan includes trialling 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.

6.2.8 What We Have Achieved In The Last Year

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

- 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 11kV 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 132kV transmission line, Bus protection and transformer protection relays at Woden Zone Substation and integrated with the new IEC 61850 system.
- Installed Under Frequency Load Shedding System at City East Zone Substation.
- Replaced SCADA remote terminal units at Woden ZSS and two distribution substations.
- Installed OPGW between Transgrid Canberra substation, Transgrid Stockdill substation and Woden ZSS.

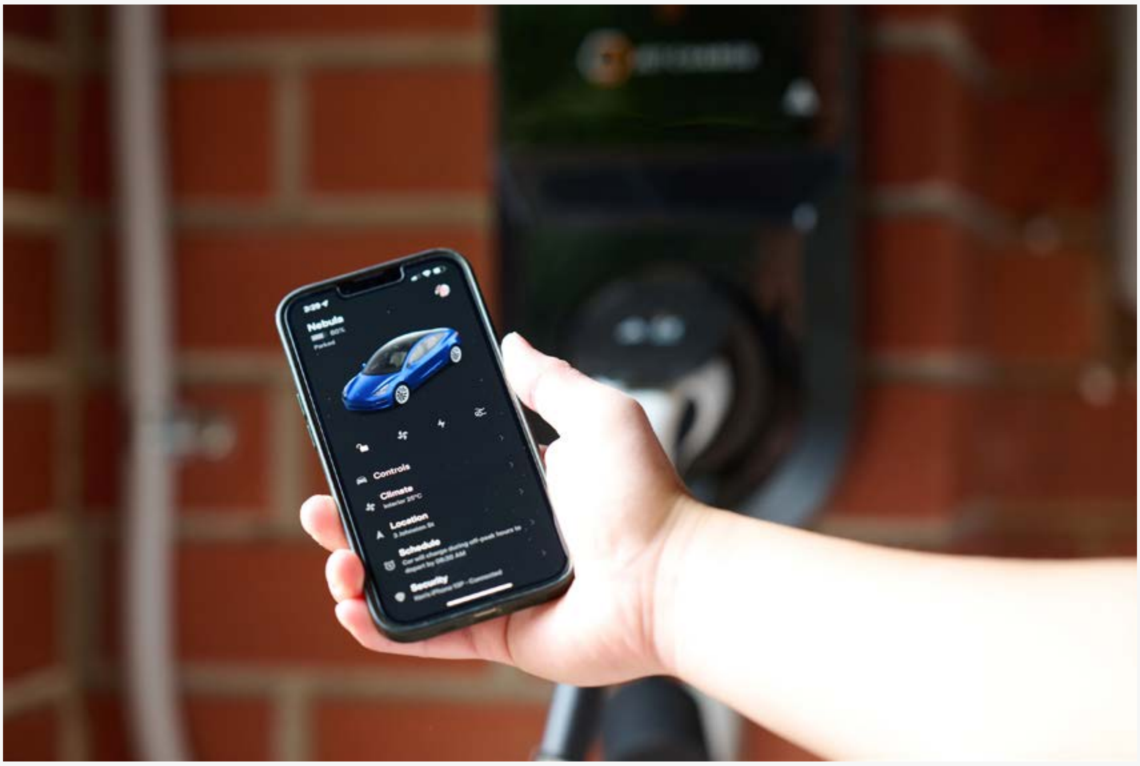
6.2.9 Secondary System - Planning Outcomes

Evoenergy assesses secondary assets needs and risks considering asset conditions, performance, compliance, criticality, and safety. The structured analysis of the needs is conducted in accordance with the Evoenergy Asset Management System Requirements and documented in the 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)
Distribution Substation Monitoring	SCADA, Communications	2022-25	Quality Reliability	$2.6m
Voltage Regulation System Upgrades	SCADA, Protection	2022-25	Quality Reliability	$2.7m
Secondary Systems Cyber Security Program	SCADA, Communications	2021-25	Safety Reliability	$1.9m
Woden ZSS Protection Replacement	Protection	2021-22	NER compliance Safety Reliability	$2.08m
Woden ZSS HMI and IEC61050 Automation Upgrades	SCADA	2021-22	Safety Reliability	0.25m
Latham ZSS Protection Replacement	Protection	2020-22	NER compliance Safety Reliability	$1.6m
Telopea Park ZSS Protection Replacement	Protection	2021-24	NER compliance Safety Reliability	$2.08m
Telopea ZSS HMI and IEC61050 Automation Upgrades	SCADA	2021-24	Safety Reliability	0.25m
Gilmore ZSS Protection Replacement	Protection	2022-24	NER compliance Safety Reliability	$2.4m
Gilmore ZSS HMI and IEC61050 Automation Upgrades	SCADA	2022-24	Safety Reliability	0.25m
Belconnen ZSS Protection Replacement	Protection	2023-24	NER compliance Safety Reliability	$2.4m
Belconnen ZSS RTU, HMI and IEC61050 Automation Upgrades	SCADA	2023-24	Safety Reliability	0.4m
Wanniassa ZSS Protection Replacement	Protection	2023-24	NER compliance Safety Reliability	$1.6m
Wanniassa ZSS HMI and IEC61050 Automation Upgrades	SCADA	2023-24	Safety Reliability	0.25m
Power Transformer Dissolved Gas Analysis Unit	Condition Monitoring	2020-21	Safety Reliability	$0.3m
Distribution Network Pilot Cable Replacement (optical fibre)	Communications	2021-25	NER compliance Safety Reliability	$1.5m
SCADA Network Radio Replacements	Communications	2021-23	Safety Reliability	$0.4m
Zone Substation WAN Router Replacements and Upgrades	Communications	2021-23	NER compliance Safety Reliability	$1.0m
Chamber Substations RTU Replacements and Upgrades	SCADA	2021-25	Safety Reliability	$1.5m



6.2.10 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 approximately 140,000 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. Basic meters are being phased out from the network and will reduce in volume at a rate of approximately 20,000 per annum.

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

No.	Project Title	Timeframe	Planned Outcomes
1	ADMS Upgrade	Q4 2022	Extend operational life of the ADMS system as well as improving functionality and 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	Systems Integration Platform	Q2 through Q4 FY2022	Progressively replace custom system to 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 Upgrade	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 Market Settlements	Q4 FY2020 through Q3 FY2022	Regulatory Compliance program.
7	Velocity - MSATS Standing Data Review, Billing and Metering Updates s	Q4 FY2020 through Q4FY2022	Compliance and Tariff related change to align Velocity with AEMO's changes to their MSATS system. Additional functionality includes 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 ADMS (3.4) was first introduced in 2016 and was upgraded in November 2022. The upgrade to Version 3.8 has delivered the following enhanced capability:

- Introduction of the Energy Management System (EMS) providing an integrated transmission network view and expanding all functionality available through the existing Distribution Management System (DMS) to the transmission level.
- Addition of Arc Flash module to facilitate the calculation of incident energy values associated with planned switching.
- Implementation of ADMS 3.8 SCADA management system
- Addition of more integrations including weather data and ability to share information with other systems.
- Updated user interface with more intuitive operation and enhanced usability.

6.3.3 Systems Integration Platform

The primary applications that support Evoenergy operations communicate with each other primarily through system-to-system interfaces. This web of system integrations is complex and difficult to troubleshoot and maintain. This can be likened to a telephone system without a central exchange, where everyone wishing to speak to someone would require a dedicated line to be installed. It's particularly inefficient with systems such as the finance system where most applications will need to communicate. An initiative is underway to implement an Enterprise Service Bus (exchange) that will manage and facilitate these system integrations. Our approach will be to gradually unpick the web of integrations and re-route through the ESB. This is a technology risk reduction initiative, but it should also allow:

- Increased 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.

Delivered in works related to program 3.

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 and 10

6.3.5 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.

6.3.6 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.

6.3.7 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.

6.3.8 Cyber Security

Cyber Security 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.

6.3.9 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.

6.3.9.1 Consumers Engagement

Providing our consumer with a 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.

6.3.9.2 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.

6.3.9.3 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.

6.3.9.4 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, 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.

6.3.10 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 secure 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 infrastructure 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.

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

Evoenergy's current network development drivers and challenges are:

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

7.2 Joint Planning With Transgrid

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

Due to ongoing COVID-19 concerns, this year's joint planning meeting was held for the third time via video conference in March 2022. Evoenergy and Transgrid also have regular discussions in addition to the formal joint planning meetings, to discuss and resolve technical issues.

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

- Diversions of ACT emergency bypass arrangement at Yass: The bypass is required to meet the requirements of the ACT Electricity Transmission Supply Code 4.1.1(1)(d) to supply the ACT agreed maximum demand within 48 hours of a special contingency event. This project relocated the existing bypass arrangement at Yass, in order to facilitate the installation of the series compensation devices on Line 2 switchbay.
- Connection to Molonglo substation: Construction of two 132kV line switch bays at recently built Stockdill 330kV substation has been completed. This project facilitates the 132kV connection to Evoenergy's proposed Woden tee Molonglo feeder (9HC) and Canberra feeder (9HF) to be supplied via Transgrid Stockdill 330kV substation.
- Upgrade of SCADA system including change of ICCP convention.

Planned Transgrid projects impacting Evoenergy's network include:

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

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

Evoenergy liaises closely with Transgrid throughout the implementation of these projects to ensure continuity and security of supply to the ACT is maintained. For further details refer to Transgrid's Transmission Annual Planning Report 2022[21].

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 220kV and above. The Australian Energy Market Operator (AEMO) published an updated Integrated System Plan[22] (ISP) in June 2022. The ISP identifies investment choices and recommends essential actions to optimise consumer benefits as Australia experiences what is acknowledged to be the world's fastest energy transition. That is, it aims to minimise costs and reduce the risk of events that can adversely impact future power costs and consumer prices, while also maintaining the reliability and security of the power system.

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

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

The 2022 ISP and its optimal development path support Australia's complex and rapid energy transformation towards net zero emissions, enabling low-cost firmed renewable energy and essential transmission to provide consumer in the NEM with reliable, secure and affordable power.

The ISP's optimal development path recognises and guides the significant investment needed in the physical infrastructure and intellectual capital of the NEM. That investment is needed to:

- *Meet significantly increased demand as homes, vehicles and industrial applications switch to electricity from existing energy sources. Without coal, this will require a nine-fold increase in utility-scale variable renewable energy (VRE) capacity, and a near five-fold increase in distributed solar photovoltaics (PV)...*

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

7.4 Urgent And Unforeseen Need

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

7.5 Planning Outcomes - Network Constraints And Limitations

Table 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.

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.

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

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

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

7.5.1.2 Commercial And Mixed Developments

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

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 1.5MW to be connected to the network to be large scale. The following projects are currently under consideration[23]:

- A 11.5MW Battery Energy Storage System in the Molonglo Valley implemented in two stages[24]
- An expansion of a landfill gas generator from 4MVA to 20MVA including a potential battery energy storage system

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

In addition to this, the ACT Government is planning to facilitate the implementation of at least 250MW of batteries as part of the Big Canberra Battery[25] project. The expression of interest process for this project closed in February 2022 with plans to commence construction 2023. Evoenergy does not yet have information on how these batteries may interact with or support 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.

23 Note: Backup generators have not been included in this summary.

24 More information can be found in **Section 7.6.1**

25 https://www.environment.act.gov.au/cc/big-canberra-battery

Table 13. Network Limitations

				MVA Required (cumulative)**					Dates					
Location	**Network Element**	**Limitation**	**RIT-D**	**2023**	**2024**	**2025**	**2026**	**2027**	**Consult**	**Decision**	**Required**	**Estimated Cost*** **	**Project Driver(s)**	**Project Reference**
Molonglo Valley	Zone Substation & Feeders	Capacity	Yes	1.5	2.8	4.1	4.3	4.5	Dec-19	Jun-20	Feb-22	$30.5m	See section 7.5.1.1.3, 7.5.1.1.4, 7.5.1.1.5 & 7.5.1.2.7	See section 7.6.1
Whitlam	Feeder	Capacity	No	4.5	11.4	15.8	15.8	15.8	Jun-21^	Oct-21	Sep-22	$1.3m	See section 7.5.1.1.4	See section 7.6.2
Denman Prospect	Feeder	Capacity	No	-	1.2	8.9	8.9	8.9	Feb-22	May-22	Apr-22	$1.8m	See section 7.5.1.1.3	See section 7.6.3
Dickson - Dooring St	Feeder	Capacity	No	1.5	2.8	4.1	4.1	4.1	Dec-19^	Jun-20	Feb-22	$3.8m	See section 7.5.1.2.3	See section 7.6.4
Gold Creek Zone	Zone Substation	Capacity / Reliability	Yes	-	-	-	-	-	Dec-22	Feb-23	Apr-25	$8.6m	See section 7.5.1.1.2, 7.5.1.1.6 & 7.5.1.2.1	See section 7.6.5
Fyshwick	Feeder	Capacity	No	38	39	40	40	40	Jun-21	Dec-21	Dec-23	$5.5m	See section 6.1.4.2	See section 7.6.6
Pialligo	Feeder	Capacity	No	6.8	7.3	8	8	8	Dec-21^	Mar-22	Jun-23	$4.8m	See section 7.5.1.2.8	See section 7.6.7
CBD West	Feeder	Capacity	No	-	-	0.5	2.6	5.6	Dec-22	Mar-23	Apr-24	$3.7m	See section 7.5.1.2.6	See section 7.6.8
Gilmore	Zone Substation	Capacity / Reliability	No	-	-	-	-	-	Dec-21	Apr-22	Oct-23	$2.5m	See section 6.1.4.6	See section 7.6.9
Strathnairn	Feeder	Capacity	No	-	0.7	2.7	2.7	3.4	Dec-22	Mar-23	Mar-25	$2.1m	See section 7.5.1.1.1	See section 7.8.1
City - Donaldson	Feeder	Capacity	No	-	-	1.4	1.4	1.4	Dec-22	Jun-23	Apr-25	$3.4m	See section 7.5.1.2.4	See section 7.8.2
Kingston^^	Feeder	Capacity	No	-	-	-	-	-	Dec-25	Jun-26	Apr-28	$1.0m	See section 7.5.1.2.9	See section 7.8.3
Lyneham	Feeder	Capacity	No	-	0.1	0.1	1.1	2.1	Dec-25	Jun-26	Apr-28	$5.3m	See section 7.5.1.2.2	See section 7.8.4
Woden/Phillip	Feeder	Capacity	No	-	-	1.1	3.1	3.9	Dec-22	Mar-23	Apr-25	$4.1m	See section 7.5.1.2.10	See section 7.8.5
Fairbairn South^^	Feeder	Capacity	No	-	-	-	-	-	Dec-26	Jun-27	Apr-29	$1.6m	See section 7.5.1.2.8	See section 7.8.6

* Network is operated beyond firm rating prior to the construction of new feeder.
** CumulativeMVA 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
^^Constraint forecast beyond 2027 planning horizon

Table 13. Network Limitations

				MVA Required (cumulative)**					Dates					
Location	**Network Element**	**Limitation**	**RIT-D**	**2023**	**2024**	**2025**	**2026**	**2027**	**Consult**	**Decision**	**Required**	**Estimated Cost*** **	**Project Driver(s)**	**Project Reference**
Gungahlin Town Centre	Feeder	Capacity	No	-	-	-	1.7	4.9	Dec-23	Jun-24	Apr-26	$5.2m	See section 7.5.1.2.1	See section 7.8.7
Hume West	Feeder	Capacity	No	-	-	-		1.1	Dec-24	Jun-25	Apr-27	$2.3m	See section 7.5.1.2.11	See section 7.8.8
Fyshwick Dairy Road	Feeder	Capacity	No	-	4.9	6.4	6.8	6.8	Dec-23	Jun-24	Apr-26	$0.7m	See section 7.5.1.2.12	See section 7.8.9
CBD South	Feeder	Capacity	No	-	-	-	-	0.1	Dec-24	Jun-25	Mar-27	$5.0m	See section 7.5.1.2.5	See section 7.8.10
Greenway	Feeder	Capacity	No	-	0.3	0.4	0.6	0.9	Dec-22	Mar-23	Mar-24	$2.8m	See section 7.5.1.2.12	See section 7.8.11
North Canberra	Transmission	Voltage	No	-	-	-	-	-	Jun-23	Dec-23	Jun-25	TBC	See section 4.2.2	See section 7.9.1
Gold Creek Zone	Zone Substation	Voltage	No	-	-	-	-	-	Dec-22	Jun-23	Jun-25	TBC	See section 4.2.2	See section 7.9.7
Ginninderry^^	Zone Substation & Feeders	Capacity	Yes	-	-	-	-	-	Dec-23	Jun-24	Sep-27	$28.6m	See section 7.5.1.1.1	See section 7.9.2
Belconnen Zone	Zone Substation	Capacity / Reliability	Yes	**2029 - 2034 period**									-	See section 7.9.3
Mitchell	Zone Substation & Feeders	Capacity	Yes	**2029 - 2034 period**									See section 7.5.1.1.2, 7.5.1.1.6, 7.5.1.2.1 & 7.5.1.2.2	See section 7.9.4
Curtin	Zone Substation & Feeders	Capacity	Yes	**2029 - 2034 period**									See section 7.5.1.2.10	See section 7.9.5
East Lake Zone	Zone Substation	Capacity / Reliability	Yes	**2029 - 2034 period**									See section 7.5.1.2.8, 7.5.1.2.12 & 6.1.4.2	See section 7.9.6
Various - Net Zero	Zone Substation & Feeders	Capacity	TBC	**Pending additional analysis**									See section 7.9.8	See section 7.9.8

* Network is operated beyond firm rating prior to the construction of new feeder.
** CumulativeMVA 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
^^Constraint forecast beyond 2027 planning horizon

Table 14. Locations Where Constraints Are No Longer Applicable

Location	Reason for Revision
Gungahlin Town Centre	Valley Feeder project complete.
Belconnen Town Centre	No recent updates on developer enquiries in the area. Not expected to need augmentation in the next 5 years. Evoenergy is monitoring this potential constraint.

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[26].

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 11kV feeders from Woden Zone Substation and two extended 11kV 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 has been provided by the Black Mountain feeder from Civic Zone Substation with a subsequent feeder extension from Belconnen Way South feeder from Civic Zone Substation.

Between 2020 and 2022 there were some delays to the anticipated land releases in Whitlam, however there was a significant acceleration of construction in Denman Prospect, shifting the anticipated constraint further west. Evoenergy is extending the Streeton feeder from Denman Prospect to connect to the Belconnen Way South Feeder in order to shift some load and utilise spare capacity.

In the short term there is a rapidly approaching constraint in the 11kV distribution network. Peak demand is forecast to exceed the combined thermal capacity of the existing 11kV feeders supplying the area by Winter of 2025. 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.

Evoenergy had planned to relocate the mobile zone substation (MOSS), which is a skid-mounted 132/11kV setup with 15MVA transformer capacity as the first stage of the zone substation. After a failure of the tap changer on the MOSS transformer the risk was reassessed and the preferred option for Stage 1 of the zone substation became to install a single permanent 55MVA transformer. This is planned to be commissioned prior to Winter 2025.

The total cost of this option is $30.6 million in present value terms.

Stage 2 is the installation of a second permanent 55MVA transformer and is expected to occur in 2029.

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

26 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.

Table 15. Forecast Load Of Feeders Supplying The Molonglo Valley

Feeder	Summer		Winter		2021		2022		2023		2024		2025	
	Firm	Thermal	Firm	Thermal	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
	100% Load Forecast (assume no demand reduction)													
Streeton	5.5	7.3	6.2	8.2	4.8	5.9	5.5	7.0	6.5	7.6	0.9	3.0	6.7	8.8
Black Mtn	5.7	7.6	7.4	9.9	1.7	6.4	3.8	7.1	5.0	9.8	2.4	7.7	7.9	14.4
Hilder	5.2	7.0	5.9	7.8	3.8	5.9	4.2	7.1	4.4	7.4	4.4	7.4	4.4	7.4
Bel Way Sth	4.7	6.2	5.3	7.0	3.3	5.0	1.1	2.0	3.6	2.8	3.6	5.6	5.5	8.2

Note: Forecast includes Belconnen Way South feeder extension, BESS stage 1 & 2 and Streeton Feeder extension. Thermal, Firm ratings and annual demand in MVA. Yellow fill denotes exceedance of firm rating, orange fill denotes the demand exceeds 90% of thermal ratings and red fill denotes exceedance of thermal rating.

