Appendix 1.13: Evoenergy Asset Portfolio Strategy: Secondary Systems Assets

Regulatory proposal for the ACT electricity distribution network 2024–29

SECONDARY SYSTEMS ASSETS

ASSET PORTFOLIO STRATEGIES

This **Asset Portfolio Strategy** provides an overview of the asset management strategy for all the Secondary Systems assets and the risks, needs, opportunities and other considerations used to create this document.

CONTENTS

EXECUTIVE SUMMARY

This Asset Portfolio Strategy summarises the asset management strategies and covers a rolling 10-year period, currently from FY25 to FY34. The following five asset classes are included within this portfolio:

- Auxiliary DC Supply Systems
- Protection Systems
- Supervisory Control and Data Acquisition (SCADA) Systems
- Communications Systems
- National Electricity Market (NEM) Metering.

Each asset class is broken down further into multiple asset types and this is detailed in Section 2.

Asset objectives, key risks, and opportunities are explored in this Asset Portfolio Strategy document, drawn from Evoenergy's Asset Management Policy, Strategic Asset Management Plan, and the Asset Risk Value Framework. This is used to determine the optimal strategy and program of work investment for the assets. In this document, each asset class is described, objectives and issues explored, strategies expounded, expenditure forecast, and resourcing requirement estimated alongside programs of work. Together, these items form a cohesive portfolio strategy for the Secondary Systems assets.

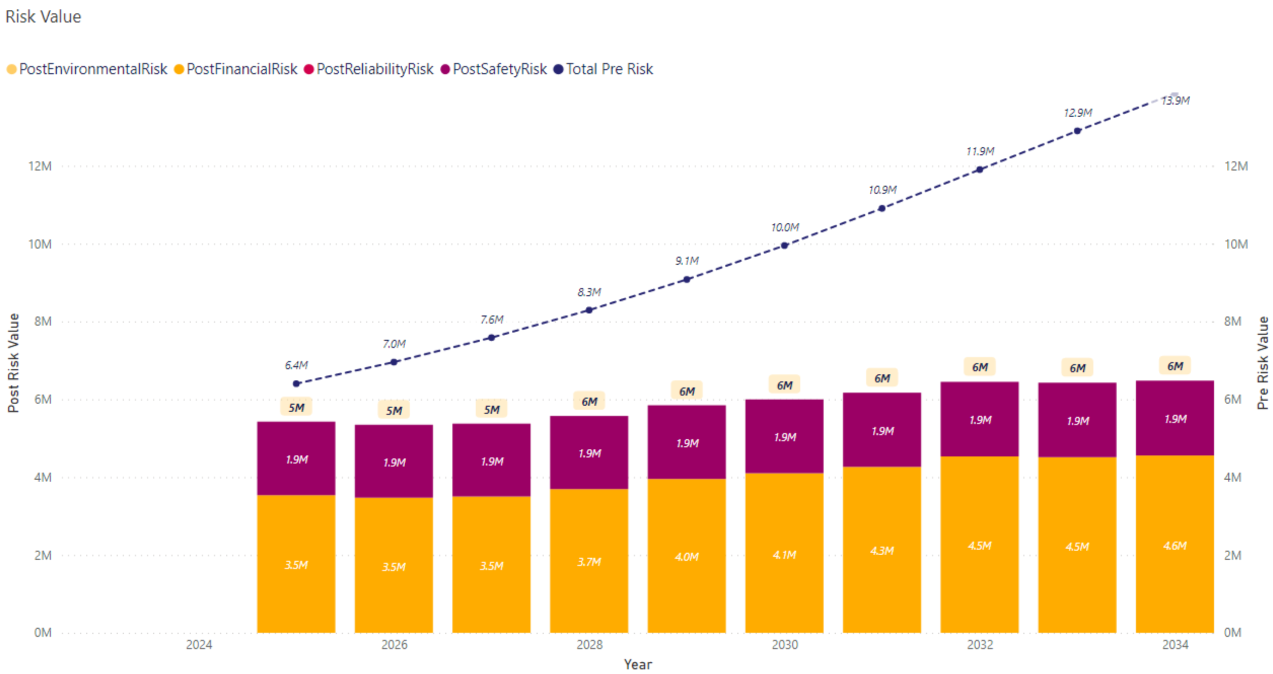
The information in this document is presented in the following structure:

- Section 1: Purpose – explains the scope of this document and introduces Evoenergy's Asset Management System (AMS) and its components at high level. It also presents the hierarchy of the plans within the AMS, where this document sits within the hierarchy, what informs this document, and how the information from this document cascades down.
- Section 2: Portfolio Overview – provides brief information on each of the constituting asset classes.
- Section 3: Asset Portfolio Objectives – provides brief information on Evoenergy's ongoing and planned business drivers and organisational objectives such as safety, reliability, sustainability, and quality of supply. It describes how this organisational context informs and influences the asset management strategy of this portfolio of assets.
- Section 4: Asset Class Strategies – describes the asset management strategy being proposed for each asset class after considering the management objectives, status of the asset and its current characteristics, failure modes, risk level, and available opportunities.
- Section 5: Program of Work – summarises planned program of work including maintenance activities and major replacement and renewal projects across this asset portfolio. Presents a summary of projected expenditure from FY25 to FY34 that is required to fulfil the objectives, address the drivers, and maintain/mitigate the risks to acceptable level.

Figure 1 demonstrates the comparison between the baseline risk ('Total Pre Risk') and the forecast risk levels over the ensuing 10 year period under the asset strategies as described within this document. The risk is displayed in nominal dollars and is an indication of the environmental, direct financial, reliability, and safety risk factors.

For secondary systems assets, safety risk and financial risk factors are present. Safety risks include failure of protection and SCADA systems to maintain network safety for staff and the community and prevent damage to network assets. Financial risk consequences include loss of protection and control affecting network operations and reliability.

FIGURE 1. 10-YEAR FORECAST FOR ASSET PORTFOLIO RISK VALUE

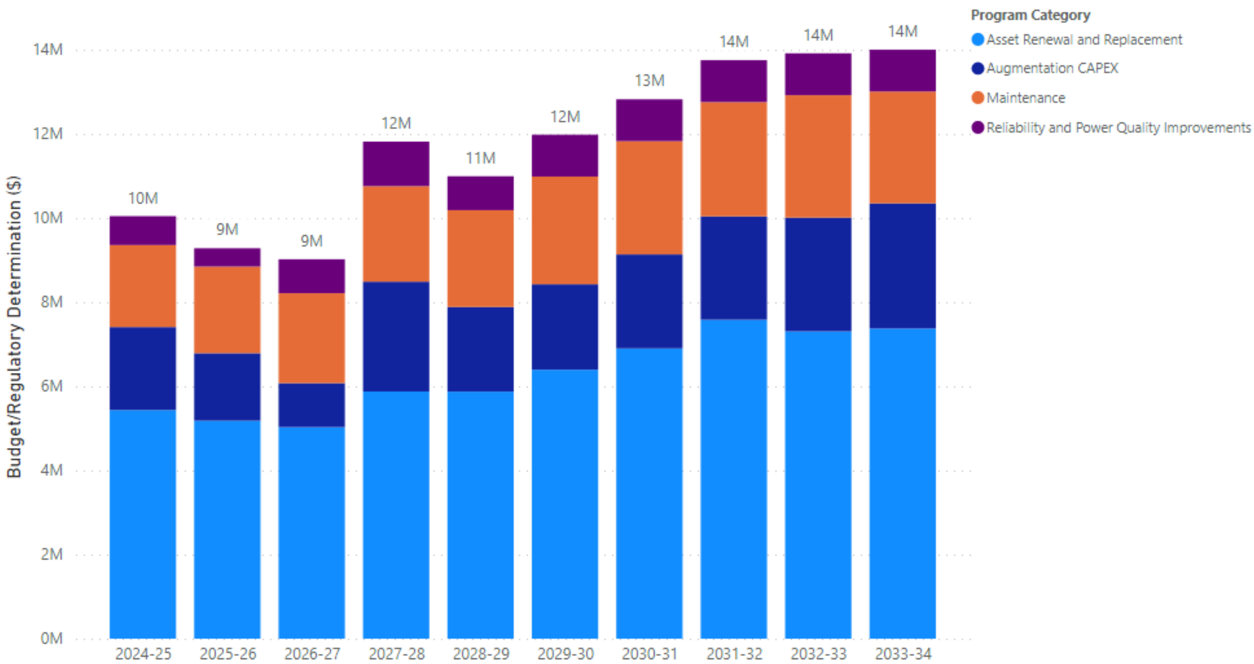


Key components of the program of work include:

- Zone transformer protection replacement at six (6) zone substations to replace ageing, obsolescent and failing transformer protection assets
- Feeder Protection replacement at three (3) zone substations to replace ageing, obsolescent and failing feeder protection assets
- Replacement of ageing and poor condition zone substation SCADA and communications assets in alignment with protection replacement projects where practical
- Replacement of poor condition chamber substation SCADA assets which are no longer vendor supported
- Upgrades for duplication of batteries and battery chargers at five (5) zone substations to comply with the National Electricity Rules (NER) requirements
- Replacement of ageing pilot cable infrastructure with optical fibre where required
- Leverage of civil projects outside of the Secondary Systems portfolio to extend the optical fibre network.