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

Figure 35. Evoenergy's 132kV 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 4.99MW connection capacity in operation by Winter 2023, while stage 2 involves the full capacity of 11.5MW. 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 2024 under a base POE50 scenario.

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

Following significant delays due to the complexity of obtaining access to land for the zone substation, Evoenergy and ACT Government have successfully negotiated acquisition of the required land and initial civil work for the project is complete.

Interacting with this project, as part of the proposed residential developments, the Suburban Land Agency has requested the replacement of sections of two Evoenergy 132kV 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-2023
- **Stage 2**: Civic–Woden line section approximately 2030.

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 network 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 16. Supply to Whitlam Options Summary

Ref	Option	Total indicative cost ($ millions)	Evaluation Summary
1	Extend Belconnen Way South feeder	1.32	• Defer Molonglo ZSS construction completion to June 2025 • 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 2025 • 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 2025.

This project is close to completion and is expected to be fully energised early in 2023.

7.6.3 Supply to Denman Prospect

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

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

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

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

Evoenergy has considered minimum cost options to increase capacity in the Molonglo Valley while providing longer term value to the network. Demand management has previously been deemed unsuitable as part of the RIT-D process that identified the Molonglo BESS.

Feeder extensions with adequate capacity were identified and assessed for lowest cost, heritage and environmental complication. Of the two viable feeder extensions, the preferred option provided the lowest cost and minimal complications.

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

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

Table 17. Supply to Denman Prospect Options Summary

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

7.6.4 Supply To Dickson

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

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

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

Table 18. Supply to Dickson Options Summary

Option	Option type	Description	Cost	Evaluation
1	Network	Construct a new 11kV 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 meed 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 **7.8.3** which together form part of a master plan for the area.

The Dooring Feeder cable augmentation work is complete. The switching station is expected to be installed and energised by December 2022.

7.6.5 Gold Creek 3rd Transformer

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

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

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

Table 19. Gold Creek Zone Substation Load Forecast

Season	Case	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Summer	MP 50% PoE	**76**	**79**	**82**	**85**	**89**	**92**	**95**	**98**	**101**	**104**
Winter	MP 50% PoE	83	**87**	**90**	**93**	**96**	**100**	**103**	**106**	**109**	**113**

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

Evoenergy has considered three network options to supply this redundant capacity as follows:

Table 20. Supply to Gold Creek Options Summary

Season	Case	2022
Base case (not credible)	Do Nothing – utilise existing network	-1,464,117
Option 1 (preferred)	Install third transformer at Gold Creek Zone Substation	-6,480,564
Option 2	Accelerate Mitchell Zone Substation	-21,425,734
Option 3	Install three feeders from Latham Zone Substation (Defers 3rd Tx at Gold Creek by 3 years)	-12,041,302

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

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

The scope of work includes connection to the existing 132kV bus, 132kV circuit breaker, 132kV CTs and surge diverters, 11kV transformer cables, 11kV switchboard and associated protection, monitoring and communications equipment. Should this be selected as the preferred solution, these works are expected to be completed and commissioned prior to winter peak 2025. Should there be a transformer failure prior to commissioning the third transformer, Evoenergy would utilise load transfer capacity to minimise the impacts of unserved energy during this time. This is the preferred option for the following reasons:

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

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

As part of the RIT-D Evoenergy has published the Gold Creek Capacity Non-Network Options Report. This is available on the Evoenergy website[27]. The consultation period for the non-network options report closed on the 28th November 2022. Evoenergy aims to publish the final project assessment report in January 2023 with the preferred option to be operational by April 2025.

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

7.6.6 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 66kV assets decommissioned. This is still an Evoenergy strategic objective which is proposed to be achieved by installing some high capacity express 11kV feeders (i.e. feeders with no intermediate loads) from East Lake to Fyshwick, and converting Fyshwick to an 11kV switching station only. Cables proposed are 11kV 3c/400 mm^2 Cu XLPE and these would replace the existing transformer incomer cables at the three Fyshwick 11kV switchgear groups. These express cables would be rated at approximately 10.5MVA each continuous, providing 31.5 MVA maximum capacity to Fyshwick and 21MVA 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 11kV switchboard to less than 21MVA.

Two options were considered for this work:

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

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

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

Estimated cost is $5.7 million. Feeder install is expected to be completed by December 2022 with cutover work to be completed throughout the 2023 calendar year.

7.6.7 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 8MVA 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 11kV feeders from Fyshwick Zone Substation, and the Dairy North 11kV feeder from East Lake Zone Substation.

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

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

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

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

Table 21. Supply To Pialligo Options Summary

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

This project is currently in progress with government planning approvals underway. The project is planned to be completed by June 2023.

7.6.8 Supply To Canberra CBD West

This project is driven by the need to provide supply to support load growth in Section 63, Canberra CBD West, to account for a cumulative incremental load increase of approximately 20.4MVA by 2027.

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

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

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

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

A preliminary cost estimate for the recommended option is $3.69m in FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST.

Table 22. Supply To Canberra CBD West Options Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	Not selected as not technically feasible
1	Grid Battery	$17.74	$49.93	Not selected due to lower NPV
2	New 11kV feeder from Civic Zone Substaion to Section 63, Canberra CBD	$3.69	$60.55	**Recommended** • Highest NPV technically feasible option
3	New 11kV feeder from City East Zone Substation to Section 63, Canberra CBD	$6.98	$57.96	Not selected due to lower NPV

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

7.6.9 Gilmore Zone Substation Spare Transformer And Third Switchboard

Gilmore zone substation is a 2 transformer, 2 11kV switchboard site commissioned in 1985. The original design catered for the site to be upgraded to a 3-bay site as demand within the Tuggeranong region increased.

Load forecasts indicate that Gilmore zone is projected to breach its continuous rating within the 2024-29 regulatory period therefore losing the zone substation requirement to maintain N-1 redundancy. In addition to this the power transformers at Gilmore Zone Substation are approaching end of life. To combat this, a transformer will be relocated from Telopea zone (TX3) and installed within the central vacant bay at Gilmore zone within FY22/23 (scheduled October 2022).

This will provide redundancy in the event of a transformer failure. A third 11kV switchboard is required in order to provide the 11kV circuit breakers (feeders) necessary for this power transformer to support load.

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

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

7.6.10 Other Projects Currently In Progress

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

- 132kV Transmission line relocations in the Molonglo Valley - Approximately 14.7 km of overhead 132kV 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. 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 of installation in June of 2023 and removal of the overhead lines by November 2023. This project is entirely customer funded.
- Proposed Harman 132/11kV Zone Substation and 2.2 km of 132kV overhead transmission line to supply increased load in the surrounding area. This is a customer-initiated project entirely funded by the external parties. Completion of construction is planned by September 2023.
- Denman North:
  - Stages 1, 2A & 2B under construction expected energisation April 2023
  - Stages 3, 4, 5 & 7 expected to be completed between mid-2023 & early 2024
  - Stage 6, 8 & 9 energisation tentatively expected for end 2025
- Jacka stage 2 - Reticulation (HV & LV) for residential development in design with energisation expected between mid-2023 and mid-2024.
- Macnamara:
  - Stage 1 A, B & D in design with energisation expected late 2023
  - Stage 1 C, E & F expected energisation late 2024
- Whitlam 3:
  - 3A & 3C - Reticulation (HV & LV) for residential development are in progress with energisation expected mid-2023.
  - 3B – expected energisation late 2023
- 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 February 2023.
- New Supply (2 x 11kV feeders from East Lake ZS) to Data Centre in Airport Precinct – Project has commenced with anticipated completion by late 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 2027.
- 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 is ongoing with targeted completion in late 2023. 7.7 Projects Completed

Significant projects completed during the year include:

- Extension of the Black Mountain Feeder to supply the greenfield development of Whitlam
- Supply to Gungahlin Town Centre – The Valley Feeder from the Gold Creek Zone Substation to supply approximately 7.6 MVA to developments in the Gungahlin Town Centre was energised in June 2022.
- Denman Prospect 1B – Stages 2E1, 2E2 complete and energised 2E3 & 2E4 expecting energisation November 2022 - of the residential greenfield development energised.

7.7 Proposed Completed

Significant projects completed during the year include:

- Extension of the Black Mountain Feeder to supply the greenfield development of Whitlam
- Supply to Gungahlin Town Centre – The Valley Feeder from the Gold Creek Zone Substation to supply approximately 7.6 MVA to developments in the Gungahlin Town Centre was energised in June 2022.
- Denman Prospect 1B – Stages 2E1, 2E2 complete and energised 2E3 & 2E4 expecting energisation November 2022 - of the residential greenfield development energised.

7.8 Proposed Network Developments

7.8.1 Supply to Strathnairn

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

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

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

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

Table 23. Supply to Strathnairn Options Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	• Not selected as not technically feasible
1	Grid battery	$128.12	$855.13	• Not selected due to lower NPV
2	Weir feeder extension	$2.12	$948.23	**Recommended** • Highest NPV technically feasible option
3	New 11kV feeder from Latham Zone Substation to Strathnairn	$2.99	$947.50	• Not selected due to lower NPV

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

The recommended option based on the options evaluation presented in this report is Option 2, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV. The recommended option will commence construction during the 2019-24 regulatory period and be completed during 2024/25.

A preliminary cost estimate for the recommended option is $3.54 million in FY24/25 dollars, excluding corporate overheads, contingency and GST with $2.12 million in FY23/24 dollars, proposed to be spent in the 2024-2029 period.

7.8.2 Supply to Donaldson Street City

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

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

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

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

Table 24. Supply to Donaldson Street, City, Options Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	Not selected as not technically feasible
1	Grid battery	$17.27	$432.40	Not selected due to lower NPV
2	New 11kV feeder from City East Zone Substation to Section 96, City East	$4.07	$442.18	Not selected due to lower NPV
3	New 11kV feeder from Civic Zone Substation to Section 96, City East	$3.41	$443.70	**Recommended** • Highest NPV technically feasible option

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

The recommended option based on the options evaluation presented in this report is Option 3, as this meets the requirements of the need, is technically and economically feasible, and has the highest net present value (NPV).

A preliminary cost estimate for the recommended option is $3.41m in FY23/24 dollars, excluding corporate overheads, excluding contingency, and excluding GST.

The recommended option would be targeted for completion by winter 2025.

7.8.3 Supply to Kingston

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

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

There is a risk that the existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from winter of 2028.

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

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

Table 25. Supply to Kingston Options Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Base Case – utilise existing network infrastructure	$0	$0	Not selected as not technically feasible
1	Grid battery	$12.20	$158.55	Not selected due to high cost
2	New 11kV feeder from East Lake Zone Substation to Section 68 Kingston	$0.99	$167.33	**Recommended** • Lowest cost technically feasible option
3	New 11kV feeder from Telopea Park Zone Substation to Section 68 Kingston	$1.84	$166.66	Not selected due to high cost

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

The recommended option based on the options evaluation presented in this report is Option 2, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV. The recommended option is required to be commissioned during 2027/28.

A preliminary cost estimate for the recommended option is $0.99m in FY23/24 dollars, excluding corporate overheads, excluding contingency, and excluding GST.

7.8.4 Supply to Lyneham

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

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

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

The existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with optimising the existing 11kV feeder network. Without action, the gap between the demand forecast and existing feeder capacity is expected to arise from 2027/28.

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

The assessment of the options considered to address the need are provided below.

Table 26. Supply to Lyneham Options Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	Not selected as not technically reasible
1	Grid battery	$32.60	$107.80	Not selected due to lower NPV
2	New 11kV feeder from Civic Zone Substation to Lyneham	$5.28	$128.42	**Recommended** • Highest NPV technically feasible option
3	New 11kV feeder from Belconnen Zone Substation to Lyneham	$8.89	$125.66	Not selected due to lower NPV

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

The recommended option based on the options evaluation presented in this report is Option 2, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV. Construction would commence in 2026/27 and be completed in 2027/28.

A preliminary cost estimate for the recommended option is $5.28m in FY23/24 dollars, excluding corporate overheads, excluding contingency, and excluding GST.

7.8.5 Supply to Woden/Phillip

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

Evoenergy's existing network supplying Woden Town Centre has insufficient capacity to service the associated load growth during the 2024-29 regulatory period. Without action, the gap between the demand forecast and existing thermal feeder capacity is expected to arise from 2025.

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

The assessment of the options considered to address the need are provided below.

Table 27. Supply to Woden/Phillip Options Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	Not selected as does not meet minimum requirements
1	Grid battery	$39.56m	$1,357.67m	Not selected due to lower NPV
2	New 11kV feeder from Woden Zone substation	**Total** - $5.10m **Stage 1** - $3.06m **Stage 2** - $2.04m	$1,385.47m	Not selected due to lower NPV
3	New 11kV feeder from Wanniassa Zone Substation	**Total** - $4.14m **Stage 1** - $2.48m **Stage 2** - $1.66m	$1,386.28m	**Recommended** • Highest NPV technically feasible option

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

The recommended option based on the options evaluation presented in this report is Option 3, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV.

A preliminary cost estimate for the recommended option is $4.14m in FY23/24 dollars, excluding corporate overheads, excluding contingency, and excluding GST.

7.8.6 Supply to Fairbairn South

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

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

There is a risk that the existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with significant optimisation of the existing 11kV feeder network. The gap between the demand forecast and existing feeder capacity is expected to arise from summer 2028/29.

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

The assessment of the options considered to address the need are provided below.

Table 28. Supply to Fairbairn South Options Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	Not selected as not technically feasible
1	Grid battery	$9.32	$18.48	Not selected due to lower NPV
2	New 11kV feeder from East Lake Zone Substation to Substation 11502	$1.57	$24.31	**Recommended** • Highest NPV technically feasible option

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

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

A preliminary cost estimate for the recommended option is $1.57m in FY23/24 dollars, excluding corporate overheads, excluding contingency, and excluding GST.

7.8.7 Supply to Gungahlin Town Area

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

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

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

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

The assessment of the options considered to address the need are provided below.

Table 29. Supply to Gungahlin Town Area Options Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	Not selected as does not meet minimum requirements
1	Grid battery	$19.07	$266.22	Not selected due to lower NPV
2	New 11kV feeder from Gold Creek Zone Substation to Manning Clark Crescent, Gungahlin	$5.22	$277.23	**Recommended** • Highest NPV technically feasible option
3	New 11kV feeder from Belconnen Zone Substation to Manning Clark Crescent, Gungahlin	$10.26	$272.87	Not selected due to lower NPV

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

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

A preliminary cost estimate for the recommended option is $5.22m in FY23/24 dollars excluding corporate overheads, contingency, and GST.

7.8.8 Supply to Hume West

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

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

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

The assessment of the options considered to address the need are provided in the table below.

Table 30. Supply to Hume West Options Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	Not selected as does not meet minimum requirements
1	Grid battery only	$10.40	$161.56	Not selected due to lower NPV
2	New 11kV feeder from Gilmore Zone Substation	$2.33	$168.00	**Recommended** • Highest NPV, technically feasible option

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

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

A preliminary cost estimate for the recommended option is $2.33m in FY23/24 dollars, excluding corporate overheads, excluding contingency, and excluding GST.

7.8.9 Supply to Fyshwick Dairy Road

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

The latest Evoenergy demand forecast shows rapid load growth associated with the planned high-density redevelopment of the Section 38 site in Fyshwick, with stage one of the development commencing in 2022.

The existing Evoenergy network will be unable to service the expected load growth during the 2024-29 regulatory period, even with load-shifting to optimise the existing 11kV feeder network. Without action, the gap between the demand forecast and existing feeder capacity is expected to materialise in 2026.

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

The assessment of the options considered to address the need are provided in the table below

Table 31. Supply to Fyshwich Dairy Road Options Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	Not selected as does not meet minimum requirements
1	Grid battery only	$134.91	$1,202.71	Not selected due to lower NPV
2	New 11kV feeder from East Lake Zone Substaion to Section 38	$0.68	$1,312.92	**Recommended** • Due to highest NPV

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

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

A preliminary cost estimate for the recommended option is $0.68m in FY23/24 dollars, excluding corporate overheads, excluding contingency, and excluding GST.

7.8.10 Supply to CBD South - S 3 Parkes & S 37 City

This project is driven by the need to provide supply to support load growth in the proposed new University of New South Wales (UNSW) Canberra City Campus, an 8 hectare, 6000-student campus straddling Parkes, Reid and Canberra CBD.

UNSW is committed to spending about $1 billion over the next 15 years to fully develop the site. An initial 2.5 MVA of load growth is anticipated by 2024, rising steadily thereafter to an estimated 14 MVA by 2035.

Evoenergy's existing network supplying the area will be unable to service the expected load growth during the 2024-29 regulatory period, even with optimised load allocations among the existing 11kV feeder network. If no action is taken, the gap between the demand forecast and existing feeder capacity is expected to arise from 2027.

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

The assessment of the options considered to address the need are provided the table below.

Table 32. Supply to CBD South - S 3 Parkes & S 37 City, Option Summary

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	Not selected as not technically feasible
1	Grid battery	$5.65	$31.27	Not selected due to lower NPV
2	New 11kV feeder from City East Zone Substation to Sections 3 and 37	$5.24	$31.29	Not selected due to lower NPV
3	New 11kV feeder from Civic Zone Substation to Sections 3 and 37	$4.98	$31.49	**Recommended** • Highest NPV technically feasible option

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

The recommended option based on the options evaluation presented in this report is Option 3, as this meets the requirements of the need, is technically and economically feasible, and has the highest NPV.

A preliminary cost estimate for the recommended option is $4.98m in FY23/24 dollars, excluding corporate overheads, excluding contingency, and excluding GST.

7.8.11 Supply to Tuggeranong Mixed Developments

The latest Evoenergy demand forecast shows rapid load growth associated with proposed developments on sections 57, 73-81.

The existing Evoenergy network does not have sufficient capacity to service the expected load growth during the 2024-29 regulatory period.

Without action, the gap between the demand forecast and existing feeder capacity is expected to arise from 2025.

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

The assessment of the options considered to address the need are provided in **Table 33** below.

Table 33. Options Assessment and Preferred Option Identification

Option	Option Type	Cost^ (millions)	NPV^* (millions)	Evaluation Summary
0	Utilise existing network infrastructure	$0	$0	• Not selected as not technically feasible
1	Grid battery	$10.57	$60.72	• Not selected due to lower NPV
2	New 11kV feeder from Wanniassa Zone Substation	$2.81	$66.97	**Recommended** • Highest NPV technically feasible option

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

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

A preliminary cost estimate for the recommended option is $2.81m in FY23/24 dollars, excluding corporate overheads, excluding contingency, and excluding GST.

7.8.12 Nona Feeder Reliability Improvement

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

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

The table below provides a summary and comparison of the two options considered.