The overall 10-year budget for secondary systems asset renewal and replacement, augmentation and reliability and quality improvement CAPEX and maintenance OPEX is shown in Figure 2. Overall forecast expenditure for the 2024-29 period is $41.5M CAPEX and $10.7M OPEX.

FIGURE 2. 10-YEAR SECONDARY SYSTEMS PROGRAM BUDGET FORECAST (IN FY23 DOLLARS)



1. PURPOSE

The purpose of this document is to detail Evoenergy's Secondary Systems asset management strategy and plans, and to provide future expenditure profiles.

The key information presented includes descriptors of each asset class, key issues and objectives, asset class strategies, expenditure forecasts, and a program of work. Together, these form a cohesive portfolio strategy.

1.1. SCOPE

This Asset Portfolio Strategy document covers all five of Evoenergy's Secondary Systems asset classes for a rolling ten-year period. The objective of this document is to provide an overview of the asset management strategy for all the asset classes in this portfolio and to discuss their existing and emerging risks, needs, opportunities, and other key considerations.

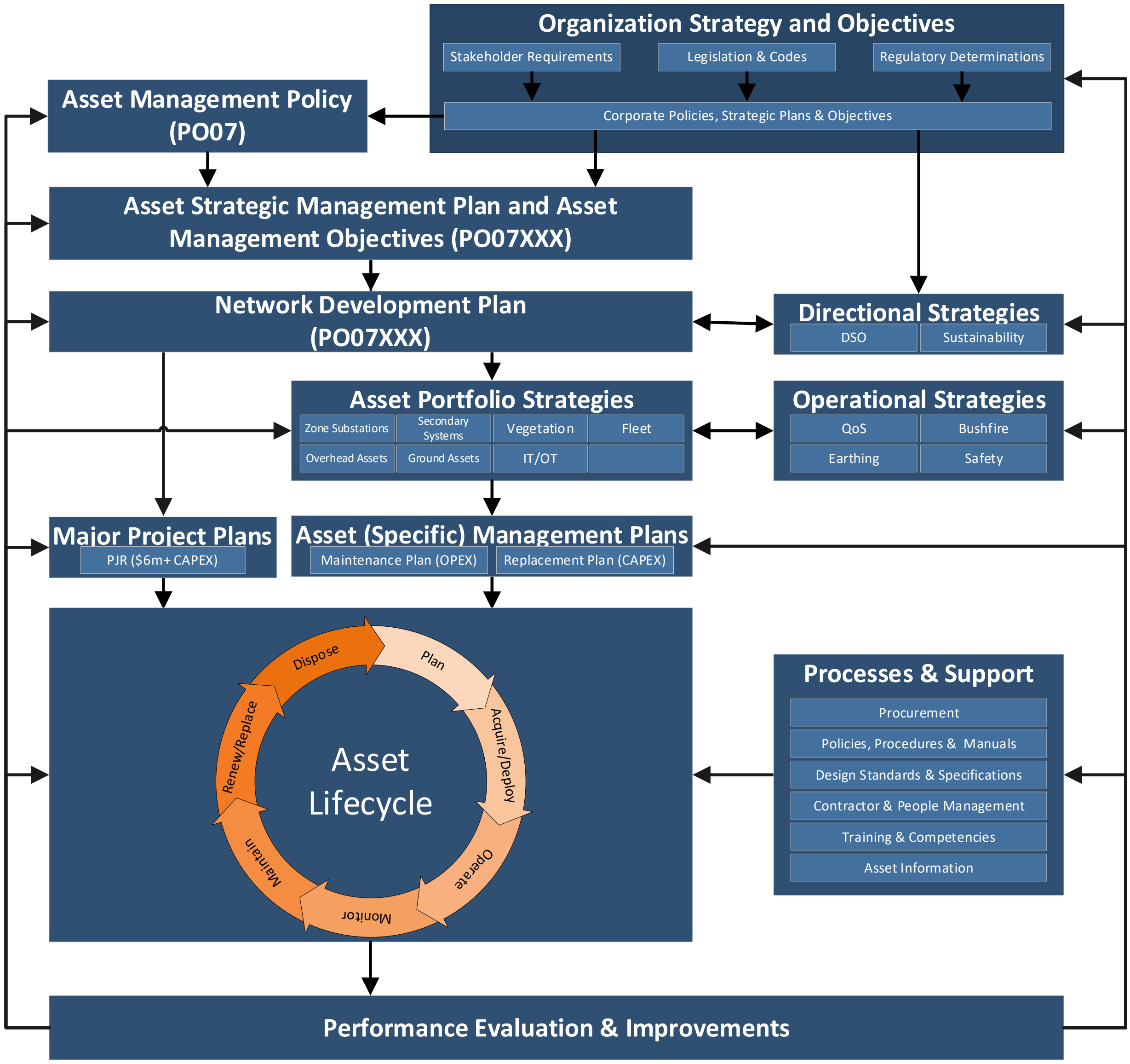
This document links the overarching business objectives and organisational drivers and the low-level operational decisions described in Evoenergy's Asset Management System.

Figure 3 provides an overview of Evoenergy's Asset Management System.

Figure 4 shows Evoenergy's Asset Management System hierarchy of plans, showing the interrelationship of this document within the overall plans.

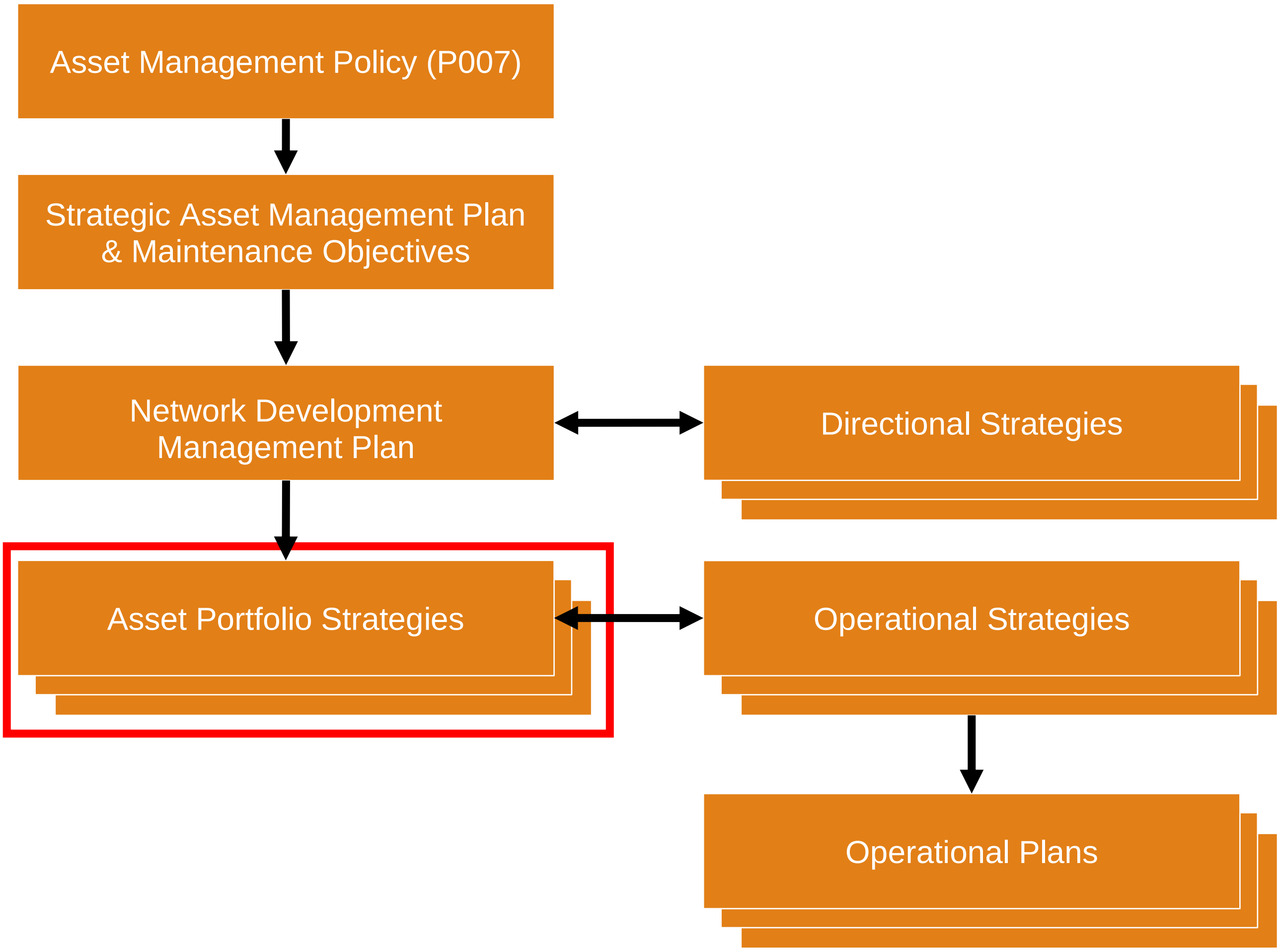
1.2. ASSET MANAGEMENT SYSTEM

FIGURE 3. EVOENERGY'S ASSET MANAGEMENT SYSTEM



1.3. HIERARCHY OF PLANS

FIGURE 4. ASSET MANAGEMENT SYSTEM HIERARCHY OF PLANS (SHOWING THE INTERRELATIONSHIP OF THIS DOCUMENT WITHIN THE OVERALL PLANS)



2. PORTFOLIO OVERVIEW

This section provides an overview of the asset grouping and asset classes contained within this document.

The Secondary Systems asset portfolio is, compared to other assets, relatively low-value but is critical for the safe and reliable operation of the network.

This portfolio includes the SCADA, communications systems, protection systems, DC supplies, and NEM metering that collectively allow Evoenergy to monitor, operate, and safely use the electricity network.

FIGURE 5. ASSET HIERARCHY (ONLY SHOWING THE ASSET CLASSES WITHIN THE SECONDARY SYSTEMS ASSET PORTFOLIO)

Overhead Assets

Ground Assets

Secondary Systems Assets

- Auxiliary DC Supply Systems
  - DC Systems (Distribution)
  - DC Systems (Zone)
- Protection Systems
  - Distribution Protection
  - Zone Substation Protection
- SCADA Systems
  - RTU
  - HMI Computer
  - GPS Clock
  - Station Controller
  - Bay Controller
  - Online Condition Monitoring Sensor
  - Network Analyser
- Communications Systems
  - Comms Power Supplies
  - Data Radio Systems
  - LAN Devices
  - Media Converters
  - Optical Fibre Cables
  - Pilot Cables
  - Tele-Protection Devices
  - Voice Radio Systems
  - WAN Devices
- NEM Metering
  - NEM Meter

Zone Substation Assets

Vegetation and Inspection

The Secondary Systems asset portfolio constitutes a major network asset category and, together with other asset portfolios, forms Evoenergy's collective network asset system. This portfolio includes five asset classes as highlighted in Figure 5. Each asset class may comprise of multiple asset types.

While many of these assets are in zone substations, Secondary Systems assets can be found throughout the network. This asset portfolio enables Evoenergy to monitor and operate the network. A more comprehensive breakdown of the asset classes and asset types associated with this asset portfolio is provided in Section 4.

Table 1 offers a count of assets within this portfolio.

TABLE 1. POPULATION OF SECONDARY SYSTEMS ASSETS – SUMMARY

ASSET GROUP	ASSET CLASS	QUANTITY	QUANTITY (UNIT)
Auxiliary DC Systems	DC Systems (Distribution)	444	Each
	DC Systems (Zone)	72	Each
Protection Systems	Distribution Protection	1,637	Each
	Zone Substation Protection	1,660	Each
SCADA	RTU	265	Each
	HMI Computer	13	Each
	GPS Clock	13	Each
	Station Controller	2	Each
	Bay Controller	10	Each
	Online Condition Monitoring Sensor	14	Each
	Network Analyser	190	Each
Communications Systems	Comms Power Supplies	26	Each
	Data Radio Systems	269	Each
	LAN Devices	305	Each
	Media Converters	147	Each
	Optical Fibre Cables	72	Each
	Pilot Cables	18	Each
	Tele-Protection Devices	46	Each
	Voice Radio Systems	87	Each
	WAN Devices	34	Each
NEM Metering	NEM Meter	58	Each

The assets within the asset portfolio have a functional relationship with the asset classes in Table 2. Further information can be found in their respective Asset Portfolio Strategy documents.

TABLE 2. ASSOCIATED ASSET CLASSES

ASSOCIATED ASSET CLASS	DESCRIPTION OF RELATIONSHIP
Zone Substation Transformers	Zone substation power transformers are high value critical assets for the supply of energy to customers and maintaining quality of supply. Transformers are protected by protection relays and have SCADA control systems for voltage regulation and monitoring critical parameters. The zone substation transformers are maintained in conjunction with the associated HV and MV circuit breakers, protection and control systems, and the protection relays.
Zone Substation 132kV & 66kV Switchgear and Zone Substation 11kV Switchboard Assemblies	The protection relays detect faults in 132kV zone substation elements and trip the 132kV circuit breaker providing secured fault disconnection. The station auxiliary system provides auxiliary supply to the breaker control circuits. The station SCADA provides the control room with visibility of circuit breaker status. The circuit breakers are maintained jointly with their corresponding protection relays. The protection relays are mounted on the 11kV switchgear and trip the circuit breaker in the event of a fault. The 11kV Current Transformers (CTs) provide the protection relays with measurable current inputs. The Station automation system provides the control room with the status of the 11kV switchgear. The primary 11kV circuit breakers are maintained jointly with the protection relays.

3. ASSET PORTFOLIO OBJECTIVES

Evoenergy's Asset Management Objectives are documented in the Strategic Asset Management Plan (SAMP) as informed by the Asset Management Policy (P007) and business strategies and plans. This Asset Portfolio Strategy takes the Asset Management Objectives and details specific asset objectives and strategies for the Secondary Systems asset portfolio.

This document, therefore, provides alignment to the high-level organisational aspirations, with specific strategies and plans for the asset portfolio for asset replacement and augmentation, and details the maintenance requirements to meet the Asset Management Objectives. The alignment between organisational strategic directions and the day-to-day activities of managing assets is an important aspect of the Asset Management System.

Table 3 provides an overview of the Secondary Systems asset objectives.

TABLE 3. SECONDARY SYSTEMS ASSET OBJECTIVES

ASSET MANAGEMENT OBJECTIVES	SECONDARY SYSTEMS ASSET OBJECTIVES

Operate and maintain our network safely	- Realise safety benefits by upgrading to current standards (digital substations) with asset replacements:
	  • Ease of implementation of advanced protection functions in software such as busbar protection that would otherwise be cost prohibitive e.g., busbar protection is an important mitigation for identified high risk arc flash hazards and this would otherwise be difficult to implement in existing zone substation 11kV switchboards.
	  • Provide systems that are self-monitoring and failsafe. Protection reliability and fault clearance will be improved.
	- Eliminating Earth Potential Rise (EPR) electric shock hazards from copper pilot cables. Evoenergy's aim is to have all pilot cables decommissioned by the end of the 2024-29 period and replaced with non-metallic optical fibre cables. Decommissioned pilot cables will be capped.
	- Meet 132kV transmission redundancy requirements for duplicate protection systems, including necessary redundancy in any communications facility upon which the protection system depends (NER V187 S5.1.9 (d)).
	- Required to meet 132kV transmission critical fault clearing time of 120ms for zone 1 faults and 220ms fault clearance time for end zone faults (NER V187 Table S5.1a.2)
	- Meet 11kV main and backup protection requirements with an ability to provide safe and timely disconnection of downstream distribution faults (NER V187 S5.1.9).