Table 34. Nona Feeder Reliability Improvement Options Summary

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

^ FY23/24 dollars, excluding corporate overheads, excluding contingency and excluding GST

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

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

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

7.8.13 Decommissioning of Causeway 132kV Switching Stations

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

Causeway Switching Station located in the Kingston suburb at the eastern end of Lake Burley-Griffin, provides a point of 132kV interconnection between City East, East Lake, Telopea Park and Gilmore zone substations. Connections to Causeway Switching Station comprise three 132kV underground cable circuits to Telopea Park Zone Substation, a single circuit 132kV overhead line to Gilmore Zone Substation, a single circuit 132kV overhead line to City East Zone Substation, and a single circuit 132kV 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 132kV 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 132kV cable circuits comprising one single core cable per phase (each circuit 3 x 1c/630 mm^2 Cu XLPE) from East Lake Zone Substation through the Jerrabomberra wetlands to Causeway Switching Station to through-joints to the existing Causeway–Telopea Park cable circuits. This route includes directional drilling under the Jerrabomberra Creek. This will create three 132kV 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 132kV bus at Telopea Park Zone Substation. It is proposed to retain them as transformer feeders.
- The East Lake–Causeway 132kV 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 132kV circuit rated at 220 MVA.
- The Causeway–Gilmore 132kV circuit is currently all overhead. A 132kV underground cable circuit comprising twin single core cables per phase (6 x 1c/1600mm^2 Cu XLPE) will be installed approximately 2.9 km from East Lake Zone Substation to connect to the existing overhead line at a new three concrete pole UGOH structure to replace pole no T87 at the corner of Canberra Ave and Monaro Highway. This will create a new East Lake–Gilmore 132kV circuit rated at 457 MVA.
- Causeway Switching Station will be subsequently decommissioned and dismantled.

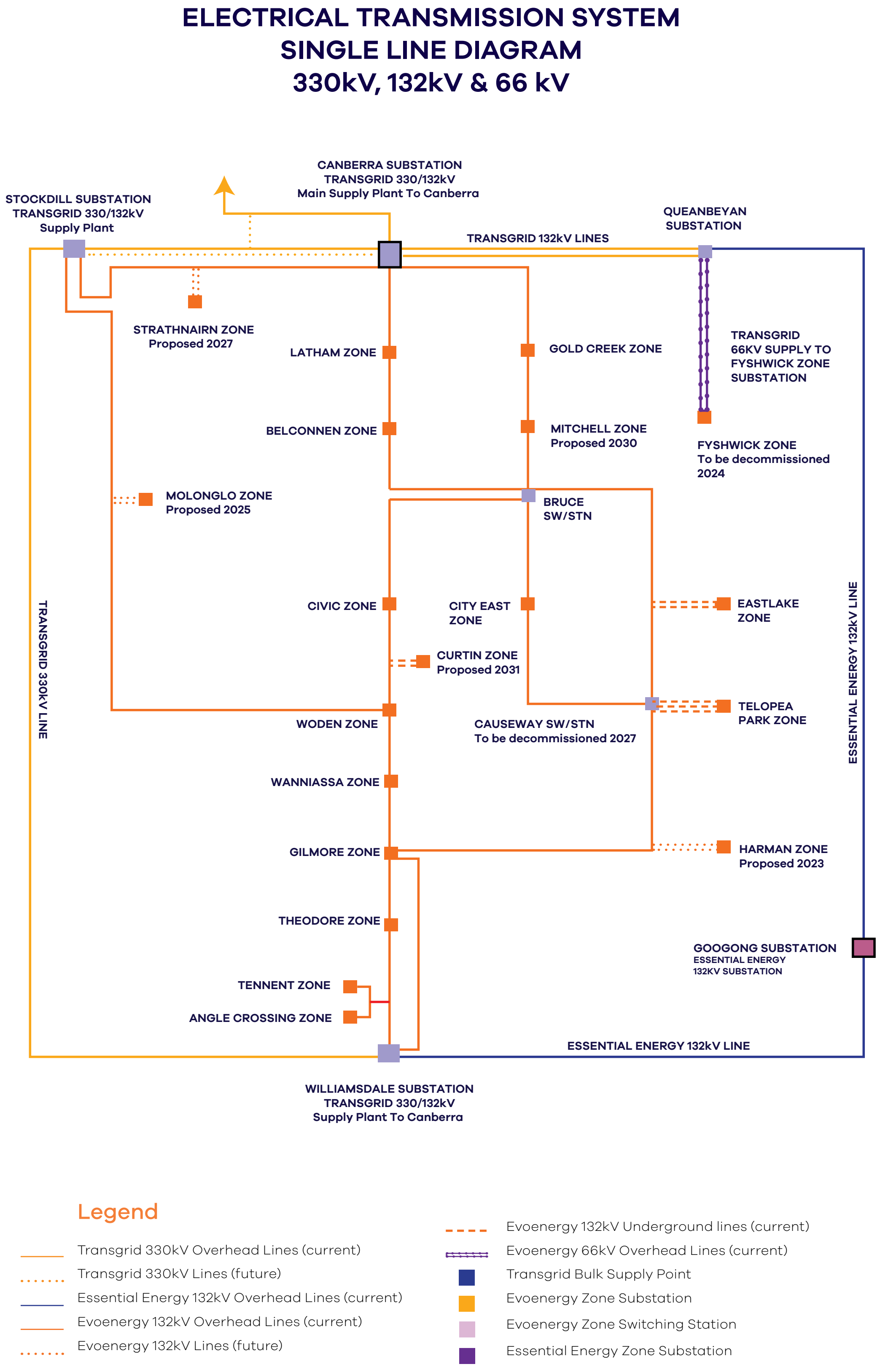
Figure 36. Causeway Switching Station

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 proposed project completion date is March 2027.

Figure 37 illustrates this proposed development.

Figure 37. Causeway Switching Station – Proposed 132kV Cabling

Figure 38. 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 11kV 10 MVAr capacitor bank at each of Evoenergy's northern zone substations.

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

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

7.9.2 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 as well as prohibitively high 11kV feeder costs. 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.

Evoenergy is planning to conduct a RIT-D for this project in FY23/24 which will include full options analysis covering both network and non-network options. Preliminary options analysis will be presented as part of Evoenergy's 2024-2029 regulatory submission.

Evoenergy is also currently working with the Ginninderry Joint Venture on final site selection for the substation.

7.9.3 Belconnen Zone Substation Third Transformer

Most years the peak demand for Belconnen Zone Substation sits between the continuous and 2-hour emergency rating for the substation. Over the next decade the maximum demand is forecast to increase however it is not expected to exceed the 2-hour emergency rating. As we see additional growth in the area as well as the impacts of ACT Government policies around zero emission vehicles and gas transition this may need to be reassessed. If the forecast maximum demand over the decade increases by approximately 10MVA Evoenergy will need to consider the installation of a third transformer at the zone substation. This project has been tentatively marked for the 2029-2034 regulatory period pending review.

7.9.4 Mitchell Zone Substation

Due to the extensive growth in the Gungahlin and North Canberra regions Evoenergy is expecting to require the first stage of a new zone substation to be commissioned early in the 2029-2034 regulatory period with work expected to begin in the 2024-2029 regulatory period. This is in addition to the third transformer proposed to be installed at the Gold Creek Zone Substation.

Evoenergy is currently working with the ACT Government to identify an appropriate site for this future zone substation which is tentatively name the Mitchell Zone Substation due to the proposed location. As well as supplying additional capacity to the Gungahlin region, this zone substation is proposed to alleviate forecast constraints on City East Zone Substation primarily due to net zero load growth.

Evoenergy is expecting to confirm land procurement and complete a RIT-D for this project later in the 2024-2029 regulatory period. This project and RIT-D will progress pending detailed options analysis and the timing is expected to be confirmed in 2027.

7.9.5 Curtin Zone Substation

The Woden Valley is experiencing significant growth primarily due to urban infill and redevelopment. Stage 2B of the Canberra light rail project will run to Woden. This is expected to increase the rate of intensification in the area.

Although the construction of the Molonglo Zone Substation is expected to ease some constraints in the Molonglo Valley which is currently primarily supplied from Woden Zone

Substation, development in the Woden Valley is expected to create additional constraints on the Woden Zone Substation. Projects include the Canberra Hospital expansion, Transport Canberra Electric Bus Depots, expansion and redevelopment of the Woden CIT campus and redevelopment of several government offices. In addition to this will be the sale of flat car parks and infill developments in Curtin and Yarralumla. The constraints arising from this development will be exacerbated by net zero load growth, particularly the increased uptake in electric vehicles and associated charging infrastructure.

Evoenergy is expecting to require an additional zone substation in the Woden Valley region early in the 2029-2034 period. Evoenergy will be working with the ACT Government to identify an appropriate site for this future zone substation. It is tentatively named the Curtin Zone Substation as Evoenergy's 132kV overhead lines pass by Curtin, indicating this may be an appropriate location. This proposed zone substation will also help to offload forecast constraints on the Telopea Park Zone Substation.

Evoenergy is expecting to confirm siting and complete a RIT-D for this project later in the 2024-2029 regulatory period. This project and RIT-D will progress pending detailed options analysis and the timing is expected to be confirmed in 2027. This will include necessary 132kV augmentation work.

7.9.6 East Lake Third Transformer

With the load from Fyshwick Zone Substation being transferred to East Lake Zone Substation as well as growth in the Fyshwick, Airport, Pialligo and Kingston Foreshore area Evoenergy has forecast East Lake Zone Substation to exceed its winter 2-hour emergency rating in the 2029-2034 regulatory period. Evoenergy will monitor this constraint and review the impacts of block loads as well as net-zero transition in order to determine the timing of the constraint.

7.9.7 Zone Substations Reactive Plant

As penetration of consumer energy resources such as rooftop PV increases we are expecting to see a deterioration of power quality at the zone substations, such as the issues seen at Gold Creek Zone Substation. Evoenergy has identified that reactive plant may be needed at zone substations. This is subject to detailed analysis and proposed investments will be detailed as they are identified.

7.9.8 Net-Zero Driven Augmentation

Due to the previously outlined announcements from the ACT Government regarding electric vehicles and electrification of the gas network in the ACT, Evoenergy is expecting to require significant additional augmentation in the network in the next 5 years and beyond with the transition of energy from transport and the gas network to the electricity network.

Evoenergy has completed modelling scenarios in order to determine the augmentation required to meet the additional demand required by net zero transition in the coming years. The forecast growth is primarily due to increased uptake in electric vehicles and the demand requirements of the associated charging infrastructure.

Under the preferred scenario, Evoenergy proposes to install 10 new feeders across a number of suburbs to accommodate a modest uptake of EVs by consumers. The feeder augmentations will occur across the 11kV network but there will also be upgrades required for transmission infrastructure, zone substation upgrades and low voltage network works. This scenario assumes 51,300 EVs including 41,944 passenger vehicles will be registered in the ACT by 2030. The below table provides a summary of the augmentation works to facilitate integration of EVs and the increased demand for electricity.

If the actual amount of EV uptake is greater than forecast, areas of the network may be constrained with insufficient augmentation works, leading to unserved energy.

Table 35. Proposed Net Zero Driven Feeder Projects

	Description
11kV feeder works	• Supply to Braddon (2.2 km) $3.87m • Supply to Watson (4.3 km) $2.97m • Supply to Ainslie (3.2 km) $4.77m • Supply to Campbell (4 km) $5.04m • Supply to Franklin (5.7 km) $4.98m • Supply to Garran and Red Hill (4.6 km) $2.54m • Supply to Phillip (3.6 km) $4.50m • Supply to Canberra CBD feeder 1 (from CE ZSS) (3 km) $3.16m • Supply to Canberra CBD feeder 2 (from Civic ZSS) (3.8 km) $2.61m • Supply to Canberra CBD feeder 3 (from Civic ZSS) (3 km) $0.28m (partial delivery, remainder in 2029-2034)
Zone substation works	• Curtin Zone Substation Stage 1 $19.31m (partial works for commissioning in the 2029-34 period) • Establishment of Mitchell Zone Substation - early works $2.20m • ZS QoS Reactive Plant $2.06m
Transmission	• Woden to Curtin 132kV UG Cable $8.5m as part of Curtin ZS establishment
Distribution	• Distribution Substation upgrades $5.13m • Low Voltage Circuit upgrades $2.87m
ENC Reliability and Quality Improvements	• ENRQI Resilience – Covered HV conductor $1.55m
Total	**$74.34 million**

7.10 Regulatory Investment Test

Under NER projects above $6 million funded by Evoenergy are subject to regulatory investment test. In 2022 Evoenergy published the non-network options report for the Gold Creek Zone Substation Capacity Constraint. The project resulting from the previous Molonglo Valley constraint RIT-D is ongoing.

Subject to the outcome of detailed technical studies, currently the network limitations identified during the planning review include additional limitations which are likely to require regulatory investment test: Strathairn Zone Substation, Mitchell Zone Substation, Belconnen Zone Substation Third Transformer and Curtin Zone Substation. Depending on detailed cost estimates there may also be some feeder projects which may qualify for RIT-D.

Chapter 8: Demand Management

8.1 Overview

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

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

In the modern context, DM may also theoretically unlock more rooftop solar PV, other DER or new services (e.g.: batteries/ VPPs, EVs, energy markets, etc) and provide improved flexibility to customers. It can therefore be considered a planning and operational approach which ultimately facilitates the Distribution System Operator (DSO) paradigm, where DNSPs provide a customer-centric "platform" for energy services adding value to customers through cost reduction, emissions reduction and flexibility.

In the context of the Australian NER investment funding regulations, DM traditionally represents operational expenditure for network businesses, who contracting for, and otherwise support, DER and other non-network solutions as an alternative to investing capital in new or augmented network infrastructure. However, as regulation evolves and technology matures and reduces in price, DM may be provided by economical and regulatory compliant capex options such as batteries to shift demand peaks.

DM is an important part of efficient and sustainable network operations. Effective use of DM reduces the cost to maintain the network and helps lower electricity charges for the customer base.

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

8.2 Demand Management Challenges

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

- **Identification of Need** – the ability to identify the demand management opportunities driven by factors impacting future network development (as outlined in **Chapter 2**) with sufficient time to establish a non-network solution. This is especially evident on small-to-medium scale constraints where the timeframe from need identification to implementation is reduced
- **Communication of Need** – communicating the constraint and relevant information to proponents in a way that is targeted, timely and effective to enable proponents to engage with DM opportunities
- **Availability of Options** – there are a limited number of established DM options that can be deployed in targeted network locations where a localised constraint is identified
- **Commercial Considerations** – the implementation of technology-based DM requires robust commercial arrangements where the proponent is satisfied and

Evoenergy 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[28]
- **Technology** – although technology is evolving rapidly, a number of DM-capable solutions are yet to mature or adhere to common standards required for application. This is expected to change in the near term.

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

8.3 Demand Management Initiatives

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

Need Identification

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

Communication

- Evoenergy has developed a Demand Side Engagement Strategy (DSES) that is published on our website[30]. 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[31] 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.

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

29 https://www.evoenergy.com.au/emerging-technology/demand-management/demand-side-engagement

30 https://www.evoenergy.com.au/emerging-technology/demand-management

Availability of Options

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

Commercial Considerations

- Evoenergy 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.

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

- **Ginninderry Residential Battery Trial** - exploring the DM capabilities of smart residential battery systems in managing local network constraints in this fully electric, 100% solar uptake greenfield developments
- **Molonglo RIT-D** - a greenfield development where load is rapidly approaching network capacity and a battery energy storage system has been assessed as a credible option as a result of the RIT-D process
- **Peak Demand Tariffs** – Peak demand tariffs were introduced as the default option for customers with smart meters in December 2017. Uptake has been monitored and will be analysed for resulting DM effects.
- **Tariff Trials** – As the uptake of battery technology (both residential and large-scale) increases, these trials aim to explore the suitability of highly cost reflective tariffs for customers with batteries and modern energy technologies. The tariffs are designed to provide energy customers who have batteries with sharper pricing signals, and the opportunity to better manage their load on the network and their network bill. This includes sending customers a price signal about the costs of importing and exporting energy at peak and non-peak times and incentivising efficient use of the distribution network. This has the potential to improve network utilisation and allow for the efficient integration of DERs, as battery technology becomes more widespread.
- **Project Converge** - The project researches and demonstrates Shaped Operating Envelopes (SOE) and their ability to provide demand management capabilities such as:
  - **Reducing** peak demand
  - **Deferring** asset augmentation using non-network options
  - **Maintain** supply reliability
  - **Maximise** integration of renewable generation in LV network through managing operating envelopes.

This project showcases how Evoenergy, and by extensions other DNSPs, can implement DM with potential to reduce long-term network costs caused by increased DER through SOE's.

Chapter 7 and **Chapter 8** contain additional details regarding these projects.

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)[32], the

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

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.

Chapter 9: Future Ways Of Working

9.1 Overview

Evoenergy has multiple innovative projects currently underway that investigate the impact and coordination of distributed energy resources with the electricity network. Evoenergy conducts these projects through network funding and in close collaboration with state and federal governments who either partner with Evoenergy and other organisations or provide grant funding for such projects along with research institutions. The projects underway are largely a continuation of previous years projects in the DER space along with EV related projects. Leveraging these smart DER technologies to efficiently manage and operate the network would be critical as Evoenergy evolves into a Distribution System Operator (DSO).

Projects that coordinate Solar PV systems with the electricity network is an increasing feature for distribution networks. To this extent, Evoenergy has initiated an orchestration project for DER which covers all eligible systems within the whole of ACT called Project Converge. In addition, Evoenergy's existing VPP program has also been utilised to develop this new initiative along with using the VPP data for various network planning and constraint identification and mitigation analyses. Other existing projects such as the Ginninderry Residential Battery Trial have also progressed which has been detailed in the section below.

9.2 Project Converge

Project Converge is an ARENA sponsored project with Evoenergy as the lead participant. It brings in collaboration of other parties such as the ANU, Zepben and other Aggregators over a 3-year period (Aug 21 – Jan 24).

Project Converge addresses problems of a congested network through novel Shaped Operating Envelope (SOE) methodology. A network operating at its physical or operational limits is said to be congested because it cannot accommodate additional flows of energy. When congestion occurs within the distribution network, the ability to incorporate DER while also supporting energy reliability and energy security is diminished. New technology capabilities, regulations and market mechanisms are necessary to support the integration and participation of DER in markets for energy and ancillary services without risking congestion.

Project Converge will demonstrate how DER can provide network ancillary services while also bidding into energy markets. These capabilities are expected to allow DER to alleviate grid constraints caused by power quality or physical network constraints and thereby unlock further network capacity without the need for additional network investment.

Project Converge aims to:

- design and develop a system to support the integration of higher penetrations of DER into the ACT distribution network;
- deploy new software systems to demonstrate the Shaped Operating Envelope concept for DER;
- integrate hardware, software and systems to pilot capabilities with over 1,000 existing customer-owned DER assets;
- deliver open-source, royalty free designs and models which can be adopted by other Australian DNSPs;
- deliver a range of knowledge sharing reports and webinars to share lessons with industry.

Project Converge is expected to:

- demonstrate that Shaped Operating Envelopes can extend dynamic operating envelopes to incorporate locally delivered network services, by use of non-network DER solutions, procured through a real-time investment decision making process
- demonstrate that dynamic network services procured from DER assets can potentially minimise or defer network augmentation costs

- demonstrate that network capacity can be maximised to enable DER to participate in energy and ancillary services markets
- identify an approach for DER congestion management and market bidding to inform future regulatory and market changes.

Results and learnings from Project Converge will be open sourced so at to allow further growth in the industry. These learnings will also feed back into Evoenergy as we develop our strategy and ultimately build a platform that can provide Operating Envelopes to our customers.