ASSET MANAGEMENT OBJECTIVES	SECONDARY SYSTEMS ASSET OBJECTIVES
Meet our network reliability targets	Provide reliable communications to support SCADA communications and teleprotection Provide zone substation voltage regulation systems and voltage setpoint optimisation to manage customer network voltage within compliance limits Provide Quality of Supply (QoS) monitoring via SCADA to assist with the proactive management of QoS issues As per NER clauses 4.2; s5.1; s5.1a, provide secure operating state and power system security: • Maintain system security operating within a satisfactory state following a credible contingency event • Operate within a technical envelope • Provide a suitable level of network redundancy, in accordance with submitted annual planning report. As per NER clause 4.3.4 – Network service providers: • Maintain system asset data and ratings in the event that it is requested by the Australian Energy Market Operator (AEMO) (including expected maximum current flow, at any point). As per NER clause 4.11.2 and the AEMO Power System Data Communication Standard: • Provide data to and from AEMO for use in AEMO control centres meeting necessary redundancy and reliability requirements.
Manage our network for the least total lifecycle cost	Lower asset replacement construction costs with digital substations: • Station communications is via an optical fibre Ethernet network within the station. This reduces substation wiring and device counts, and thereby lowers implementation costs.
Manage and invest in our network using prudent risk management approaches	The management of asset related risk and asset management related risk shall be undertaken in accordance with Evoenergy's Risk Management and Legal Compliance requirements Assets shall be managed as appropriate to their scale and criticality.
Deliver sustainable and cost-efficient network investments	Realise digital substation efficiency and reliability benefits with asset replacements: • Digital substations providing automated condition monitoring of primary and secondary systems will report issues and system faults facilitating condition-based maintenance and overall reliability improvement at a lower operating cost.
Operate an AMS that satisfies the needs of our stakeholders	All assets shall be managed in full compliance with any relevant statutory and mandatory legal and safety requirements Evoenergy shall proactively seek continual improvement of its Asset Management capabilities and activities to maximise value for customers and stakeholders.

ASSET MANAGEMENT OBJECTIVES	SECONDARY SYSTEMS ASSET OBJECTIVES
Manage opportunities and drive continuous improvement	• Opportunities to reduce maintenance with automated condition monitoring of Primary Assets and Secondary Systems • Develop Failure Modes Effects and Criticality Analysis/Reliability Centered Maintenance (FMECA/RCM) maintenance strategies • Provide greater visibility of the power flows in the network resulting from Distributed Energy Resources (DERs), Electrical Vehicles (EVs), and full electrification (consumer transitioning gas network).

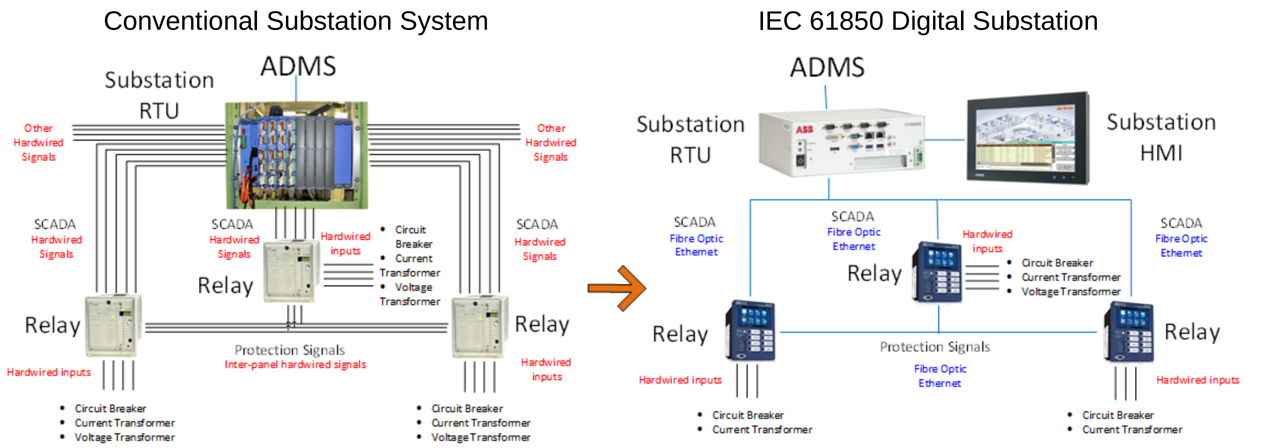
Evoenergy needs to assess its risk exposure, plan its investment to address those risks to as low as reasonably practicable, meet market demand and the changing need of energy transformation, and ensure optimal functioning and performance of this asset portfolio to meet these obligations. The subsequent sections in this portfolio document systematically describe Evoenergy's approach in addressing these requirements via its Asset Management System and pertaining to its Secondary System asset portfolio.

Overarching key strategies for the Secondary Systems Portfolio have been developed as described in the following sub-sections.

3.1. DIGITAL SUBSTATION STRATEGY

The secondary systems protection and automation upgrade program is proposed using a digital substation systems implementation utilising IEC 61850 engineering and integrated substation automation system. The integrated systems engineered solution of the digital substation approach comprises the protection, automation (SCADA) systems, and reliant communications systems working together to deliver the required functionality.

FIGURE 6. COMPARISON OF CONVENTIONAL SUBSTATION SYSTEMS AND IEC 61850 DIGITAL SUBSTATIONS



Digital substation technologies offer tangible benefits to system operation, safety, and maintenance as outlined below:

- Reduces the amount of wiring and reduces construction cost by up to 25% compared to conventional secondary systems designs
- Automated condition monitoring that results in reduced maintenance expenditure
- Elimination of working adjacent to energised equipment
  - The digital substation implementation eliminates the need for bus wiring in the 11kV switchboard, eliminating the need to work on the adjacent live panels during construction fit-out and maintenance

- Eliminates live terminals due to usage of sampled value power system signals thereby ensuing safety to operating personnel
- Reduces the amount of wiring and reduces construction cost