9.3 Ginninderry Energy Pilot Project

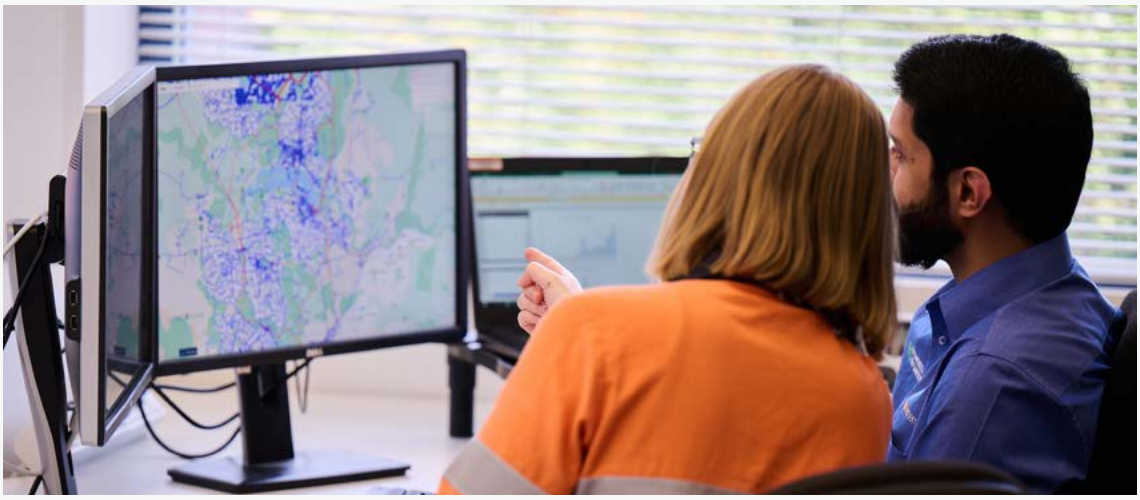
This is a continuing project for Evoenergy that aims to assess the real time implications/outcomes from an electricity-only neighbourhood with a very high penetration of solar PV systems. The EPP will cover the planning, design and construction/installation of the relevant infrastructure, and post-occupancy data collection in respect of the performance of the residential energy systems and their interaction with the electricity grid within Stage 1 of Ginninderry.

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.

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.

Evoenergy has partnered with ACT Government to utilise the Next Gen Battery Scheme to maximise the uptake of battery powered systems to trial for the energy pilot in conjunction with the HEMS devices. In line with this objective, in September 2020, Evoenergy received a grant from the ACT Government under the Renewable Energy Innovation Fund (REIF) for the Ginninderry Residential Battery Trial. This grant is being used to provide further subsidies for residential batteries in Stage 1A of the development, in addition to the Next Gen Battery rebates. The Trial is aimed at exploring how HEMS enabled residential battery systems can be leveraged to manage the local network in this fully electric, 100% PV penetration scenario.

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



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

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**.

9.4 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[32].

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 Au 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.

32 The ability for customers to access lower network bills on this tariff depends on the way in which retailers pass through the network tariff to end customers.

9.5 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. The tables below outline some of the key projects we are currently involved in and their proposed timings.

Table 36. Electric Vehicle Based 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
EVGrid Trial	2021- 23	Develop and demonstrate demand management (DM) capabilities required to efficiently manage peak electricity demand from residential electric vehicle (EV) charging in line with consumer expectations. Evoenergy is collaborating with EV owners in the ACT to test the concept of managing EV charging dynamically with real-time assessment of available network capacity. This project aligns with Evoenergy's strategic intent to support rapid uptake of EVs while utilising existing electricity distribution network infrastructure efficiently and avoiding unnecessary network expenditure.	Link

Table 37. Solar PV Based Innovation Projects

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
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
Battery Tariff Trials	2021 - 24	Develop and implement cost reflective tariffs for residential and grid connected battery storage systems to reduce network congestion caused by high levels of solar exports during the middle of the day and incentivise exports during peak consumption hours when upstream assets are under heavy loads. Evoenergy received approval from the AER to trial the battery tariffs to provide pricing signals to BESS units in the network and encourage efficient utilisation of network assets while promoting uptake in renewable energy systems.	Link
Project Converge	2021 - 24	The project researches and demonstrates Shaped Operating Envelopes (SOE) and their ability to provide demand management capabilities such as: • Reducing peak demand • Deferring asset augmentation using non-network options • Maintain supply reliability • Maximise integration of renewable generation in LV network through managing operating envelopes. This project showcases how Evoenergy, and by extensions other DNSPs, can implement DM with potential to reduce long-term network costs caused by increased DER through SOE's.	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

Term	Definition
FCAS	Frequency Control Ancillary Services
FLISR	Fault Location, Isolation and Supply Restoration
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 The Evoenergy's Network

The Evoenergy network consists of an interconnected 132kV transmission network supplying thirteen 132/11kV zone substations and two 132kV switching stations. There is also a single 66/11kV zone substation. All 132kV and 66kV 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 330/132kV bulk supply substation
- Stockdill 330/132kV bulk supply substation
- Williamsdale 330/132kV bulk supply substation
- Queanbeyan 132/66kV bulk supply substation.

Evoenergy's assets include 132kV transmission lines, 66kV sub-transmission lines, 132/11kV and 66/11kV zone substations, 22kV and 11kV distribution feeders, 22/0.400kV and 11/0.400kV 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 132/11kV 14MVA mobile substation that can be deployed as required at short notice.

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

Tennent zone substation has one permanent power transformer supported by the temporary mobile substation deployed at the adjacent Angle Crossing zone substation. All other zone substations have two or three power transformers, providing some redundancy based on 2-hour emergency rating. In a case of network N-1 contingency such as a transformer outage, Evoenergy would allow remaining transformer(s) to be loaded up to their 2-hour emergency rating for that limited time.

There are currently 270 x 11kV feeders. Most of these are interconnected with other feeders (i.e. a meshed 11kV network) and provide links between zone substations. There are also two 22kV distribution feeders, supplied via 11/22kV 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 11kV 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 207,300 electricity consumers. There are 36 consumers directly connected at 11kV, two consumers directly connected at 22kV, and no consumers directly connected at either 66kV or 132kV. 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 25kVA to 2000kVA.

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

Electrical energy consumed in the ACT is generated mainly outside the ACT and enters via Transgrid's transmission network. However, an increasing proportion of demand is being satisfied form internal sources.

Evoenergy owns, operates, and maintains a telecommunications network that supports the operation of the electricity network. It provides bearers for SCADA monitoring and control, protection signalling, telephones and mobile radios for operations and maintenance activities. Telecommunications assets include optical fibres on transmission and distribution lines, digital microwave and UHF radios and associated repeater stations.

Chapter 2 includes transmission schematics and geographic representation of the Evoenergy transmission network.

System Supply Security

Supply is secure when the system capacity is sufficient to cater for the existing and forecasted demand.

A system constraint is a situation where the power flow through a part of the transmission or distribution network must be restricted in order to avoid exceeding a known technical limit. Examples of technical limits include the thermal rating of conductors or other equipment such as transformers, operating voltage levels, and equipment protection settings. Some constraints can exist under normal operating conditions; however, they are most likely to occur when an element (such as a transmission line or distribution feeder) is out of service.

There is one 132/66kV bulk supply point and three 330/132kV bulk supply points interconnecting Evoenergy network to NSW network.

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

All 132kV lines have sufficient capacity to supply full capacity to each zone substation without constraint in the event of an outage of a 132kV 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 330kV 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 38**.

Table 38. Evoenergy Network Assets

Asset Type	Nominal Voltage	Quantity
Bulk Supply Points[33]	330/132kV	3
	132/66kV	1
Transmission Lines	132kV	176 km Overhead
	132kV	5 km Underground
Sub-transmission Lines	66kV	7 km Overhead
Switching Stations	132kV	2
Zone Substations	132/11kV	12 (+ 1 mobile substation)
	66/11kV	1
Power transformers	132/11kV	30
	66/11kV	3
Feeders	22kV	2
	11kV	269
Distribution Substations	22kV/400 V	11
Distribution Substations	11kV/400 V	4,772
Distribution Switching Stations	11kV	351
Number of transmission towers and pole structures	132kV	1,464
	66kV	63
Number of poles	22kV, 11kV and 400 V	48,795
Circuit km of distribution overhead lines	22kV, 11kV and 400 V	2,118 km
Circuit km of distribution underground cables	11kV and 400 V	2,522 km
Number of customer connections	22kV	2
	11kV	36
	400 V/230 V	207,234
Coverage area		2,358 km^2
System maximum demand (FY21/22)		685MW

33 Bulk Supply Point substations are owned and operated by Transgrid

Ratings Of Zone Substations And Transmission Lines

Zone Substation Ratings

Evoenergy operates the thirteen 132/11kV zone substations and one 66/11kV substation. **Table 39** summarises the total capacity and firm capacity for each substation including the year of commissioning. The firm capacity refers to the continuous capacity of the substations available after a single credible network contingency event (e.g. an outage of one of the power transformers).

Table 39. Evoenergy's Zone Substations

Zone Substation	Year commissioned	Voltage	Total capacity	Firm capacity	No of transformers
Angle Crossing (mobile substation)*	2012	132/11kV	15MVA	12/14 MVA	1
Belconnen	1977	132/11kV	110 MVA	55MVA	2
City East	1979	132/11kV	169MVA	95/110MVA	3
Civic	1967	132/11kV	165MVA	110MVA	3
East Lake	2013	132/11kV	110MVA	50/55MVA	2
Fyshwick	1982	66/11kV	70MVA	28MVA	3
Gilmore	1987	132/11kV	90MVA	45MVA	2
Gold Creek	1994	132/11kV	114MVA	57MVA	2
Latham	1971	132/11kV	150MVA	95/100MVA	3
Telopea Park	1986	132/11kV	150MVA	100MVA	3
Tennent	2017	132/11kV	15MVA	15MVA	1
Theodore	1990	132/11kV	90MVA	45MVA	2
Wanniassa	1975	132/11kV	150MVA	95/100MVA	3
Woden	1967	132/11kV	150MVA	95/100MVA	3

Additional notes on zone substation ratings:

In addition to the ratings listed in **Table 39**, for network planning and operations, Evoenergy is using 2 hour emergency rating of the transformers. 2-hour emergency rating refers to the estimated level of electrical load which transformer could supply for up to two hours.

*Angle Crossing Zone Substation is currently out of service while a fault in the transformer is being investigated and repaired

Transmission Line Ratings

Evoenergy currently operates a number 132kV lines and two 66kV lines. **Table 40** list continues rating and emergency rating of Evoenergy lines.

Table 40. 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
132kV						
Belconnen	Bruce	A-21	1934	2916	2514	3277
Belconnen	Latham	A-20	1955	2958	2545	3325
Bruce	City East	A-54	967	1463	1259	1644
Bruce	Civic	A-11	1934	2926	2518	3289
Bruce	East Lake	A-45	967	1122	1122	1122
Bruce	Gold Creek	A-30	1934	2916	2514	3277
Canberra	Gold Creek	A-3	1934	2916	2514	3277
Canberra	Latham	A-2	1955	2958	2545	3325
Canberra	Stockdill	9HF	1935	2916	2514	3277
Stockdill	Woden	9HC	1935	2916	2514	3277
Causeway	City East	A-50	968	1458	1257	1638
Causeway	East Lake	A-46	968	1122	1122	1122
Causeway	Gilmore	A-44	1935	2916	2514	3277
Causeway	Telopea Park 1	A-51	390	390	390	390
Causeway	Telopea Park 2	A-52	390	390	390	390
Causeway	Telopea Park 3	A-53	390	390	390	390
Civic	Woden	A-10	1955	2958	2545	3325
Gilmore	Theodore	A-43	968	1458	1257	1638
Gilmore	Wanniassa	A-41	968	1458	1257	1638
Gilmore	Williamsdale	97F	968	1458	1257	1638
Wanniassa	Woden	A-40	1990	3002	2586	3374
Angle Crossing Tee	Theodore	97H/2	968	1458	1257	1638
Angle Crossing Tee	Williamsdale	97H/1	1935	2916	2514	3277
Angle Crossing Tee	Tennent Tee	97H/3	968	1458	1257	1638
Angle Crossing	Tennent Tee	97H/4	968	1458	1257	1638
Tennent	Tennent Tee	97H/5	968	1458	1257	1638
66kV						
Fyshwick 1	Queanbeyan 1	0844	583	865	750	970
Fyshwick 2	Queanbeyan 2	0845	583	865	750	970

Embedded Generation

Generators connected directly to Evoenergy's distribution network rather than through the transmission network are called Embedded Generators (EGs).

There are a number of different types of embedded generator connected to our network as follows:

- Solar Photovoltaic
- Gas, including bio-gas (from land fill sites)
- Micro hydro
- Battery Energy Storage Systems (BESS)

Capacities of these EGs vary from domestic solar PV systems of typically 5-10 kW to a 20MW solar PV farm. The total installed capacity of embedded generation is approximately 247.3MW as of 30 June 2021. Of this 190.6MWs 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 20MW. Mugga Lane Solar Park at Mugga Lane in Hume has a maximum design output of 12.85MW. Williamsdale Solar Farm at Williamsdale has a maximum design output of 10.6MW. Mount Majura Solar Farm at Majura has a maximum design output of 3.6MW. There is a bio-gas generator installed at Mugga Lane waste transfer station (5MW) and another at Belconnen waste transfer station (3MW), a co-gen plant (1.2MW) at the Harman defence facility and a co-gen plant (1.4MW) at the Canberra airport.

There is approximately 169.7MW 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[34]. 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.

Table 41: PV Installations - Number Of Enquiries, Number Of Applications And Time To Process Applications; FY 2022-2023

Installation Size	Number of Enquiries	Number of Applications	Average timeframe to process connection application (days)
≤ 5kVA single phase or ≤15kVA three phase – no battery Automated Micro	N/A*	4114	0
< 30kW Complex Micro	N/A*	4797 total 1960 with batteries	7
> 30kW Low Voltage and High Voltage	66	54	50

*N/A – not applicable

34 Evoenergy considers that rooftop PV could be installed on separate houses as well as semi-detached houses. The 2021 Census reported 106,433 separate houses and 28,921 semi-detached, row or terrace house, townhouse etc. This is a total of 135,354 dwellings. Source: https://www.abs.gov.au/census/find-census-data/quickstats/2021/8

To date there are approximately 3500 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, connection of other large systems is currently underway.

PV generation is unpredictable due to intermittent cloud cover. It is difficult to forecast availability and output accurately which makes it difficult to account for in network planning. However, research is currently being undertaken to correlate weather forecast information more closely with solar generation to provide a degree of forecasting capability in real time.

The developers of several new residential developments in the ACT are mandating or heavily incentivising rooftop solar PV generation to be installed on all detached dwellings. This low voltage inverter-based generation 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.

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

Figure 39. Distribution Of Domestic Rooftop Solar PV Installations Throughout The ACT.

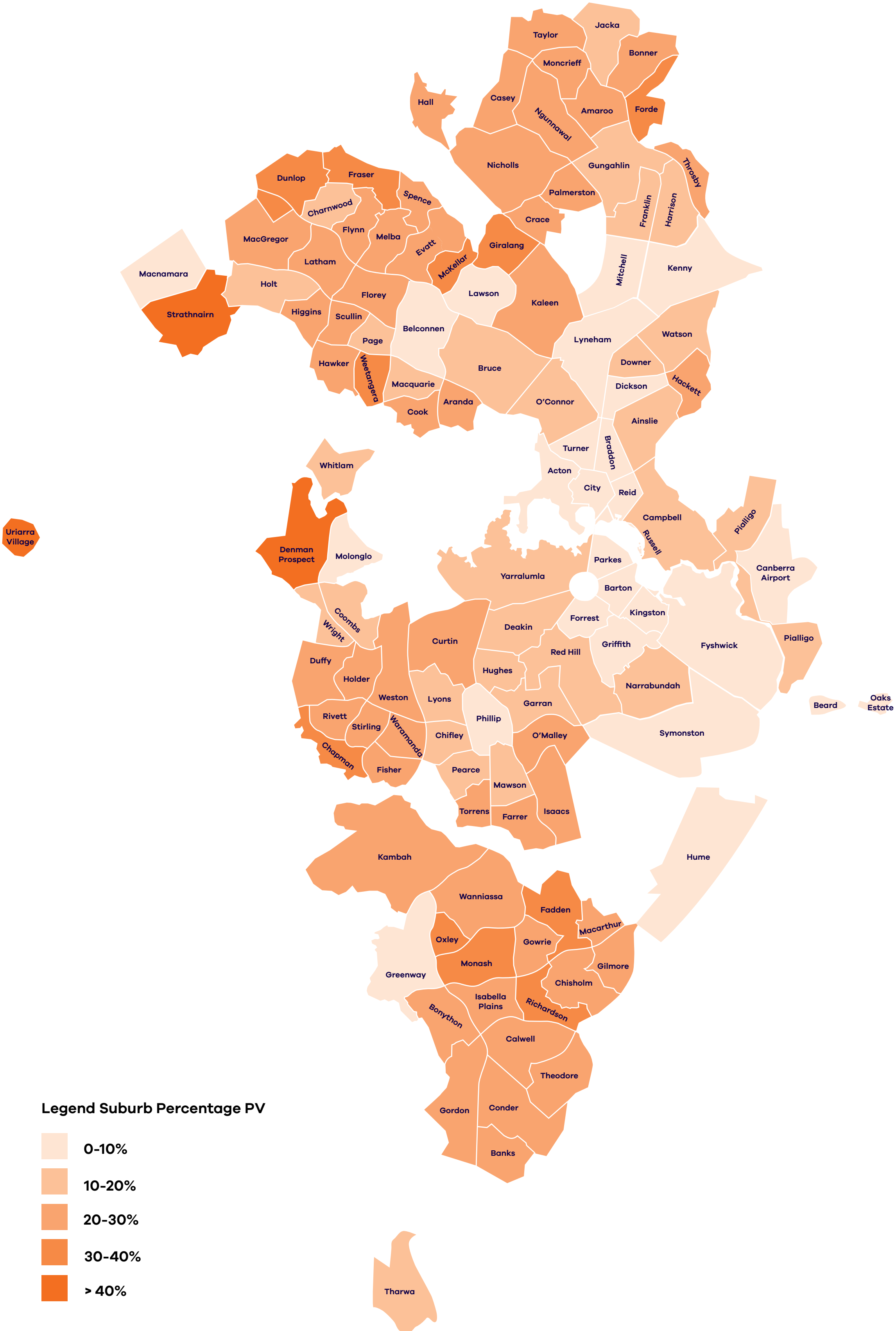


Table 42. Rooftop Solar PV generation (Micro and LV) Installations By Feeder As Of 30 June 2022

Zone Substation/Feeder	No. of Sites	Installed Capacity (kW)
BELCONNEN	3,199	19,424
Baldwin-Joy Cummins	390	1,984
Battye	10	70
Benjamin-Laurie	416	2,365
Cameron South	38	148
Chuculba	276	1,684
Eardley	100	659
Emu Bank	2	15
Haydon	155	1,009
Maribyrnong	65	595
Mcguiness-Bellbird	293	1,857
Meacham-Bean	547	3,404
Shannon	324	1,904
Swinden-Lampard	117	758
William Slim	466	2,974
CITY EAST	2,276	14,542
Aero Park	3	300
Allara	1	100
Braddon	3	167
Chisholm	136	787
Constitution	2	111
Cowper	142	935
Duffy	217	1,274
Ebden	390	2,005
Electricity House	3	126
Fairbairn	5	23
Ferdinand	209	1,225
Haig	33	418
Ijong	20	133
Lonsdale	2	73
Mackenzie	418	2,559
Masson	9	74

Table 42. Rooftop Solar PV generation (Micro and LV) Installations By Feeder As Of 30 June 2022

Zone Substation/Feeder	No. of Sites	Installed Capacity (kW)
Northbourne	8	160
Petrie	2	41
Quick	20	213
Stott	365	1,957
Wakefield	138	947
Wolseley	150	915
CIVIC	**2,177**	**13,799**
ANU No 1,2,3,4,5	1	314
Belconnen Way North	228	1,417
Belconnen Way South	370	2,039
Black Mtn	814	4,746
CSIRO	2	194
Dryandra	302	1,708
Edinburgh	3	18
Girrahween	3	154
Hobart Long	1	72
Hobart Short	3	181
Jolimont	2	140
McCaughey	47	353
Miller	353	2,082
Nicholson	46	323
Wattle	2	59
EASTLAKE	**94**	**4,068**
Dairy North	40	2,721
Dairy South	4	119
Isa	30	704
Lyell	20	524
FYSHWICK	**93**	**2,373**
Abattoir	26	259
Airport	3	221
Barrier	13	516
Domayne	16	445
Gladstone	8	258
Tennent	14	337
Whyalla-Pialligo	13	337