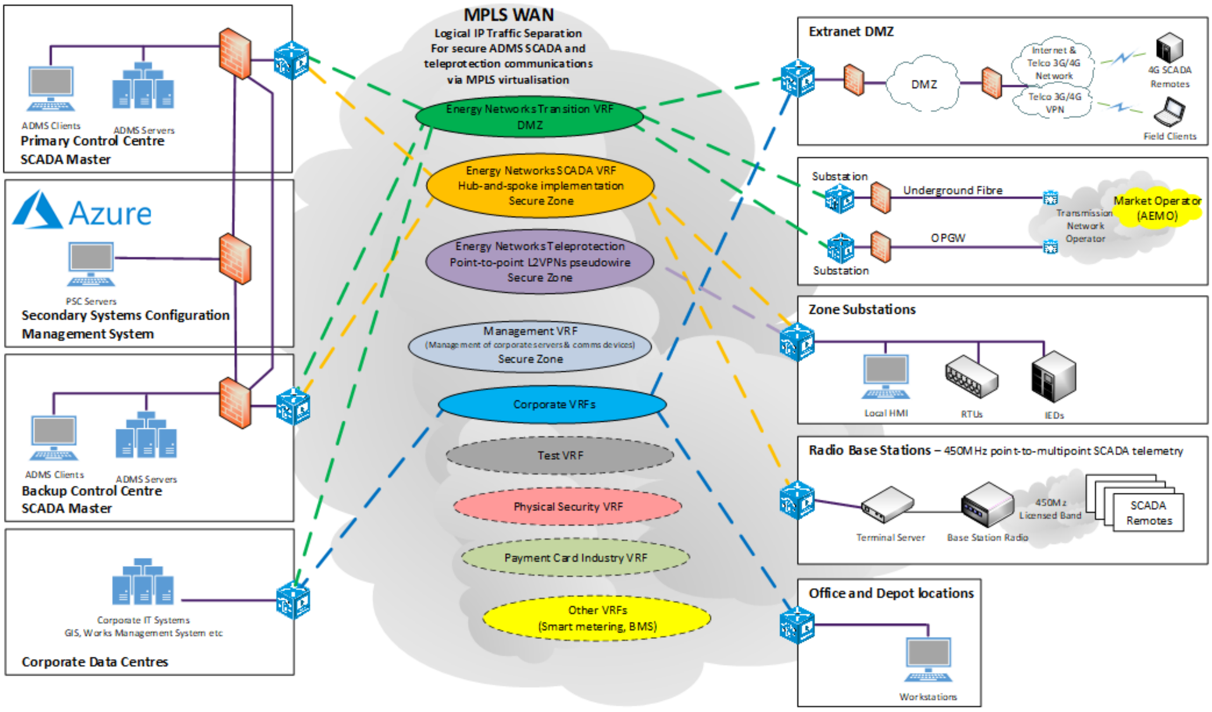
- Improved and more sophisticated interlocking can be achieved for improved safety
- Lowering arc flash incident energies with combinations of protection setting changes
  - Digital substation implementation will incorporate current best practice protection systems including photon sensing arc flash protection in the No.1 scheme and bus differential protection in the No.2 scheme. Other optimisation of protection settings are also available in the proposed protections.
- Improved switchgear and power transformer asset management practices
  - Digital substation implementation will incorporate operation and condition monitoring of the switchgear including operating travel times, spring charge, and contact wear. For power transformers, Online Tap Changer (OLTC) operation can be monitored and online Dissolved Gas Analysis (DGA) and other condition monitoring implemented. This will permit automated detection of abnormal conditions and enable an RCM maintenance approach for the primary assets.
- In addition, the 11kV bus protections will ensure compliance with the earthing systems requirements, shortening the trip time for 11kV bus faults and reducing the earth potential rise. With the current group protection settings, fault clearing time is needs to be set high to grade with outgoing feeder protections. This results in high earth potential rise and a possible non-compliance with the Australian Standards.
- Implementation of a digitised underfrequency load shedding scheme that will selectively trip feeders based on load (magnitude and direction) and priority, and maintain feeders with net positive power contribution from embedded generation for improved power system stability.

3.2. OPERATIONAL COMMUNICATIONS NETWORK STRATEGY

With the rollout of optical fibre covering zone substations and key sites within the Evoenergy electrical network, the implementation of an IP-based Wide Area Network (WAN) to support the SCADA network was required to deliver services. The technology chosen for the deployment of the WAN is Multi-Protocol Label Switching over IP (IP-MPLS). In addition to providing high bandwidth high speed capabilities for the SCADA network and tele-protection services, the integration of MPLS devices allows for the carriage of other corporate functions on the same network without impacting electrical network protection or SCADA operation.

By installing an optical fibre core and utilising MPLS technology, the communications network becomes scalable while protecting mission critical services. Quality of Service (QoS) prioritisation provides the capability to support additional network functions without impacting on the primary network protection and SCADA functions of the communication network. The versatility of the IP-MPLS based network enables full integration of the capabilities of substation Intelligent Electronic Devices (IEDs), allowing for more detailed monitoring and control of the network and equipment in addition to the core protection and control functions of the Secondary Systems network. Figure 7 shows the MPLS logical architecture and connectivity for individual services. Each service is implemented in separate virtual networks (Virtual Routing and Forwarding (VRF) instances) across the MPLS WAN. Virtual Local Area Networks (VLANs) are implemented within substations, the Advanced Distribution Management System (ADMS) and corporate datacentres, office locations, and communications sites. This logical architecture maintains segregation for cybersecurity and permits service levels to be applied for specific applications.

FIGURE 7. MPLS LOGICAL ARCHITECTURE AND SERVICE CONNECTIVITY



IP-MPLS was chosen because of the following advantages:

- Maturity and proven capabilities across large-scale industrial and enterprise networks,
- Ability to support both traditional applications and next-generation requirements,
- Ability to virtualise the WAN into independent sub-networks,
- Centralised management of physical infrastructure and virtualised sub-networks,
- Ability to enhance and become an integral part of the security framework across the WAN,
- Modularity for scalability and flexibility, as well as the ability to protect the overall system from domain failures, and
- Lowest cost compared to other options.

The IP-MPLS communications network supports IEC 61850 technology in substations, Distributed Network Protocol 3 (DNP3) over IP for SCADA reporting to ADMS, tele-protection over IP and other operational needs. The IP-MPLS network is an extension on the existing IT infrastructure and implements virtualised sub-networks, utilising MPLS VRFs and VLANs, to maintain separation from the core corporate network for the SCADA/OT networks.

The Evoenergy MPLS network is nearing completion with the primary purpose of provisioning network protection and ADMS/SCADA communications to zone substations. The only remaining tasks are completion of redundant fibre routes for a few zone substations and the associated upgrade of legacy SCADA equipment in a couple of zone substations before all zones will achieve redundant fibre communications.

The communications network also provides Inter Control Centre Protocol (ICCP) communications to TransGrid and AEMO.

At a high level, the communication systems project portfolio includes replacing legacy pilot cables with fibre and upgrading data radios to the latest standards. It is forecast that the next generation 5G network mobile network devices will be available prior to the commencement of the period. Upgrading existing 4G devices to 5G before the 4G network is decommissioned has been forecast towards the end of the period.

3.3. SECONDARY SYSTEMS CYBER SECURITY STRATEGY

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3.4. SEF PROTECTION – BUSHFIRE MITIGATION STRATEGY

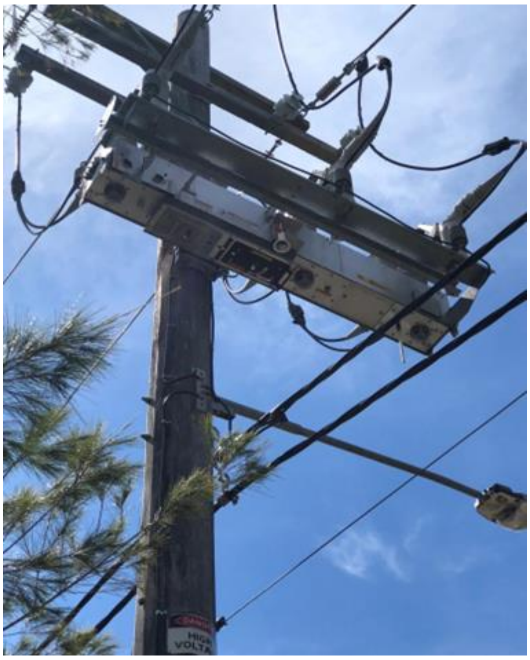
One of the challenges on the network is detecting high-impedance earth faults using Sensitive Earth Fault (SEF) protection on 11kV feeders. High-impedance earth faults are often caused by vegetation or broken power line conductors that touch the ground and generate uncharacteristically low current. Most traditional SEF protection schemes are unreliable because they lack the required sensing and measurement precision needed to detect very low fault current. Evoenergy's best SEF protection option, reclosing, required high current flow where the resulting sparks during fault-testing can lead to dry vegetation ignition.

Evoenergy has introduced a new solution to detect high-impedance earth faults using lower fault current based on point of wave switching reclosers (see Figure 9). Evoenergy has trialled the solution, which uses high-precision sensing and measurement methods and a low-pulse fault-testing. This technology uses less than 5 percent of a network's fault energy to detect a fault, significantly decreasing the energy – and sparks – produced by downed conductors and vegetation faults.

A new voltage supervised sensitive earth fault algorithm, SEF, has been developed to detect high resistive earth fault currents of the order of one (1) ampere to provide an improved fault detection and clearance of high impedance vegetation faults with improved operating time in less than 2 seconds.

The solution has been endorsed by the ACT Technical Regulator as meeting requirements for mitigation of high resistive vegetation fault resulting in the Evoenergy network.