Table 42. Rooftop Solar PV generation (Micro and LV) Installations By Feeder As Of 30 June 2022

Zone Substation/Feeder	No. of Sites	Installed Capacity (kW)
GILMORE	**2,093**	**13,629**
Alderson	19	759
Beggs	170	1,052
Edmond	279	1,616
Falkiner-Tralee	267	2,132
Findlayson	270	1,624
Jackie Howe-Monaro	328	2,099
May Maxwell	244	1,278
Penton-Willoughby	279	1,727
Rossman	237	1,340
GOLD CREEK	**6,850**	**47,263**
Anthony Rolfe	321	2,450
Barrington	609	3,820
Birrigai	721	5,314
Ferguson	615	3,092
Gribble	27	1,185
Gungahlin	130	1,412
Hamer	605	4,482
Lander	540	3,244
Lexcen	361	2,179
Ling-Hughes	320	1,836
Magenta-Boulevard North	202	2,135
Nona	324	1,974
Riley	154	1,224
Saunders	673	4,458
Valley	72	1,093
Wanganeen-Bunburung	320	2,020
Wellington-Gurrang	319	2,027
West	537	3,318
LATHAM	**6,651**	**38,069**
Bowley	408	2,425
Conley	199	1,095
Copland	240	1,276
Elkington	327	1,847
Fielder	71	594
Florey	584	3,097

Table 42. Rooftop Solar PV generation (Micro and LV) Installations By Feeder As Of 30 June 2022

Zone Substation/Feeder	No. of Sites	Installed Capacity (kW)
Homann	290	1,925
Latham	534	2,589
Lhotsky	783	4,198
Low Molonglo East	57	285
Low Molonglo West	266	1,717
Macrossan	315	1,644
Markell	380	2,363
Melba	274	1,806
O-Loghlen	313	1,673
Paterick	183	1,090
Powers	194	1,010
Seal	314	1,769
Tillyard	336	2,057
Verbrugghen	211	1,394
Weir	371	2,213
TELOPEA PARK	**1,550**	**11,529**
Blackall	3	170
CNBP1	2	179
Cunningham	410	2,317
Empire	207	1,304
Forster	98	782
Giles	38	303
Jardine	3	22
KF1	48	368
King Edward + Belmore	50	580
Kurrajong	2	43
Mildura	1	99
Monash	18	138
Mundaring-Russell No 3	1	33
NSW Cres	22	433
Ovens	20	174
Power House	105	664
Queen Victoria Terrace	1	80
Riverside	1	31
Strzelecki	134	780
Sturt	135	980

Table 42. Rooftop Solar PV generation (Micro and LV) Installations By Feeder As Of 30 June 2022

Zone Substation/Feeder	No. of Sites	Installed Capacity (kW)
Telopea Park East	12	85
Throsby	239	1,963
TENNET	**18**	**1,800**
Williamsdale	18	1,800
THEODORE	**3,246**	**18,417**
Banyule	317	1,647
Callister	515	2,795
Chippindall	398	2,327
Eaglemont	511	3,011
Fairley	322	1,758
Lawrence Wackett	353	1,956
Lethbridge	301	2,018
Morison	344	1,820
Templestowe	185	1,084
WANNIASSA	**5,897**	**34,384**
Ashley	219	1,314
Athllon	308	1,592
Bissenberger-Hawkesbury	633	3,692
Brookman	247	1,528
Conolly	228	1,257
Erindale	2	107
Fincham	7	58
Gaunson	184	1,083
Gouger	163	901
Grimshaw	658	2,635
Hawker-Pridham	364	2,129
Hemmings	221	1,261
Lambrigg	155	1,078
Langdon	327	1,993
Longmore	374	2,155
Mannheim	217	1,341
Marconi	270	1,544
Matthews	316	1,805
Mugga	1	30
Muresk	334	2,040
Pitman-Rowland	10	764

Table 42. Rooftop Solar PV generation (Micro and LV) Installations By Feeder As Of 30 June 2022

Zone Substation/Feeder	No. of Sites	Installed Capacity (kW)
Reid	331	2,111
Sainsbury	143	942
Sternberg	2	20
Symers	177	1,004
WODEN	**5,063**	**33,099**
Bunbury	407	2,465
Carruthers	258	1,558
Cooleman	155	819
Corinna	1	30
Cotter 11kV	475	3,235
Curtin North	271	1,771
Daplyn	315	1,725
Deakin No 1	157	1,261
Deakin No 2	92	598
Devonport	65	461
Easty	6	134
Follingsby	342	2,121
Hilder	417	2,636
King	26	433
Launceston	1	100
Lyons West	391	2,176
McInnes	239	1,490
Phillip North	11	161
Phillip South	1	2
Streeton	479	3,558
Theodore	239	1,780
Tidbinbilla 22kV	3	65
Weston East	280	1,629
Wilson	310	2,011
Yarralumla	122	878
Grand Total	**39,200**	**252,391***

* Please note minor discrepancy between this number and overall total due to feeders not being assigned for some systems. Data cleansing is underway

Hydro-Electric And Gas

There is an existing micro-hydro generator connected to the Evoenergy network, the Stromlo micro-hydro which has a peak output capacity of 630 kW. This is connected to Woden Zone Substation via a shared 11kV 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 5MVA generator is connected to Gilmore Zone Substation via a shared 11kV feeder and is planned to expand in 2023. There are two gas generators at Canberra Airport with a total generation capacity of 2.9MVA. These are connected to Fyshwick Zone Substation via a shared 11kV 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). 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.

The 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.

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.

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

Efficiency Benefit Sharing Scheme (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, this certificate is valid until: 10 January 2024

To check the validity of this certificate please call tel. 1800 855 190

Further clarification regarding the scope of this certificate and the applicability of the Management System requirements may be obtained by consulting the organisation.

Certificate Number: AU004286-1

Date: 6 January 2021

Andrew Mortimore
Vice President – SP 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 AEMOS's revised connection point forecasting methodology, forecasts provide:

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

The forecasting horizon is 10 years except for Fyshwick Zone Substation and Queanbeyan Bulk Supply Point for which the forecasting horizon is 3 years (due to the decommissioning of Fyshwick Zone Substation by 2024).

Also included are seasonal 10-year maximum demand forecasts for the new Stockdill Bulk Supply Point, which are based on seasonal Canberra Bulk Supply Point forecasts and a load flow analysis, as summarised in the "Bulk Supply Points Demand Forecasts" section below.

Key Forecasting Terms As Applied By Evoenergy In This Report

Maximum Demand

Zone substations

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

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

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

Bulk supply points

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

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

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

System maximum demand

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

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

System minimum demand

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

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

Financial year

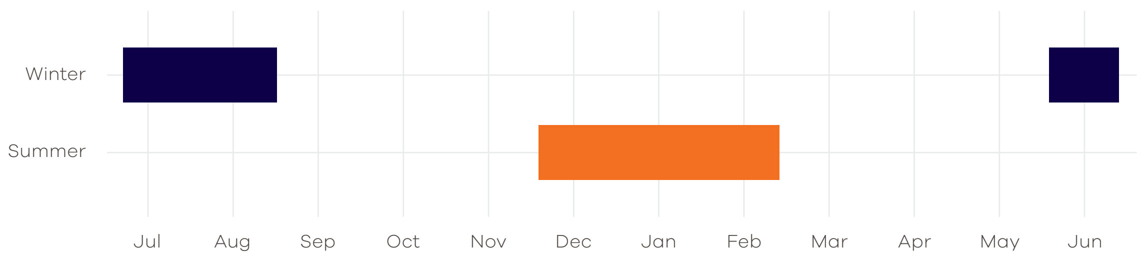
A financial year (FY) is defined as the period from (and including) 1 July, 00:00 AEST until (and excluding) 30 June, 00:00 AEST (left-inclusive interval). Throughout this section, the terms "year" and "financial year" are used interchangeably, and always refer to a financial year as the unit of time.

Seasons

The summer and winter seasons are defined by the months:

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

Figure 40. Seasons Across One Financial Year



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

Time-Of-Day Periods

The daytime and night-time periods are defined by hours:

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

Which is a definition used commonly within the industry.

Probability Of Exceedance

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

Source Data

Maximum Demand Data

Historical data of seasonal maximum demands during previous financial years excluding the current financial year (FY21/22) for the zone substations (in MVA), bulk supply points (in MW) and the system (in MW) are taken from the Annual Planning Report 2019.

Data for the current financial year (FY21/22) are extracted from measured energy values recorded by network metering installed at bulk supply points (operated by Transgrid) and zone substations (operated by Evoenergy).

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

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

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

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

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

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

Minimum Demand Data

All historical data are extracted from measured energy values recorded by network metering installed at the bulk supply points (operated by Transgrid).

Real energy consumption values at the bulk supply points are converted to real power values, again assuming uniform usage during the 15 minute interval and as detailed in the previous subsection.

Block Loads

In addition, forecasts account for known commercial and residential block loads. The block load information was collated on the connection enquires, applications and government land release programs, as shown in **Table 43** and **Table 44**.

Table 43. Summer Block Loads (MVA)

Zone	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Belconnen	0.7	0.7	0.7	1.0	1.1	1.0	1.3	1.4	1.1	1.3	1.4
City East	1.8	2.9	3.4	3.3	3.1	3.5	4.0	4.7	5.5	6.3	7.0
Civic	1.5	2.2	2.9	2.8	2.5	2.6	3.1	3.0	2.7	2.5	2.8
East Lake	0.0	8.6	18.4	1.6	1.9	2.1	1.3	0.8	0.9	0.9	0.9
Fyshwick	0.0	2.8	0.5	1.5	0.0	0.0	0.5	0.0	0.0	0.5	0.0
Gilmore	0.0	0.1	0.6	0.6	0.9	0.9	1.0	1.0	1.1	1.2	0.8
Gold Creek	0.1	1.0	0.3	0.4	0.5	0.6	0.8	1.1	1.5	1.7	2.0

Table 43. Summer Block Loads (MVA)

Zone	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Latham	0.6	1.0	1.5	1.5	1.6	1.6	1.7	1.8	2.3	2.1	2.5
System	1.4	1.4	5.1	7.0	7.7	9.2	10.9	11.7	13.7	15.7	17.9
Telopea Park	0.3	0.2	1.9	2.5	1.9	1.7	1.9	2.3	2.5	2.9	2.8
Theodore	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5
Wanniassa	0.1	2.8	3.4	1.0	1.5	1.9	1.6	1.8	2.4	1.8	2.0
Woden	0.2	1.3	1.9	2.6	2.3	2.4	2.4	2.6	3.0	3.4	3.9

Table 44. Winter Block Loads (MVA)

Zone	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Belconnen	1.0	1.0	0.9	1.4	1.4	1.3	1.9	2.1	1.8	2.0	2.2
City East	2.4	3.9	4.6	4.7	4.7	5.4	6.1	7.1	8.3	9.5	10.5
Civic	1.8	2.5	3.3	3.2	3.0	3.3	3.8	3.8	3.7	3.7	4.1
East Lake	0.0	10.7	22.9	1.7	2.0	2.3	1.3	0.9	1.0	1.0	1.1
Fyshwick	0.0	2.7	0.5	1.5	0.0	0.0	0.5	0.0	0.0	0.5	0.0
Gilmore	0.1	0.1	0.6	0.6	0.9	1.0	1.0	1.1	1.3	1.4	0.8
Gold Creek	0.2	0.9	0.4	0.6	0.7	0.9	1.2	1.6	2.1	2.5	2.9
Latham	0.8	1.4	1.7	1.8	1.9	2.0	2.3	2.6	3.3	3.1	3.7
System	2.0	2.0	6.0	8.5	9.5	11.2	13.9	15.6	18.8	21.7	24.8
Telopea Park	0.4	0.2	2.0	2.6	2.3	2.4	2.8	3.3	3.8	4.4	4.7
Theodore	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7
Wanniassa	0.1	3.0	3.6	1.6	2.0	2.5	2.3	2.5	3.2	2.7	2.9
Woden	0.2	1.8	2.6	3.5	3.1	3.3	3.3	3.6	4.3	4.9	5.5

To estimate the impact of block loads at Bulk Supply Points, the following method was applied:

1. 1. Determined proportion of system load at each Bulk Supply Point at system peak demand.
2. 2. Applied the porportions from step 1 for each Bulk Supply Point to estimate a blockload for each Bulk Supply Point for each forecast year.
3. 3. Produced a forecast for Queanbeyan to 2026.
4. 4. Added the 2026 forecasts for Queanbeyan to the remaining Bulk Supply Points for 2026 using the proportions found in Step 1.

Note that no blockloads were applied to Stockdill as the Canberra forecast is used to estimate the Stockdill forecasts due to limited historical data for Stockdill.

Table 45 Summer Block Loads - Zone substations and Systems (MVA)

Zone	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Canberra	0.8	0.8	3.0	4.1	23.0	5.6	6.6	7.1	8.4	9.6	10.9
Queanbeyan	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Williamsdale	0.5	0.5	1.9	2.6	14.7	3.6	4.3	4.6	5.3	6.1	7.0

Table 46. Winter Block Loads - Zone substations and Systems (MVA)

Zone	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Canberra	1.2	1.2	3.5	5.0	22.3	6.9	8.5	9.5	11.5	13.2	15.1
Queanbeyan	0.1	0.1	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Williamsdale	0.8	0.8	2.3	3.2	14.2	4.4	5.4	6.1	7.3	8.5	9.7

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:

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

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 $t_{ch,k}$ 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 $\beta_{1,MD}$, 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_q at time t_q. 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 - α)% quantiles of the posterior predictive MD density at every year. Posterior predictive densities of minimum demand densities are not adjusted for future block loads, as the effect of block loads on minimum demand is difficult to assess; consequently, minimum demand estimates provide a lower bound on the forecast minimum demand trends.

All models are fitted to maximum and minimum demand data using the Bayesian inference framework and probabilistic programming language Stan [Stan Development Team, 2020, Stan 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.

Table 47. Summer (Su) And Winter (Wi) Maximum Demand Forecast Table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2023	211	266	338	344	449	562
2024	212	268	340	346	453	566
2025	215	270	342	349	457	570
2026	235	292	366	371	479	592
2027	237	296	371	375	485	601
2028	242	303	377	381	492	610
2029	246	309	386	388	501	620
2030	251	316	395	399	512	630
2031	257	324	404	410	524	648
2032	264	335	416	422	540	664

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 48. Summer (Su) And Winter (Wi) Maximum Demand Forecast Table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2023	44	55	70	168	219	275
2024	44	56	71	169	221	276
2025	45	56	71	171	223	278
2026	49	61	76	181	234	289
2027	49	62	77	183	237	294
2028	50	63	78	186	240	298
2029	51	64	80	189	245	303
2030	52	66	82	195	250	308
2031	53	67	84	201	256	317
2032	55	70	86	206	264	324

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 49. Summer (Su) And Winter (Wi) Maximum Demand Forecast Table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2023	23	29	35	19	26	33
2024	24	30	35	19	26	34
2025	24	30	36	20	27	34
2026	-	-	-	-	-	-
2027	-	-	-	-	-	-
2028	-	-	-	-	-	-
2029	-	-	-	-	-	-
2030	-	-	-	-	-	-
2031	-	-	-	-	-	-
2032	-	-	-	-	-	-

Williamsdale Bulk Supply Point Demand Forecast

Table 50. Summer (Su) And Winter (Wi) Maximum Demand Forecast Table (MW)

Year	POE90 (Su)	POE50 (Su)	POE10 (Su)	POE90 (Wi)	POE50 (Wi)	POE10 (Wi)
2023	134	185	236	157	216	273
2024	136	188	239	159	220	278
2025	140	192	244	163	224	284
2026	153	207	261	178	240	299
2027	157	212	264	182	247	307
2028	160	216	270	188	253	314
2029	165	222	277	193	261	323
2030	171	227	283	201	269	333
2031	175	234	291	210	280	344
2032	182	242	299	221	291	356

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 red font**.

Table 51. Zone Substation - Summer Forecast Demand (MVA) Summary

ZSS	Continuous Rating	Emergency 2-hr Rating	POE	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Belconnen	55	74	90	49	49	49	50	50	51	52	53	54	55
			50	56	56	57	58	58	59	60	61	62	63
			10	65	65	66	67	68	69	70	71	72	73
City East	95	95	90	60	61	63	65	67	70	73	77	82	87
			50	68	70	72	74	76	79	82	86	91	**97**
			10	79	81	83	85	87	90	93	**98**	**103**	**109**
Civic	110	114	90	63	65	67	69	71	74	76	78	80	82
			50	55	57	59	61	63	66	68	70	72	74
			10	63	65	67	69	71	74	76	78	80	82
East Lake	50	60	90	19	37	39	40	42	43	44	44	45	46
			50	24	42	44	45	47	48	49	49	50	51
			10	29	47	49	51	53	54	55	55	56	57
Fyshwick	28	28	90	26	26	28	-	-	-	-	-	-	-
			50	**32**	**32**	**34**	-	-	-	-	-	-	-
			10	**38**	**38**	**40**	-	-	-	-	-	-	-
Gilmore	45	62	90	29	30	32	33	35	37	39	41	43	45
			50	33	35	36	38	40	42	44	46	48	50
			10	38	40	42	44	45	48	50	52	54	56
Gold Creek	57	74	90	64	67	70	73	**77**	**80**	**84**	**88**	**92**	**97**
			50	**76**	**79**	**82**	**85**	**89**	**92**	**96**	**100**	**105**	**110**
			10	**91**	**94**	**97**	**101**	**104**	**108**	**112**	**116**	**121**	**125**
Latham	95	95	90	47	49	50	52	54	55	57	59	62	64
			50	54	56	57	59	61	62	64	67	69	72
			10	64	65	67	69	70	72	74	76	79	81
Telopea Park	100	114	90	65	66	67	68	68	69	70	72	73	75
			50	78	79	81	82	82	83	85	86	88	90
			10	94	95	97	99	100	101	102	105	107	109

Table 51. Zone Substation - Summer Forecast Demand (MVA) Summary

ZSS	Continuous Rating	Emergency 2-hr Rating	POE	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Theodore	45	62	90	21	22	22	22	22	22	22	22	23	23
			50	25	25	25	25	25	26	26	26	26	27
			10	29	29	29	30	30	30	30	31	31	31
Wanniassa	95	95	90	52	55	55	56	57	57	58	60	61	62
			50	62	65	65	66	67	68	69	71	72	73
			10	74	78	78	79	80	81	82	84	85	87
Woden	95	95	90	61	62	63	65	66	68	70	71	74	77
			50	71	72	74	75	77	79	80	82	85	88
			10	85	86	88	89	91	92	94	**97**	**99**	**103**

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

Table 52. Zone Substation - Winter Forecast Demand (MVA) Summary And Capacity Constraints

ZSS	Continuous Rating	Emergency 2-hr Rating	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2030
Belconnen	55	76	90	56	57	59	60	61	63	65	67	69	71
			50	60	61	62	64	65	67	69	71	73	75
			10	63	64	65	67	68	70	73	75	**77**	**79**
City East	110	114	90	71	75	80	84	90	96	102	111	**120**	**130**
			50	75	79	84	89	94	100	107	**115**	**124**	**135**
			10	79	84	88	93	98	104	111	**120**	**129**	**140**
Civic	110	143	90	52	55	58	61	64	68	72	75	79	83
			50	55	59	62	65	68	71	75	79	82	86
			10	59	62	65	68	71	75	79	82	86	90
East Lake	55	60	90	24	46	48	50	52	53	54	55	56	57
			50	27	50	51	53	55	57	58	58	59	60
			10	30	53	55	57	59	60	**61**	**62**	**63**	**64**
Fyshwick	28	28	90	21	21	23	-	-	-	-	-	-	-
			50	**29**	**29**	**31**	-	-	-	-	-	-	-
			10	**36**	**37**	**39**	-	-	-	-	-	-	-
Gilmore	45	69	90	35	36	38	39	41	43	45	48	50	51
			50	36	38	40	41	43	45	47	50	52	54
			10	38	40	41	43	45	47	49	52	54	56