FIGURE 9. RECLOSER DEVICE AND THE TARGET HIGH RISK ACT BUSHFIRE ABATEMENT ZONES



3.5. DISTRIBUTION SUBSTATION MONITORING STRATEGY

Distribution networks are undergoing the largest transformation in history driven by technology, ambition to decarbonise the grid, and changing needs of customers interacting with the grid. Key challenges for Evoenergy include managing this transformation, solving new and existing challenges in efficient and cost-effective ways.

Technology has enabled our customers to be increasingly active participants in a two-way electricity market that represents a paradigm shift for network electricity management. Government policy is driving changes in demand for network services, through policy and projects designed to meet Canberra's ambition to achieve net zero emissions by 2045. For Evoenergy to continue to provide the high quality and valuable services to our customers that they seek, extending visibility of our network is one of the important tools we need to have available to us.

Traditionally Evoenergy has successfully managed our network with good visibility of the High Voltage (HV) network from SCADA, and relied upon predicable customer behaviour and loads to manage the Low Voltage (LV) network. Preparing to be a Distribution System Operator (DSO) and rapid uptake of DER by customers is changing the way LV networks must operate, requiring greater insight into LV networks to actively manage load and power quality constraints in real time.

Evoenergy has recently commenced its distribution substation monitoring program and the installation of low-cost distribution substation monitor devices within strategically selected distribution substations. Real time data collected from transformer monitors is provided via SCADA to Evoenergy's ADMS system and is available for utilisation in dynamic control schemes such at zone substation voltage regulation and implementation of operating envelopes for customer-connected DER such as photovoltaics (PV) and batteries. Effective implementation of these types of schemes will be critical in ensuring Evoenergy's network adapts and is able to meet the challenges of transitioning to DSO operations and managing an evolving two-way power flow network.

4. ASSET CLASS STRATEGIES

4.1. CONTEXT

This section provides details of the asset class strategies for maintenance and replacement. From strategies, a viable program of work is developed to replace the assets that are most in need to allow safe operation of our network.

Based on the condition of assets, strategies and remediation have been suggested for the portfolio of assets comprising of auxiliary DC systems, protection relays, SCADA, communications systems, and NEM metering.

4.2. AUXILIARY DC SYSTEMS STRATEGY

Auxiliary DC systems supply batteries that feed secondary system devices in zone substations, switching stations, distribution substations (chamber and automated pads), and automated ring main units. These assets are essential for the safe and reliable operation of the network. Rectifiers charge batteries and power the DC system. If AC power supplying the rectifiers fails, then the batteries will continue to supply the loads (including monitoring and communication systems).

The Secondary Systems auxiliary DC systems are categorised into the following asset groups:

- DC Systems (Zones) – Zone substation DC systems
  - Lead Acid Batteries (Zone)
  - NiCad Batteries (Zone)
  - Battery Chargers (Zone)
- DC Systems (Distribution) – Distribution DC systems
  - Lead Acid Batteries (Distribution)
  - NiCad Batteries (Distribution)
  - Battery Chargers (Distribution).

However, as these two groups are similar from a portfolio perspective, they are combined into one section for brevity, as found below.

4.2.1 Asset Class Summary and Objectives

Substation batteries are required to supply backup power for protection systems, and remote monitoring and control (SCADA) systems. They also provide a supplementary current supply when high currents are drawn in the case of motorised operating mechanisms of primary assets such as Circuit Breakers and Isolators (415V, 11kV, 22kV, 66kV and 132kV).

The battery backup DC supply in both distribution and zone substations is intended to operate at times of mains supply outages for approximately 4-8 hours (the duration depends on the current drawn).

4.2.2 Asset Types

Evoenergy currently has multiple types of batteries and power supplies operating within the network. These are introduced in this section.

4.2.2.1 Lead Acid Batteries

Most of the distribution substation batteries are dry type (gel) lead acid batteries, while the older Nickel Cadmium (NiCad) batteries are still present in some substations. Nickel Cadmium, despite having the advantages of longer life and deeper discharge; also have the disadvantages of higher purchase cost, taking longer to routinely check, and requiring special disposal incurring substantial end-of-life costs. Therefore, when they reach the end of their service life, distribution substation NiCad batteries are replaced with lead acid batteries.

Evoenergy distribution substation DC systems have two operating voltages, 24V and 32V. This has now been standardised, and since approximately 1985 all new substations have 24V DC systems. SCADA systems on older 32V DC substations operate on a separate 24V DC supply. A voltage of 32V is usually achieved using five 6V (close to 6.4V) batteries in series, and 24V is achieved using two 12V batteries in series.

Reclosers and Load Break Switches have a smaller (in capacity and size) dry type 12V lead acid battery. As these batteries are reasonably low in cost and are exposed to harsh environmental conditions, they are replaced as part of the protection maintenance on a 5 yearly cycle, and this is costed as part of the overhead assets.

4.2.2.2 NiCad Batteries

The current strategy for zone substation batteries is to use NiCad batteries due to their higher energy storage capacity and increased reliability. The type of batteries used at zone substations and 132kV switching stations are Nickel Cadmium wet cell. These battery banks are at a voltage of 125V.

4.2.2.3 Battery Chargers

DC supply systems are installed to maintain a constant and reliable DC supply to auxiliary equipment. This is achieved by the battery charger converting 415V AC (3-phase) or 230V AC (single-phase) into 24, 32 or 125V DC. The output of the battery charger charges the battery bank and maintains a constant supply to the DC distribution board. In the event of losing the AC supply to the battery charger, the DC supply is maintained by the charge stored in the battery bank.

4.2.3 Current Population, Age, and Health Profile

This section offers a high-level count of auxiliary DC system assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

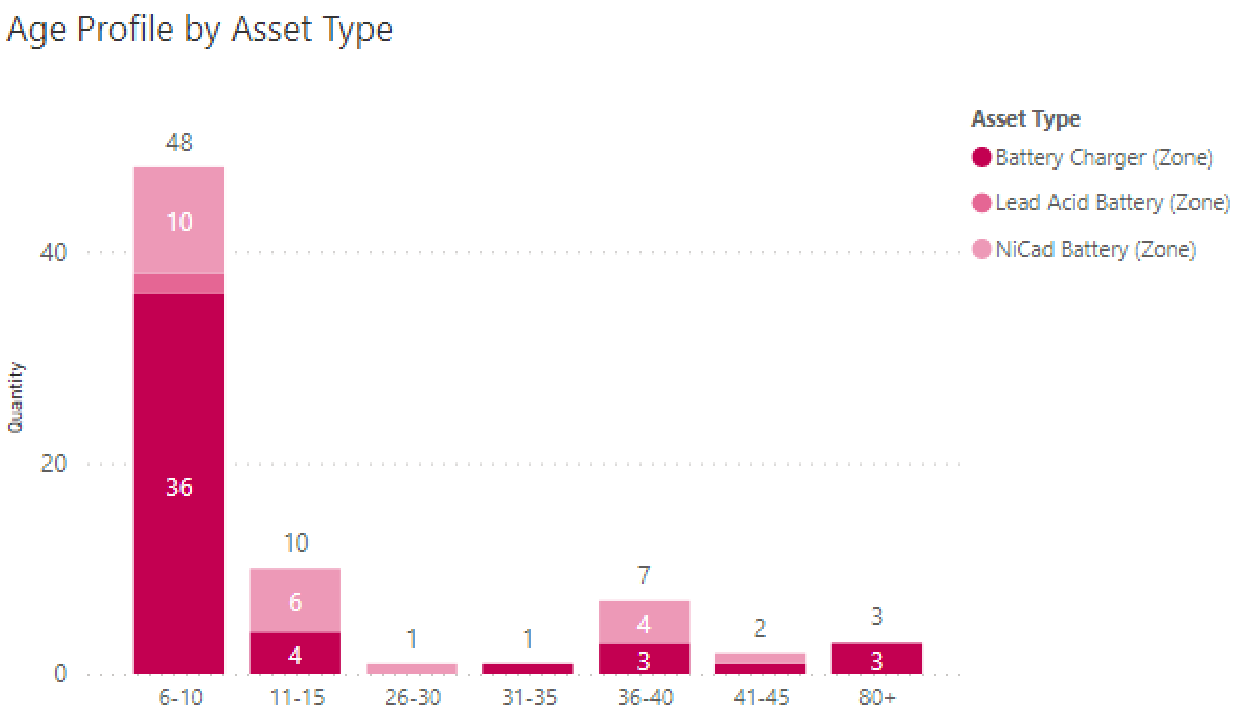
The Zone Battery asset class health profile is summarised below in Table 4, and age profile in Figure 10.

Based on this table, four sets of batteries and their corresponding battery chargers have been found to be in poor condition and need replacement.

TABLE 4. ASSET POPULATION, AGE, AND HEALTH PROFILES – AUXILIARY DC SYSTEMS (ZONES)

Asset Group	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
DC Systems (Zones)	72	each	33.33	21.44	14	71.13	Fair
CORDEX,OTHER	3	each	40.00	8.00	0	100.00	Very Good
CORDEX,UNKNOWN	2	each	40.00	123.00	2	0.00	Very Poor
ELTEK,FLATPACKS	26	each	40.00	7.00	0	100.00	Very Good
GAZ,KL185P	2	each	20.00	11.00	0	99.00	Very Good
JUNGER,M406	1	each	20.00	41.00	1	0.00	Very Poor
N/A,N/A	5	each	33.33	6.00	0	92.89	Good
N/A,UNKNOWN	2	each	20.00	6.00	0	100.00	Very Good
RECTIFIERCT,N/A	2	each	40.00	10.00	0	100.00	Very Good
SAFT,L302-2	3	each	20.00	37.00	3	0.00	Very Poor
SAFT,L303-6	1	each	20.00	37.00	1	0.00	Very Poor
SAFT,SBL102-2	2	each	20.00	18.00	1	50.00	Fair
SAFT,SBM112-2	2	each	20.00	12.00	0	98.50	Very Good
SAFT,SBM277-2	2	each	20.00	10.00	0	99.00	Very Good
SAFT,UP1M100-4	3	each	20.00	8.00	0	100.00	Very Good
SAFT,UP1M40-4	2	each	20.00	12.00	0	98.00	Very Good
UNKNOWN,UNKNOWN	14	each	40.00	28.00	6	57.14	Fair
Total	**72**	**each**	**33.33**	**21.44**	**14**	**71.13**	**Fair**

FIGURE 10. ASSET AGE PROFILE CHART (AS AT JULY 2022) – AUXILIARY DC SYSTEMS (ZONES)

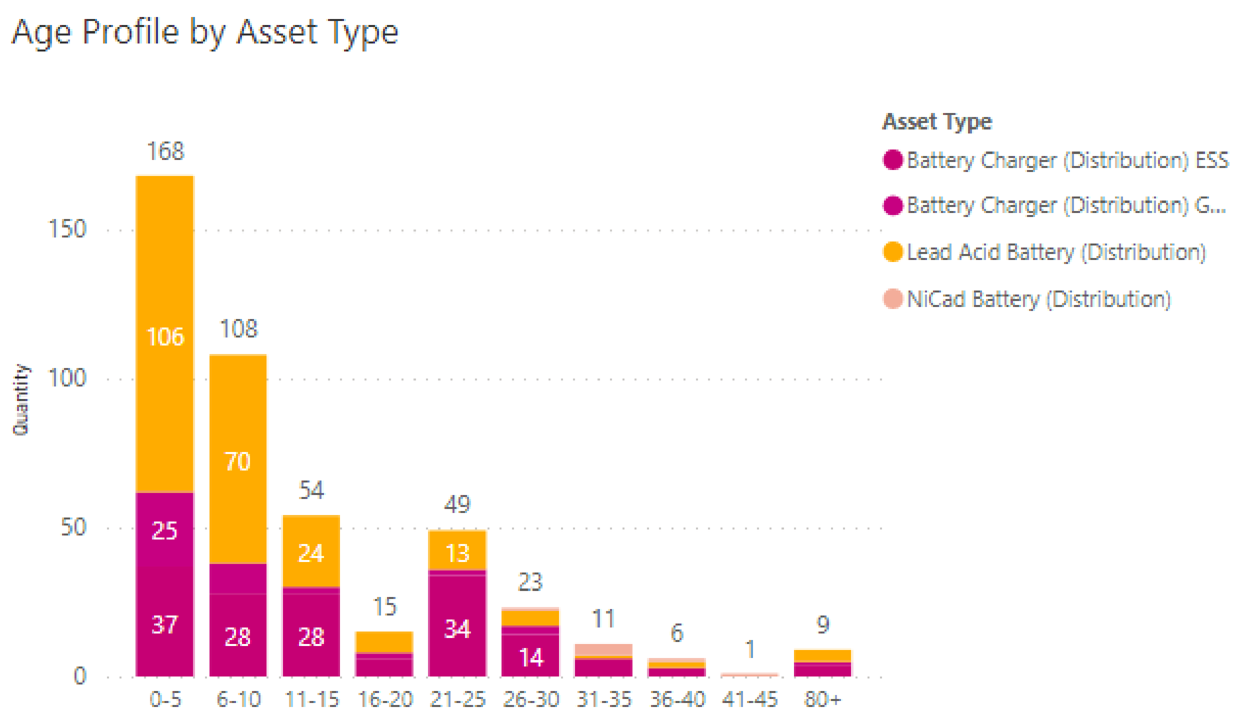


The Distribution Battery asset class health profile is summarised in Table 5, and age profile in Figure 11.

TABLE 5. ASSET POPULATION, AGE, AND HEALTH PROFILES – AUXILIARY DC SYSTEMS (DISTRIBUTION)

Asset Group	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
DC Systems (Distribution)	444	each	22.03	17.26	128	51.85	Fair
ALCAD,GPI	1	each	24.00	43.00	1	0.00	Very Poor
ALCAD,MP95	1	each	24.00	38.00	1	0.00	Very Poor
BRODRIBB,D5459	5	each	40.00	30.00	4	17.20	Very Poor
BRODRIBB,D5655	7	each	40.00	28.00	2	43.57	Fair
BRODRIBB,D5655-1	11	each	40.00	26.00	0	63.82	Good
BRODRIBB,D5656-11	1	each	40.00	22.00	0	86.00	Good
BRODRIBB,UNKNOWN	1	each	40.00	22.00	0	86.00	Good
CENTURY,P6200	2	each	6.09	10.00	2	0.00	Very Poor
CORDEX,CordexCXCi	32	each	40.00	17.00	3	90.63	Very Good
CORDEX,CXCR24-400	24	each	40.00	6.00	0	99.63	Very Good
CORDEX,N/A	7	each	40.00	7.00	0	99.86	Very Good
CORDEX,UNKNOWN	3	each	40.00	7.00	0	100.00	Very Good
ELTEK,N/A	8	each	40.00	2.00	0	100.00	Very Good
GENESIS,N/A	2	each	6.09	4.00	0	92.00	Very Good
GENESIS,NP24-12R	1	each	6.09	11.00	1	0.00	Very Poor
GENESIS,NP38-12R	3	each	6.09	12.00	3	0.00	Very Poor
GENESIS,UNKNOWN	4	each	6.09	3.00	0	98.00	Very Good
KUNGLONGBATTERY,12SB20C	2	each	6.09	8.00	2	0.00	Very Poor
M+HPOWER,410MHP153	12	each	40.00	21.00	0	89.00	Good
M+HPOWER,N/A	1	each	40.00	37.00	1	0.00	Very Poor
M+HPOWER,PE1669	1	each	40.00	24.00	0	77.00	Good
M+HPOWER,PE1694	14	each	40.00	22.00	0	83.07	Good
M+HPOWER,UNKNOWN	1	each	40.00	25.00	0	71.00	Good
N/A,A400/20Ah	3	each	6.09	7.00	3	0.00	Very Poor
N/A,CXCR24-400	1	each	40.00	3.00	0	100.00	Very Good
N/A,N/A	186	each	22.00	13.00	56	71.84	Fair
N/A,OTHER	3	each	6.09	10.00	3	0.00	Very Poor
N/A,PN:ACTEW32-10	1	each	40.00	23.00	0	82.00	Good
N/A,UNKNOWN	25	each	6.09	12.00	22	11.76	Very Poor
NIFE,58M56-3	1	each	24.00	33.00	1	0.00	Very Poor
Total	**444**	**each**	**22.03**	**17.26**	**128**	**51.85**	**Fair**

FIGURE 11. ASSET AGE PROFILE CHART (AS AT JULY 2022) – AUXILIARY DC SYSTEMS (DISTRIBUTION)



4.2.4 Current Condition and Performance

Lead Acid Batteries

Lead acid batteries are predominately found within the Distribution network due to their lower initial cost and less frequent maintenance requirements. While a large subset of these batteries is reaching end of expected service life, there are no current performance issues being experienced. This is largely due to Canberra's favourable geography (inland) and climate conditions that lead to less battery degradation over time.