Table 52. Zone Substation - Winter Forecast Demand (MVA) Summary And Capacity Constraints

ZSS	Continuous Rating	Emergency 2-hr Rating		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2030
Gold Creek	57	84	90	84	**88**	**91**	**95**	**100**	**104**	**109**	**114**	**120**	**126**	
			50	**89**	**92**	**96**	**100**	**105**	**109**	**114**	**120**	**125**	**132**	
			10	**93**	**97**	**101**	**105**	**109**	**114**	**119**	**125**	**131**	**137**	
Latham	100	114	90	66	67	69	71	73	75	78	81	84	87	
			50	71	73	75	76	78	81	83	87	90	93	
			10	76	78	80	82	84	86	89	92	95	99	
Telopea Park	100	114	90	76	78	80	82	84	87	89	93	97	101	
			50	81	83	86	88	90	92	95	99	103	108	
			10	87	89	92	94	96	99	102	106	110	**115**	
Theodore	45	69	90	27	27	27	27	27	27	27	28	28	29	
			50	28	28	28	28	28	29	29	29	30	31	
			10	30	30	30	30	30	31	31	31	32	33	
Wanniassa	100	114	90	71	73	74	76	77	79	81	83	85	87	
			50	77	79	80	82	84	85	87	89	92	94	
			10	83	86	87	88	90	92	94	97	99	101	
Woden	100	114	90	79	81	85	88	92	95	99	103	108	114	
			50	83	86	90	93	97	100	104	109	114	**119**	
			10	87	90	94	97	101	105	109	113	**118**	**124**	

Notes:

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

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

Zone Substation Demand Forecast Charts

Figure 41. Belconnen Substation 12-year Summer And Winter Demand Forecast Chart

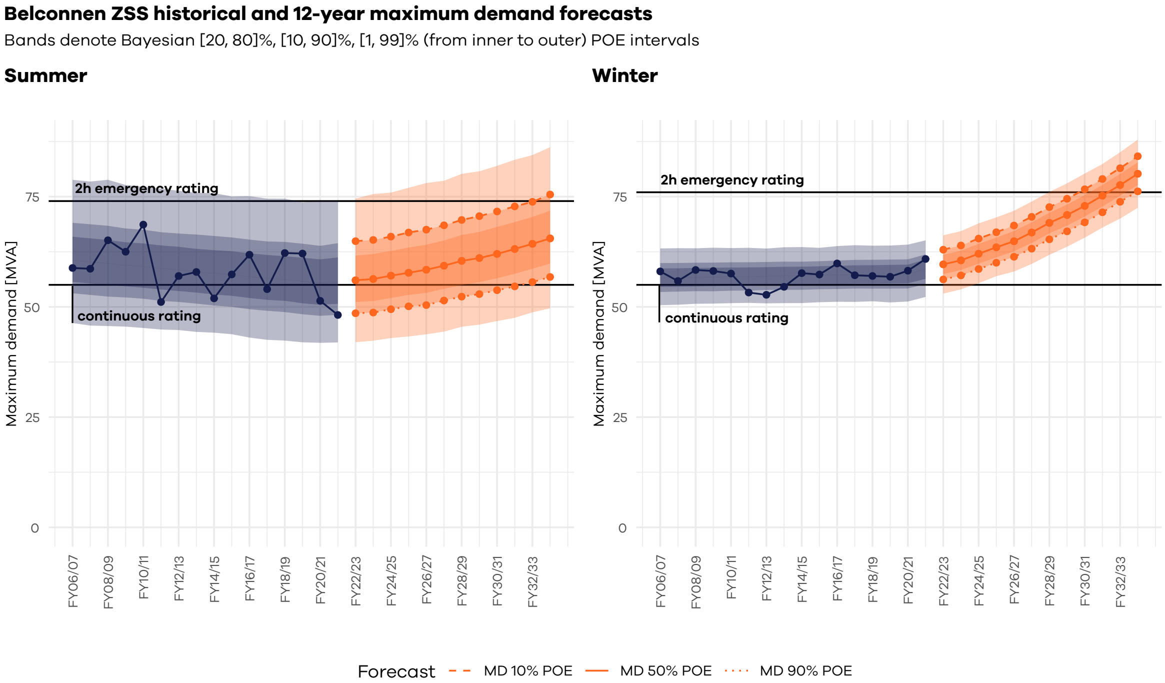


Figure 42. City East Substation 12-Year Summer And Winter Demand Forecast Chart

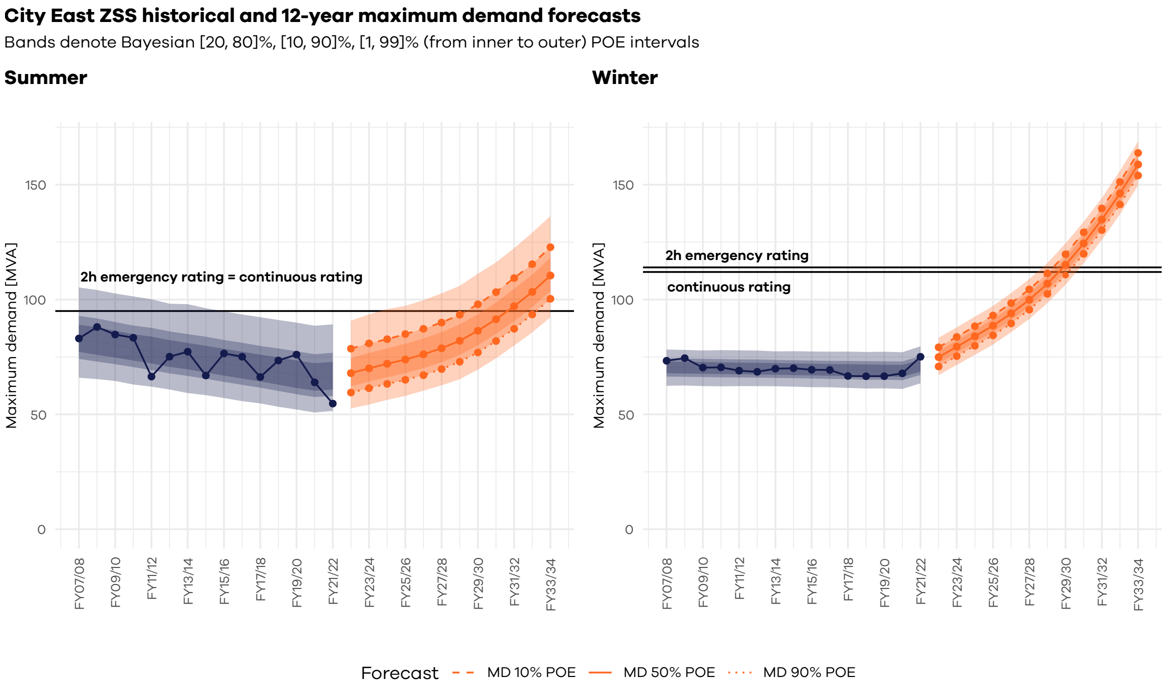


Figure 43. Civic Substation 12-year Summer And Winter Demand Forecast Chart

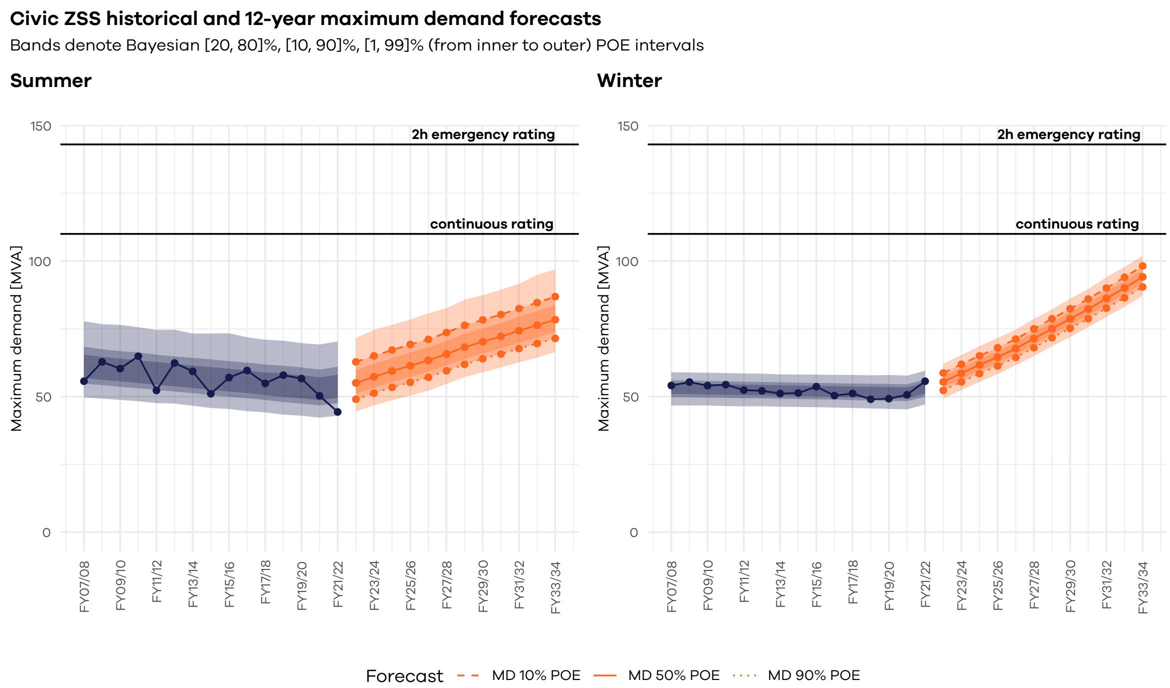


Figure 44. East Lake Substation 12-Year Summer And Winter Demand Forecast Chart

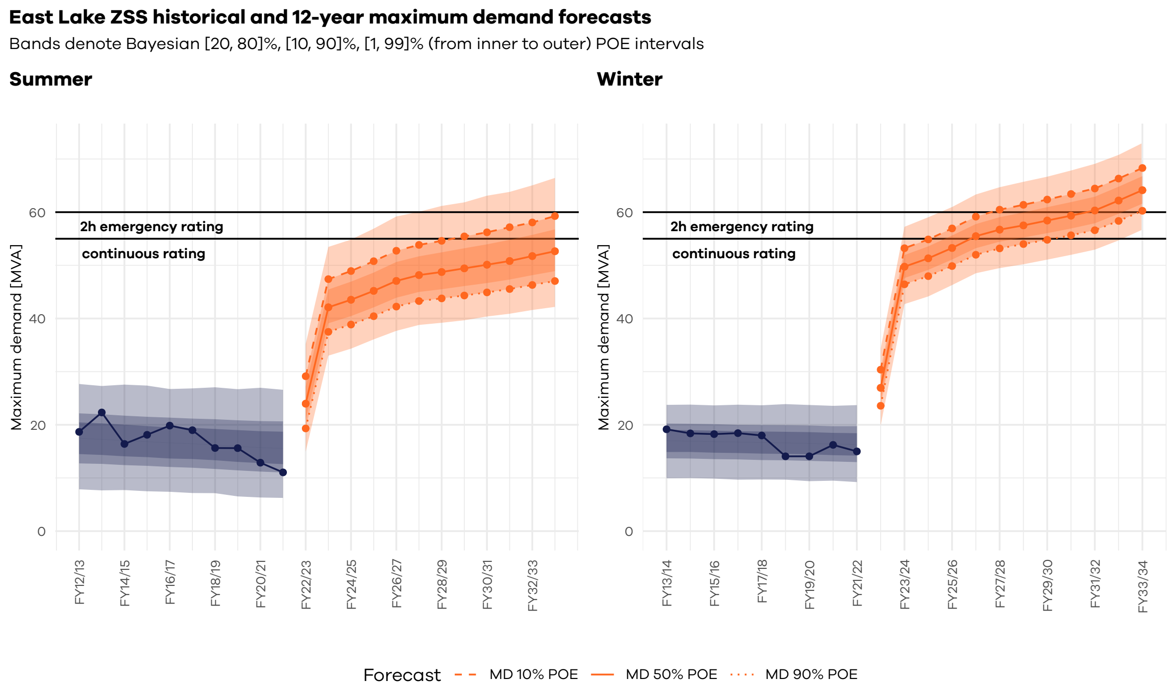


Figure 45. Fyshwick Substation 3-Year Summer And Winter Demand Forecast Chart

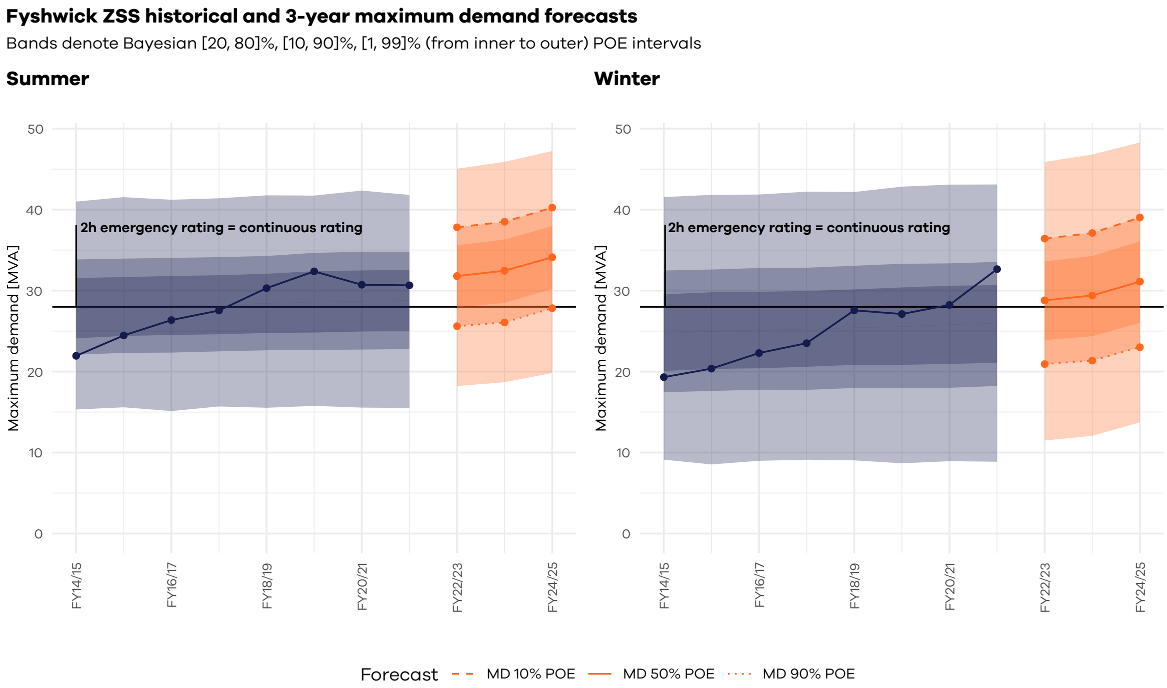


Figure 46. Gilmore Substation 12-year summer and winter demand forecast chart

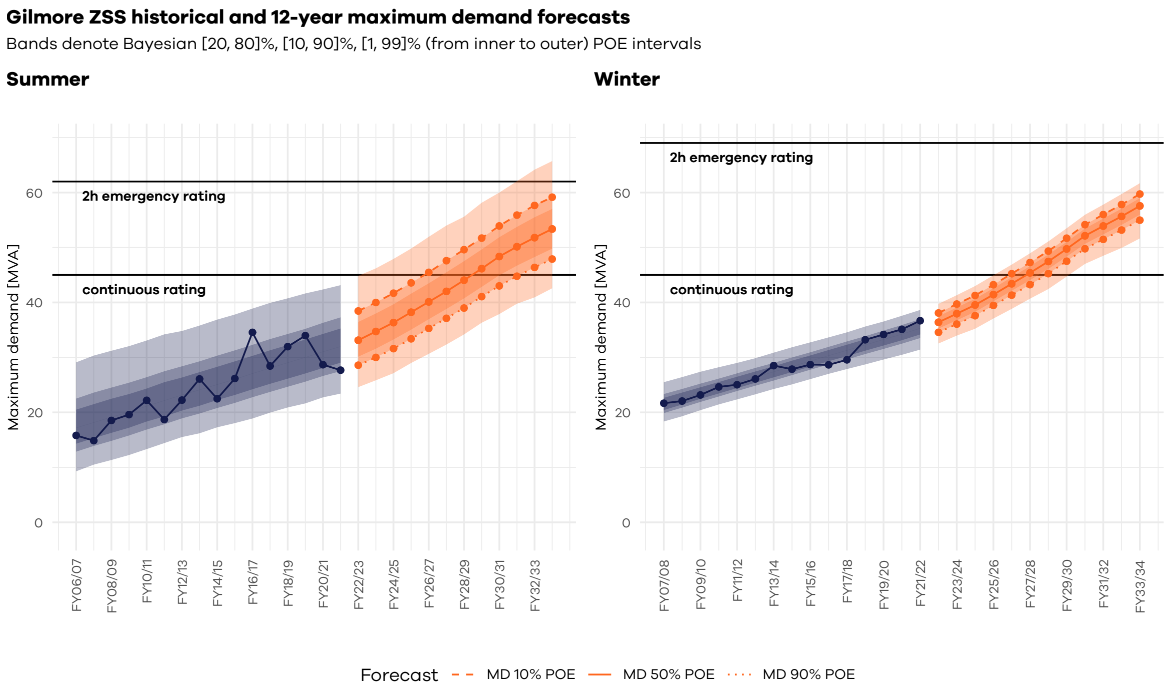


Figure 47. Gold Creek Substation 12-Year Summer And Winter Demand Forecast Chart

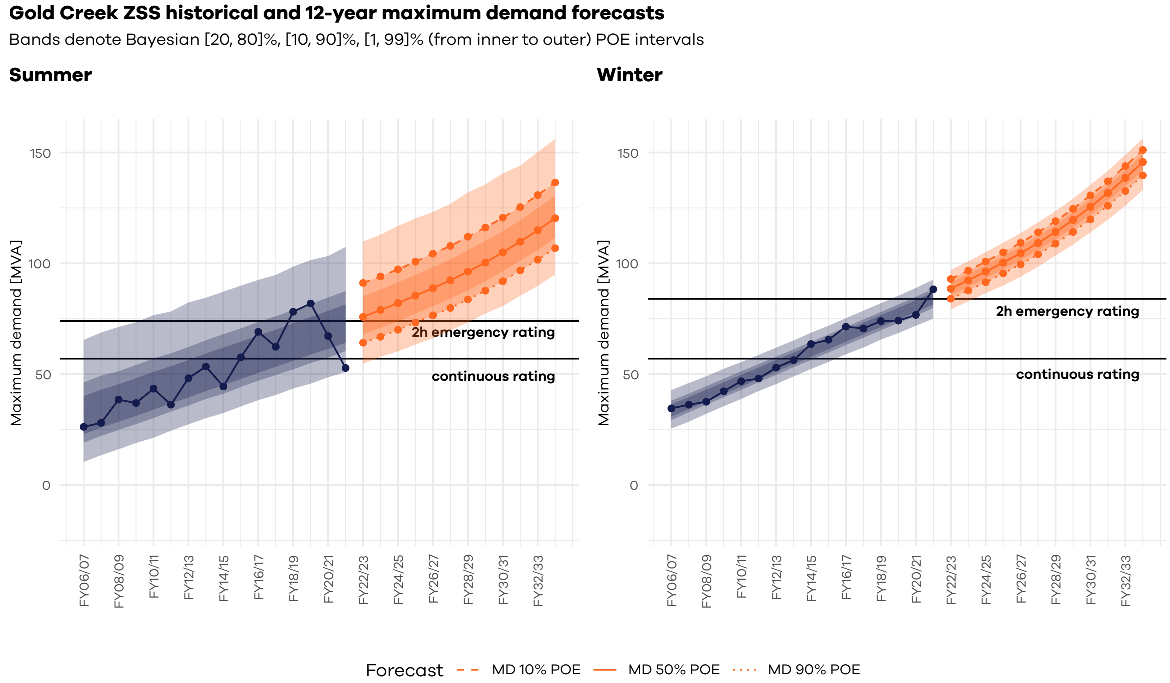


Figure 48. Latham Substation 12-Year Summer And Winter Demand Forecast Chart

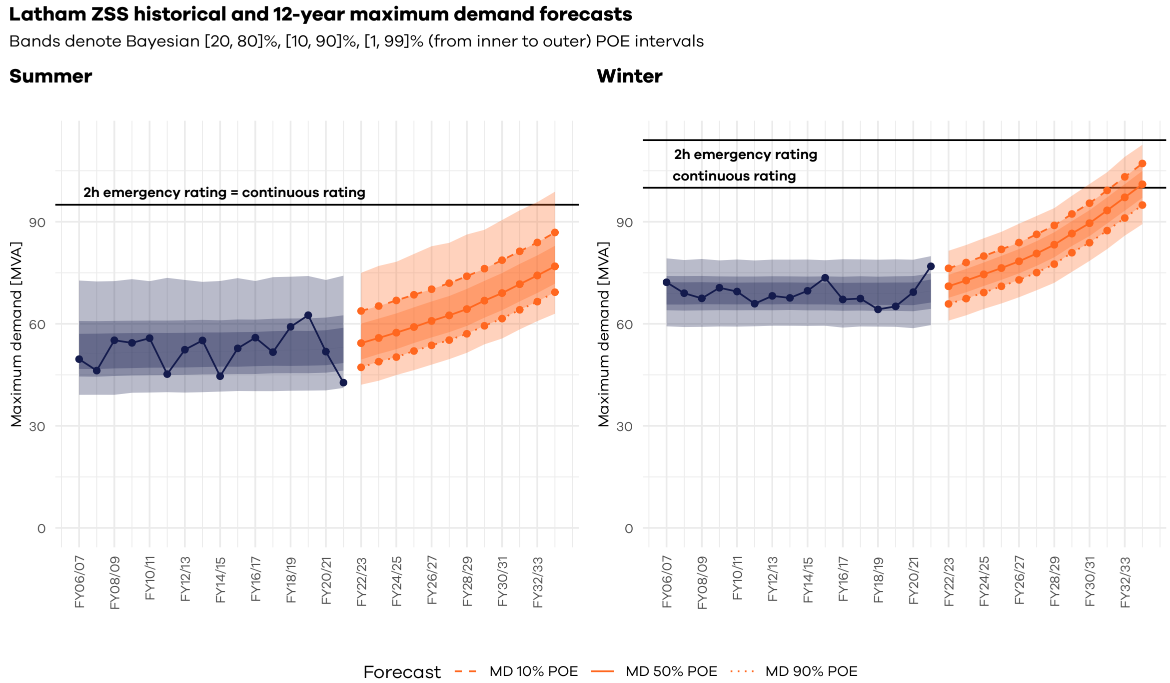


Figure 49. Telopea Park Substation 12-Year Summer And Winter Demand Forecast Chart

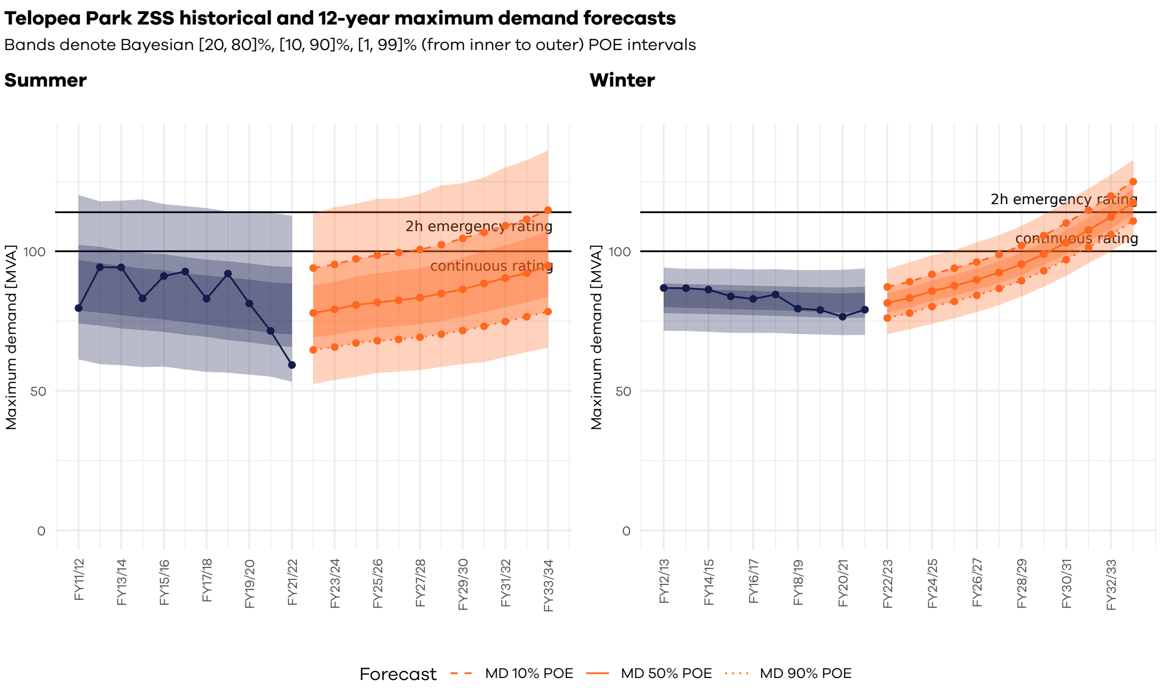


Table 53. Tennent Substation Historical Generation & Consumption Peaks

Year	Season	Generation Peak (MVA)	Consumption Peak (MVA)
2019	Summer	10.	2.5
2019	Winter	7.2	0.2
2020	Summer	9.9	0.1
2020	Winter	8.7	1.7
2021	Summer	10.1	1.6
2021	Winter	6.6	0.1
2022	Summer	10	0.1
2022	Winter	8.8	0.1

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 50. Theodore Substation 12-Year Summer And Winter Demand Forecast Chart

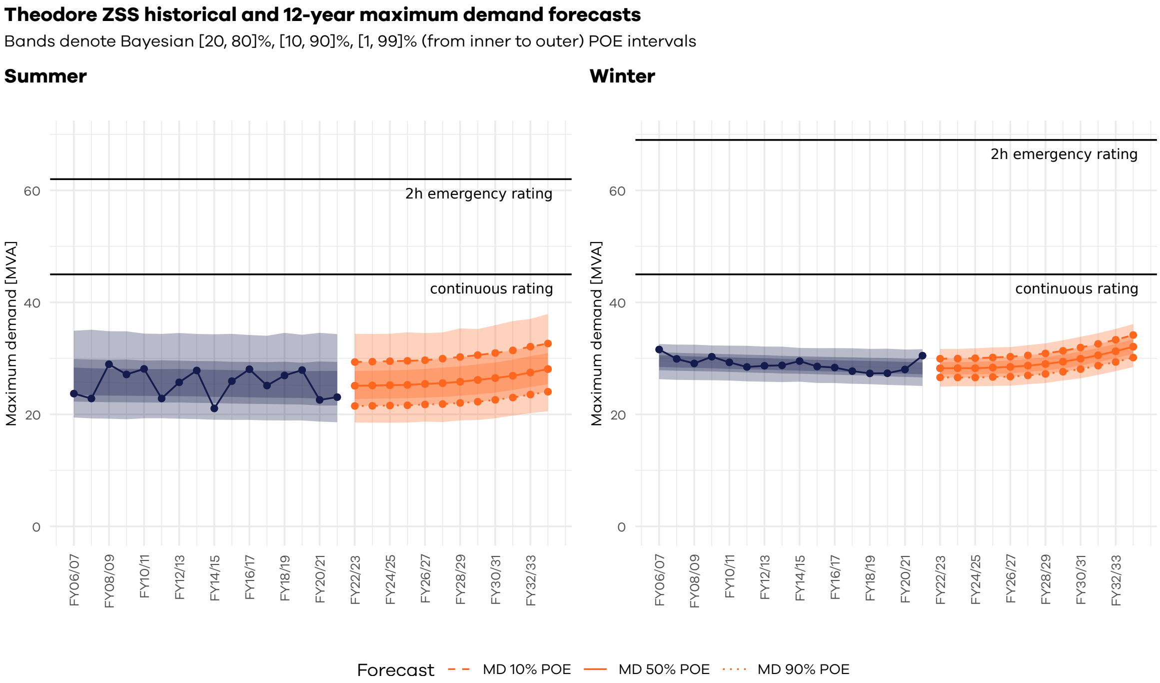


Figure 51. Wanniassa Substation 12-Year Summer And Winter Demand Forecast Chart

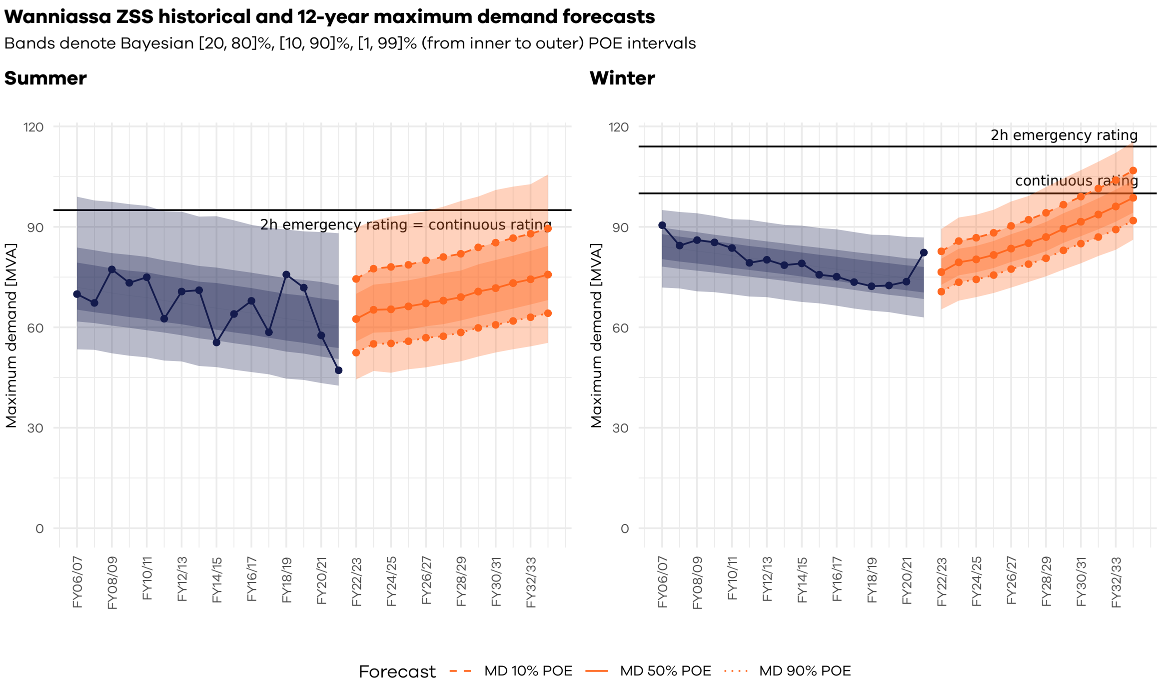
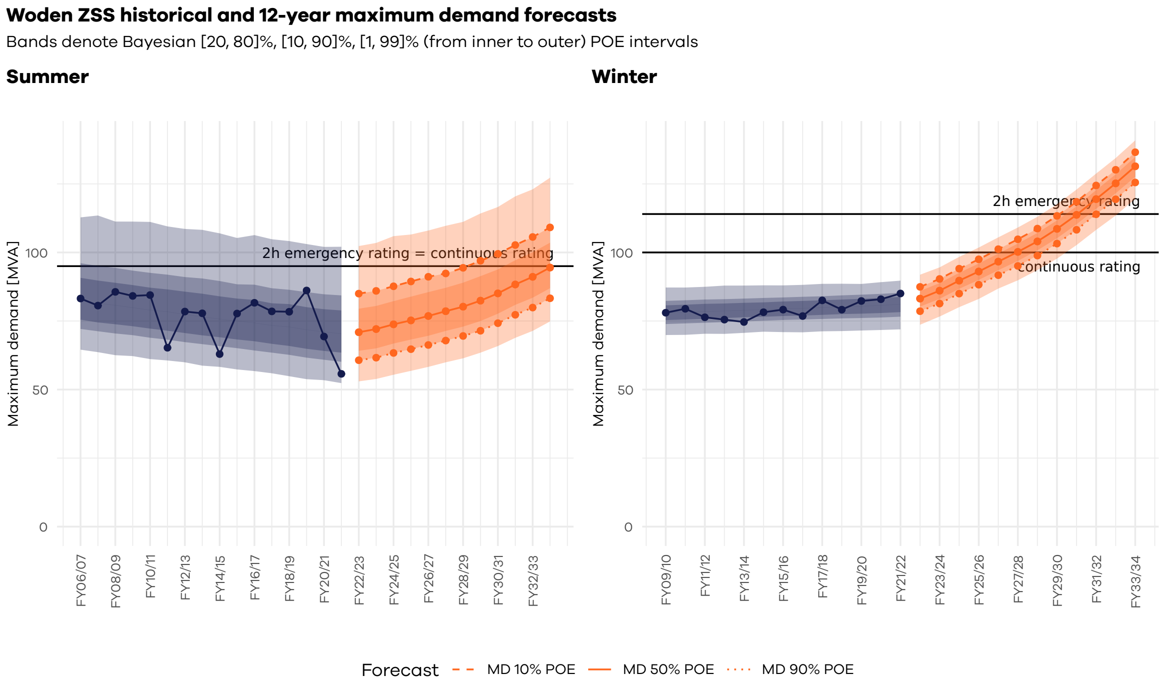


Figure 52. Woden Substation 12-Year Summer And Winter Demand Forecast Chart



Zone Substation Export Forecasts

The table below shows the adjusted net export (MVA) forecast for the zone substation and comparison with the two hour and continuous emergency rating of the substations. Only POE50 is included in the tables. There are no Zone Substation constraints from exports forecast for the next ten year period.

Table 54. Zone Substation - Adjusted Net Exports (MVA) summary

ZSS	Continuous Ratings*	Emergency 2-hr Ratings *	POE	2023 (MVA)	2024 (MVA)	2025 (MVA)	2026 (MVA)	2027 (MVA)	2028 (MVA)	2029 (MVA)	2030 (MVA)	2031 (MVA)	2032 (MVA)
Belconnen	55	74	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
City East	95	95	50	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6
Civic	110	114	50	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
East Lake	50	60	50	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3
Fyshwick	28	28	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gilmore	45	62	50	3.2	3.6	3.9	4.1	4.1	4.0	4.0	4.2	4.4	4.4
Gold Creek	57	74	50	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Latham	95	95	50	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4
Telopea Park	100	114	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Theodore	45	62	50	6.1	6.4	6.7	6.8	6.7	6.7	6.7	6.8	6.8	6.7
Wanniassa	95	95	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Woden	95	95	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*Continuous rating for summer as minimum demand will likely be in warmer weather

Appendix F: Network Reliability Standards And Performance

Key Definitions

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

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

Australian Energy Regulator Reliability Targets

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

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

STPIS targets are set by the AER for the five-year regulatory control period. The targets set by AER for 2019-24 are in **Table 55**. The targets apply to unplanned supply interruptions only.

Table 55. STPIS Reliability Performance Targets for Unplanned Outages:

Year	2019-24
Unplanned SAIDI I[35]	
Urban	32.524
Short Rural	35.056
Whole Network (weighted average)	33.366
Unplanned SAIFI[36]	
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 56**. The ACT targets apply to planned and unplanned supply interruptions.

Table 56. 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

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

36 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 57provides 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 57. Performance Vs Targets – Planned And Unplanned Interruptions

		2015-17			2017-19			2019-24	
2021-22	**Target**	2015-16	2016-17	**Target**	2017-18	2018-19	**Target**	**2019-20**	**2020-21**	**2021-22**
SAIDI										
Whole Network Overall	**91 (ICRC)**	79.04	83.74	**91 (ICRC)**	99.97	92.53	**91 (ICRC)**	81.7	82.04	164.69
Whole Network Planned	-	38.86	44.21	-	57.18	41.54	-	33.32	39.87	35.63
Whole Network Unplanned	-	35.1	39.53	-	31.44	34.94	-	35.31	37.79	54.57
Urban Unplanned	**31.912 (AER)**	35.73	39.11	**30.32 (AER)**	29.76	33.19	**32.524 (AER)**	29.32	31.78	47.33
Short Rural Unplanned	**49.32 (AER)**	30.25	42.74	**46.86 (AER)**	34.19	36.58	**35.056 (AER)**	46.63	57.35	51.49
SAIFI										
Whole Network Overall	**1.2 (ICRC)**	0.92	0.9	**1.2 (ICRC)**	0.79	0.95	**1.2 (ICRC)**	0.71	0.75	1.
Whole Network Planned	-	0.18	0.21	-	0.21	0.19	-	0.17	0.2	0.21
Whole Network Unplanned	-	0.67	0.69	-	0.49	0.63	-	0.49	0.52	0.83
Urban Unplanned	**0.616 AER)**	0.68	0.67	**0.585 (AER)**	0.45	0.6	**0.565 (AER)**	0.44	0.46	0.82
Short Rural Unplanned	**0.942 (AER)**	0.62	0.85	**0.895 (AER)**	0.56	0.6	**0.591 (AER)**	0.59	0.72	0.85
CAIDI										
Whole Network Overall	**74.6 (ICRC)**	85.91	93.04	**74.6 (ICRC)**	126.54	97.4	**74.6 (ICRC)**	115.07	109.39	136.89
Whole Network Planned	-	215.89	210.52	-	272.29	218.63	-	196	199.35	171.36
Whole Network Unplanned	-	52.39	57.29	-	64.16	55.46	-	72.06	72.67	65.91
Urban Unplanned	-	52.54	58.37	-	66.13	55.32	-	66.64	69.09	57.72
Short Rural Unplanned	-	48.79	50.28	-	61.05	60.97	-	79.03	79.65	60.58

Reliability Strategy And Plan

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

Invest In People And Process

Network reliability performance depends on capable people given appropriate tools and training, delivering to well-designed process. Events that stress-test the system and anomalous performance outcomes can reveal gaps in existing people and process management. We can reflect on these experiences to drive changes that improve the system and make it more robust to future events.

Plan For A More Responsive Network

One of the most direct ways to improve network reliability performance is to enhance the typical speed at which supply is restored when outages occur. We can achieve this by creating a more flexible network that lends itself to rapid deployment of resources to areas of need and can be easily reconfigured to avoid dependencies on faulted assets.

Embed risk-based asset management

A mature understanding of risks and the asset management choices we can make to control them is critical to efficient and effective management of network reliability. We will benefit from improving our understanding of the condition and lifecycle stages of our assets, with implications for inspection, maintenance, and resource prioritisation.

Incorporate Best-Practice Vegetation Management

Vegetation is a large contributor to unplanned outages on overhead networks. Outages can occur when trees come in contact with overhead wires or when trees fall on overhead networks, often during storms. Recent revisions to Australian Standards for vegetation management present an opportunity to review our own practices, and re-establish what best practice vegetation management looks like for Evoenergy.

Create A Better Outage Experience

Customer engagement undertaken in preparation for the 2024-2029 regulatory submission has revealed that customers are interested in Evoenergy doing more to improve their experience and level of support when an outage occurs. Whilst these considerations may not contribute directly to our outage duration and frequency statistics, they are clearly an important contributor to the impact that outages have on our customers.

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.

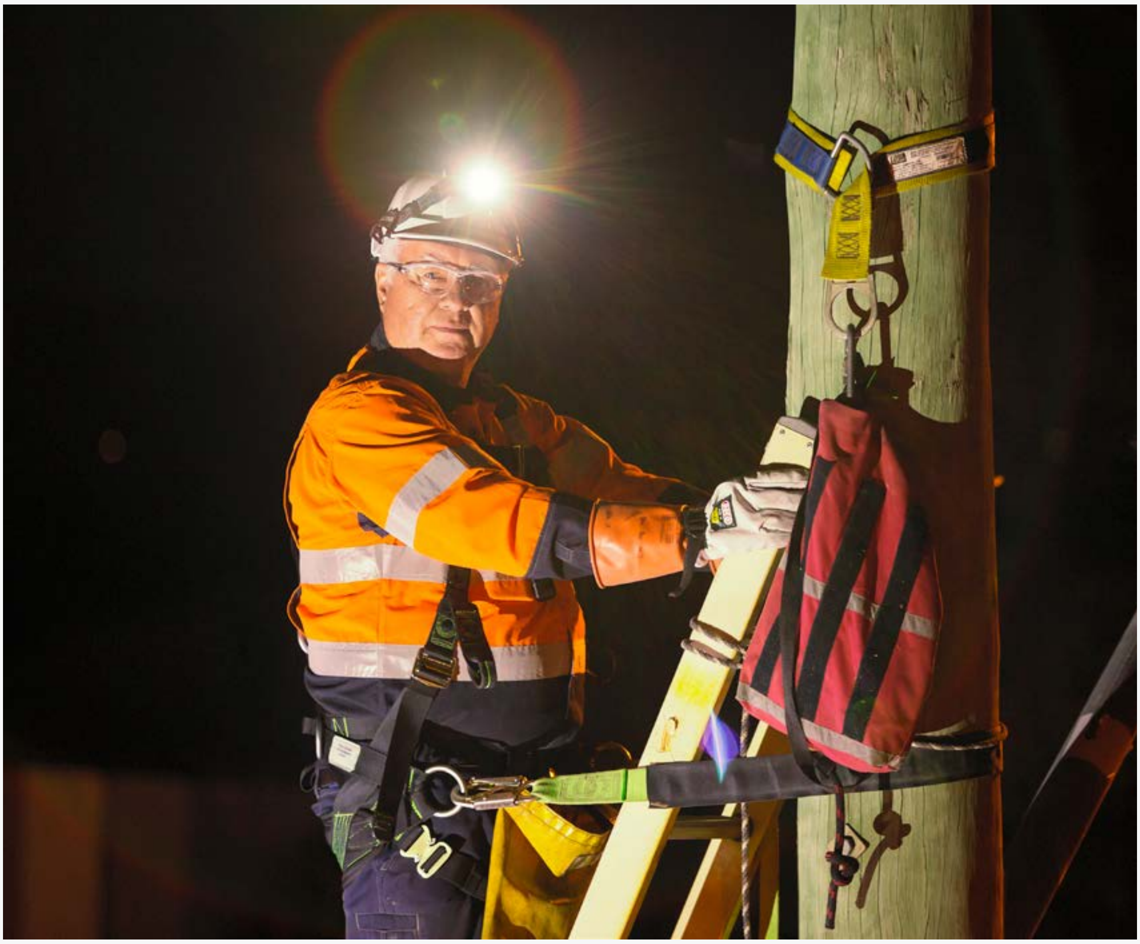
Remote network indication & control

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 Performance

This appendix provides additional information in relation to power quality in addition to the information provided in Chapter 4.

The appendix includes the following commentary:

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

Power Quality Standard And References

Schedule 5.1 of the NER lists the Network System Standards that are to be achieved by Network Service Providers (NSPs). Evoenergy's approach to network planning complies with these reliability and performance requirements when considering network developments and aims to meet the NER requirements, relevant standards codes, and guidelines. These include:

- *NER Schedule 5.1a – System Standards.*
- *NER Schedule 5.1 – Network Performance Requirements to be provided or co-ordinated by Network Service Providers.*
- *NER Schedule 5.3 – Conditions for Connection of Customers.*
- *AS 2344 – Limits of electromagnetic interference from overhead a.c. powerlines and high voltage equipment installations in the frequency range 0.15 MHz to 3000 MHz.*
- *AS/NZS 3000 – Australian/New Zealand Wiring Rules.*
- *AS/NZS 7000 – Overhead Line Design.AS/ NZS 61000 – Electromagnetic Compatibility (various sub-standards).*
- *AS/NZS 60038 – Standard Voltages.*
- *HB 264:2003 – Power quality handbook.*
- *AS/NZS 4777 Grid connection of energy systems via inverters.*
- *Evoenergy Service & Installation Rules for Connection to the Electricity Distribution Network.*
- *Evoenergy Requirements for Connection of Embedded Generators up to 5MW to the Evoenergy Distribution Network.*

Power Quality Parameters

Steady State Voltage

Voltage levels at consumers' premises must be supplied and maintained within regulation limits to ensure correct operation of appliances and safety to equipment and personnel. Exceeding the upper voltage limit may result in insulation breakdown and subsequent equipment damage, whilst operating below the lower limit impacts on power quality and could cause fuses to blow due to higher current.

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

Table 58. Voltage Tolerance Limits:

Voltage Boundary	AS 600038	As 61000.3.100
Nominal Voltage	230 Volts	230 Volts
Upper Limit	+10%	+10%
Lower Limit	-6%	-6%
$V_{99\%}$ / V_{MAX}	253 Volts	253 Volts
$V_{1\%}$ / V_{MAX}	216 Volts	216 Volts
Utilisation Limit (+10% / -11%)	440 Volts (Phase-to-Phase Maximum) 253 Volts (Phase-to-Neutral Maximum)	-
	356 Volts (Phase-to-Phase Minimum) 205 Volts (Phase-to-Neutral Minimum)	-

Rapid Fluctuations In Voltage (Flicker)

Voltage fluctuations are defined as repetitive or random variations in the magnitude of the supply voltage. The magnitudes of these variations do not usually exceed 10% of the nominal supply voltage. However small magnitude changes occurring at certain frequencies can give rise to an effect known as flicker. Voltage fluctuations may cause spurious tripping of relays, interference with communications equipment, and may trip electronic equipment.

Flicker is usually consumer-generated due to the following:

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

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

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

Table 59. 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.

Table 60. Voltage Flicker Levels For Different Voltage Levels

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

Voltage Dips

Voltage dips are typically caused by events such as lightning or faults on adjacent feeders, or are generated by equipment located within consumers' premises (e.g. induction motor starting).

Dips caused by faults on adjacent feeders can propagate throughout the network, affecting consumers' supply voltage on all feeders at the zone substation. Although only consumers on the faulted feeder experience an interruption, many experience the reflected voltage sags generated by the fault.

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

Table 61. Voltage Dip Voltage Tolerances[37]

Dips Down to % Nominal Voltage	Max No. of Dips Per Year (per point of supply) Urban	Max No. of Dips Per Year (per point of supply) Rural
< 30	2	6
30 – 50	20	40
50 – 70	20	40
70 – 80	25	50
80 – 90	200	300

Voltage Transients

Switching transients are primarily associated with the operation of circuit breakers and are typically the consequence of the switched current being extinguished prior to the natural current zero value of the sinusoidal current waveform. This characteristic is termed as current chopping.

The chopping of the current results in transient voltages being generated which enter and travel through the interconnected network. Switching transients can also be generated by the switching of lumped capacitances (e.g. capacitor banks).

Switching transients are typically high frequency, short duration voltage conditions (mainly overvoltage conditions) which can result in damage to sensitive equipment.

Evoenergy shall manage switching transient voltages through switchgear procurement standards (i.e. utilising switching equipment that has small chopping current characteristics) and asset specific maintenance regimes, and routine maintenance programs designed to avoid excessive switch contact arcing.

The Electricity Distribution Technical Standards Code requires Evoenergy to take all reasonable steps to ensure that switching transients on its electricity network are limited to less than two times normal supply volts.

37 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 consumers' 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 consumers of correct earthing practices. Evoenergy includes neutral to earth monitoring as part of its power quality monitoring program to assist with classifying neutral to earth voltage non-compliance.

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

Table 62. Voltage Difference Between Neutral To Earth Limits[38]

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.

The Electricity Supply Distribution Code requires Evoenergy to take all reasonable steps to ensure that the voltage of electricity distributed through its electricity network does not exceed:

- a 6% difference between the highest and lowest phase to neutral or phase to phase steady state voltage (five minutes average) for the low voltage network; and
- a 3% difference between the highest and lowest phase to phase steady state voltage (five minutes average) for the high voltage network

Direct Current Component

Direct current component in the neutral conductor has the effect of offsetting the sinusoidal waveform and can be caused by equipment that has different operating characteristics in each half of the voltage cycle. A high DC component can cause damage to electronic devices and impact on the correct operation of protective devices. It can also lead to an increase in losses and result in heating within electrical and electronic equipment. Limiting the direct currents in the neutral to acceptable limits is important because such current can cause corrosion of the network and a customer's earthing system, leading to potentially unsafe operating condition.

The Electricity Supply Distribution Code requires Evoenergy to take all reasonable steps to ensure that electricity distributed through its electricity network does not exceed a direct current voltage component of the neutral conductor with respect to earth of more than plus or minus 10 volts at the point of supply.

38 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.

Table 63. 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).

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) which describes EMF's in detail and methods to mitigate magnetic fields. Evoenergy follows these guidelines where practicable and complies with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Guidelines in the design of its network with respect to electromagnetic fields.

Inductive interference

Inductive interference refers to the ability of the magnetic fields generated by current flowing in typically overhead line conductors, to cause interference with other electromagnetic radiation such as radio, television and communication signals.

Evoenergy shall continue to undertake routine maintenance programs to ensure all equipment is in good working condition, in particular all HV and LV overhead lines, to ensure that inductive interference is within the limits specified in Australian Standard AS 2344.

Power Factor

Power factor relates to the relationship between real and reactive power. In an alternating current (AC) system the in-phase portions of voltage and current waveforms produce "active" or real power which is the capacity of the electricity system to perform work. The out of phase portions of voltage and current waveforms produce "reactive" power. The combination of active and reactive power is termed apparent power. A low or poor power factor will result in inefficiency due to high apparent power loading with a low real power delivery.

Evoenergy monitors power factor as part of its programmed proactive and reactive monitoring of the network. Evoenergy uses the ADMS to identify areas of the network that may be experiencing power factor issues. Metering data is also used to identify installations with power factor outside acceptable limits.

Consumers can gain significant benefits by improving the power factor at their premises. These benefits include reduced electricity costs, increased plant load capacity and utilisation, and better voltage regulation. Improvement of power factor is usually achieved by the installation of capacitors.

Evoenergy requires that the power factor at the point of common coupling between Evoenergy's network and the consumer's installation shall be between 0.9 lagging and unity. Leading power factor is unacceptable. Details can be found in Evoenergy's Service & Installation Rules for Connection to the Electricity Distribution Network which can be found on our external website.

Appendix H: Network Technical Parameters And Systems

This appendix provides and additional information on the network technical parameters and systems.

Key Network Systems

SCADA Systems

Evoenergy's Supervisory Control and Data Acquisition (SCADA) systems provide essential real-time monitoring and control of Evoenergy's electrical network assets. Data from the field is captured within Remote Terminal Units (RTUs) which then communicate and provide monitoring and control capability to Evoenergy using our centralised Advanced Distribution Management System (ADMS). This data is available to Evoenergy's 24/7 control room for real-time network management and response and is also stored as historical for later analysis and investigation by engineering teams. A summary of the kinds of data and control provided by Evoenergy's SCADA system, and the applications for this data, includes:

- Remote control of circuit breakers and switches in the electrical network. This assists with reducing outage restoration times and mitigating the risks of arc flash by avoiding manual switching operations.
- Protection operation and fault passage indication. This again assists with reducing outage restoration times by providing information to the control room on the location of the faulted assets.
- Network load and voltage measurements. This assists Evoenergy with ensuring the network is run within real time load and voltage constraints. It also provides key historical information to network planning and power quality engineering teams to better target network augmentation and power quality remediation programs.
- Asset failure reporting for onsite investigation and remediation before further failures occur.
- Asset health and condition monitoring to better understand the health of the assets and make informed decisions around optimised maintenance and replacement programs.
- Monitoring and control of large scale embedded generation systems to ensure the embedded generation does not cause any negative impacts on the wider electrical network.

Evoenergy currently has SCADA capability at all Zone substations and in recent years has also been significantly increasing SCADA capability within the distribution network. Newer devices and communications technologies available on the market have made SCADA installation in distribution substation easier and more cost effective. This has become important, particularly in recent times, with significant increases in the connection of rooftop solar, residential batteries and EVs to Evoenergy's network. Having access to SCADA data on a low voltage network level helps Evoenergy better assess the impact of these technonologies and plan accordingly to ensure the ongoing security and reliability of electricity supply to Evoenergy's customers.

Evoenegy has a SCADA asset replacement program targeted at older, less reliable devices with poor asset condition scores or utilising obsolete technolgies. When SCADA assets are replaced they are generally upgraded to the latest generation technologies, providing additional monitoring and control capabilities. Cyber security is also critical for Evoenergy SCADA systems and is a significant consideration in any targeted replacement or upgrade programs. For communications between Evoenergy's SCADA RTUs and central ADMS system, Evoenergy currently uses either direct optical fibre connection or 4G communications depending on availability and best cost benefit option for individual sites.

Protection Systems

Evoenergy uses protection systems 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 132kV zone substation applications as required by the NER.
- Main and backup protection devices shall be installed in 11kV 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 132kV bus at Canberra and Williamsdale substations is controlled by Transgrid via its 330/132kV interconnecting transformers' on-load tap changers (OLTCs) and 132kV capacitor banks. Similarly, the 66kV bus voltage at Queanbeyan bulk supply substation is controlled by Transgrid.

The 11kV bus voltage at each Evoenergy zone substation is maintained by the voltage-regulating relay which controls the tap position of the 132/11kV transformers. In order to maintain the voltage within limits along the 11kV 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 11kV group circuit breakers at all 132/11kV 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 11kV equipment to be capable of withstanding 25 kA three-phase short circuit fault current. Maximum 11kV fault level on the network has been calculated at approximately 12.2 kA. Evoenergy's 11kV 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 11kV equipment.

Evoenergy specifies new 132 kV equipment to be capable of withstanding 31.5 kA three-phase short circuit fault current. Maximum 132kV fault level on the network has been calculated at approximately 24.0 kA.

The high voltage system supplied by the 132kV transmission network is not effectively earthed employing a neutral earthing transformer to limit 11kV 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 11kV 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[39]. Evoenergy's system is designed to ensure that step and touch voltages arising from earth potential rise are within the allowable limits of Australian Standard AS/NZS 7000. Evoenergy has developed a set of guides and standards relating to earthing design, construction, testing, and repair. 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.

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 132kV transmission network and the 11kV 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 150,000 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 continuing to explore opportunities to work with retailers and metering providers to utilise advanced meters functionality in relation to cost reflective tariffs, outage management, network planning, power quality monitoring and demand management.

Key Network Technical Parameters

Electromagnetic Fields (EMF)

Electromagnetic fields are a key design consideration for bare electrical conductors such as overhead lines and bus-work, particularly those which operate at high voltage. For conductors with an earth shield, such as underground cables, the fields are encapsulated within the cable and do not present external hazards.

Electromagnetic fields incorporate both electric fields resulting from the voltage on conductors and 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.

39 ENA EG-O Power System Earthing Guide
ENA EG-1 Substation Earthing Guide
AS 3835 – EPR – Protection of Telecommunication Network
AS/NZS 4853 – Electrical Hazards on Metallic Pipelines

The Energy Networks Australia (ENA) Association has published an EMF Management Handbook (January 2016)[40] which describes EMF's in detail and methods to mitigate magnetic fields. Evoenergy follows these guidelines where practicable and complies with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Guidelines in the design of its network with respect to electromagnetic fields.

Inductive Interference

Inductive interference refers to the ability of the magnetic fields generated by current flowing in typically overhead line conductors, to cause interference with other electromagnetic radiation such as radio, television and communication signals.

Evoenergy shall continue to undertake routine maintenance programs to ensure all equipment is in good working condition, in particular all HV and LV overhead lines, to ensure that inductive interference is within the limits specified in Australian Standard AS 2344:2016 Tables 1 and 2 (limits of radiated radio disturbance from overhead AC powerlines 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 5MW to the Evoenergy Distribution Network "document. This includes the requirement that inverters must comply with the requirements of the Clean Energy Council (CEC) and Australian Standard AS/NZS 4777 (Grid connection of energy systems via inverters).

Power Factor

Power factor relates to the relationship between real and reactive power. In an alternating current (AC) system the in-phase portions of voltage and current waveforms produce "active" or real power which is the capacity of the electricity system to perform work. The out of phase portions of voltage and current waveforms produce "reactive" power. The combination of active and reactive power is termed apparent power. A low or poor power factor will result in inefficiency due to high apparent power loading with a low real power delivery.

Evoenergy monitors power factor as part of its programmed proactive and reactive monitoring of the network. Evoenergy uses the ADMS to identify areas of the network that may be experiencing power factor issues. Metering data is also used to identify installations with power factor outside acceptable limits.

Consumers can gain significant benefits by improving the power factor at their premises. These benefits include reduced electricity costs, increased plant load capacity and utilisation, and better voltage regulation. Improvement of power factor is usually achieved by the installation of capacitors.

Evoenergy requires that the power factor at the point of common coupling between Evoenergy's network and the consumer's installation to be between 0.9 lagging and unity, with no allowance for leading power factor. Details can be found in Evoenergy's Service & Installation Rules for Connection to the Electricity Distribution Network which can be found on our external website.

System Losses

As electrical energy flows through the transmission and distribution networks, a portion is lost due to the electrical resistance and heating of network elements such as conductors, switchgear and transformers. Across the Evoenergy network these losses may be up to 3%–5% of the total energy transported. Energy losses on the network must be factored in at all stages of electricity production and transportation. This is to ensure adequate supply is available to meet prevailing demand and maintain the power system in balance after energy losses. In practical terms, this means more electricity must be generated to allow for this loss during production and transportation.

Management of losses assists with achieving better business and environmental outcomes. Evoenergy periodically reviews open points on the network to enable the network to be reconfigured to reduce losses. This includes load balancing between zone substation transformers.

40 http://www.ena.asn.au/sites/default/files/emf_handbook_2016

Electrical losses in the network are proportional to the square of the current (I2). Power factor is an important part of distribution network, and is generally expressed as either a decimal value, for example 0.9, or as a percentage: 90%. Having a higher power factor results in a lower current, for the same amount of useful energy, and therefore reduces network losses. Evoenergy's service and installation rules require that the power factor is not lower than 0.9. However, there a 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 particular cable selection.

Distribution Loss Factors

Distribution Loss Factors (DLFs) represent the average energy loss between the distribution network connection point and the transmission network connection point to which it is assigned. Loss factors are calculated and fixed annually to facilitate efficient scheduling and settlement processes in the NEM.

Under the NER Clause 3.6.3, Evoenergy is required to calculate and publish annually the distribution loss factors on its network. Publishing of the loss factors improves transparency of the network loss performance to retailers and consumers. Evoenergy calculates distribution loss factors for both site-specific consumers (embedded generators with output greater than 10 MW and load consumers with maximum demand greater than 10MW 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[41], and Evoenergy's published DLFs can be found on AEMO's website[42].

41 https://www.evoenergy.com.au/-/media/evoenergy/about-us/evoenergy-loss-factor-methodology.pdf

42 https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/loss_factors_and_regional_boundaries/2022-23/distribution-loss-factors-for-the-2022-23-financial-year.pdf?la=en