NiCad Batteries

NiCad (Nickel-Cadmium) batteries are predominately found within Evoenergy's zone substations. They have approximately twice the expected service life of lead acid batteries yet require more frequent maintenance activities. While a subset of these batteries are reaching end of expected service life, there are no current performance issues being experienced. This is largely due to Canberra's favourable geography (inland) and climate conditions that lead to less battery degradation over time, and management of environmental conditions by housing the batteries indoors.

Battery Chargers

There are currently no performance or condition issues present within the battery charger asset population.

4.2.5 Risks and Opportunities

Risk of Failure

The most significant element of risk is the reliability consequence associated with a battery bank failing. However, the outcome of this would likely not be severe as the batteries are a backup auxiliary supply system. In addition, on-site zone generators provide a second level of redundancy for auxiliary supply.

The successful operation of the protection systems that rely on this supply are critical, therefore all new zone substations (and replacements) are equipped with double-bank battery systems. This further reduces the risk associated with battery failure.

Enhanced Battery Inspection Opportunities

Modern battery chargers with the ability to monitor battery condition and perform new testing techniques provide the ability of in-built condition monitoring, giving the opportunity for further investigation into the capability of new chargers and their ability to discharge and assess individual battery conditions. This functionality would also send the condition score via SCADA.

New testing techniques have proven to provide information previously unavailable, with the addition of battery internal impedance results obtained during site inspections and testing. Internal ohmic values (AC resistance) can be useful as a trending tool and can help to indicate the overall health of a battery being measured. This AC resistance can be measured by injecting a small AC current into the battery and calculating any variations using Ohm's law. Lower internal resistance generally indicates higher capacity, so an increase in internal resistance over time can indicate declining battery capacity. Measuring the trend over time will indicate which cells are weakest, or abnormal. It is important to note that internal resistance varies between different batteries and battery manufacturers.

With battery asset management, there is an opportunity to optimise maintenance programs, both in the way tasks are performed during maintenance and with the frequency of maintenance.

In summary, the maintenance practices differentiate the strategic approach for lead acid and NiCad batteries. In particular, AS2676-1 is applicable for NiCad and AS2676-2 for lead acid batteries with the following approach:

- Implement monthly checks for vented batteries within zones (low quantity)
- Implement 4-yearly full-discharge performance testing for NiCad batteries across zones (high quantity), and distribution (low to no quantity).

Enhanced Distribution Network Monitoring and Control

As new technologies for remote monitoring and operating are made available there will be a likely increase in the need for battery backup not previously seen in the Evoenergy network. With equipment such as IntelliRupters, fault passage indicators, power quality meters, and remotely operated switching devices, planned strategies for maintenance and replacement of the batteries contained will need to be considered. Battery replacement CAPEX and maintenance budgets for both zone substation and distribution batteries have been identified in the EN24 program.

4.2.6 Planned Projects, Replacements and Retirements

A DC supply is an integral part of distribution chamber substation designs. Therefore, all new chamber substations have batteries and chargers. Approximately 10-12 new substations are commissioned every year.

Zone substation batteries are augmented from single to dual batteries to comply with the NER rules. The zone substation duplicate battery charger upgrade involves a planned replacement of the existing single 110V DC battery bank with dual 110V DC battery bank and charging system. This will modernise the system and improve the resilience of DC supplies within zone substations. There are currently five dual-bank battery replacement projects budgeted for within the EN24 regulatory submission. In addition, four sets of batteries and battery chargers have been found to be in poor condition and will require replacement.

The distribution batteries are replaced based on maintenance and condition reports as per AS 2676.

Based on age and failures, it is envisaged that we will replace on an average 15 distribution batteries per year to the tune of 75 batteries in the EN24-29 regulatory period.

4.2.7 Asset Management Strategy

The updated Australian Standards for "Installation, maintenance, testing and replacement of secondary batteries in buildings" (2020) differentiates maintenance practices between sealed and non-sealed (vented) battery types. Evoenergy typically utilises both of these battery types across zones and distribution. Nickel cadmium and lead acid batteries can be of either type, and similarly are both used across Evoenergy's network. Generally speaking, zones are predominately NiCad and distribution is predominately lead acid.

As per AS 2676 (2022) distribution and zone batteries are inspected quarterly and ‘performance’ tested annually (discharge test), with NiCad batteries being further subject to a deep cycle (full discharge) test every 4 years.

4.3. PROTECTION SYSTEMS (ZONE SUBSTATION) STRATEGY

The primary function of protection systems is to limit damage to power system apparatus and to protect the community. Whether the fault or abnormal condition exposes the equipment to excessive voltages or excessive currents, shorter fault times will limit the amount of stress or damage that occurs. Protection devices monitor critical system parameters, detect abnormality, and initiate isolation of electrical network elements under pre-defined fault conditions. The successful operation of protection schemes is a crucial element in ensuring community safety, the safety of Evoenergy personnel, and the integrity of equipment.

Evoenergy’s zone protection assets have traditionally incorporated electromechanical feeder protection and early-generation static relays for zone transformers, busbars, lines, and other 11kV feeder protection.

Newer-generation numerical protection devices are being introduced into the network. These devices are classified as multifunction IEDs. In addition to incorporating the required protection functions, IEDs also provide control, interlocks (safety), metering, alarm, and monitoring functions.

This asset class includes:

- Zone 11kV Feeder Protection
- Zone 132kV Busbar Protection
- Zone 132kV Transmission Line Protection
- Zone Voltage Regulation Device
- Circuit Breaker Fail Protection
- Alarms and Metering
- Zone 132kV Power Transformer Protection
- Underfrequency Load Shedding Protection.

4.3.1 Asset Class Summary and Objectives

Zone substation protection assets are located in Evoenergy zone substations and are used to detect and isolate faulty electrical equipment within the substations and detect and isolate faults which occur on any connected transmission lines or distribution feeders. The protection systems ensure reliable operation of the network by isolating faulty sections of the network and ensure the safety of our staff and the community. The correct operation of the protection systems limits the impact of faults on system stability and any potential damage to network infrastructure.

4.3.2 Asset Types

A variety of asset types exist within this group. These are briefly introduced in this section.

4.3.2.1 Zone 132kV Transmission Line Protection

The following protection functions are considered necessary to protect 132kV transmission line assets:

- Line Distance Protection – These devices are traditional 132kV transmission line distance protection schemes. Distance protections operate on impedance principles, on the basis that impedance is a means of identifying distance to the point of fault on the transmission line. On the 132kV network, this type of protection has difficulty in meeting current NER fault clearance time performance standards.
- Line Differential Protection – Line differential protections operate as a unit protection, and measure difference of currents between the two ends of the line. This function disconnects the circuit only for faults which occur within the protected section of transmission line. This type of protection operates faster and meets current NER performance standards. This is the preferred protection scheme for 132kV line augmentation projects and asset replacement.

- Back-up Overcurrent Protection – Back-up overcurrent protection for transmission lines comes into effect when the Voltage Transformer (VT) supply fails and the line distance protection is out of service. Under VT fail condition, back-up overcurrent protection provides back-up protection for any transmission line faults.

4.3.2.2 Zone 132kV Busbar Protection

The following protection functions are considered necessary to protect 132kV substation and switching station buses:

- High Impedance Busbar Protection – These devices provide 132kV zone busbar protection. The high impedance busbar protection operates as a unit protection for faults involving the 132kV bus. For faults external to the protected section, a high impedance circuit in the differential circuit prevents any maloperation.
- Bus Section breaker back-up Overcurrent Protection – In the event of failure of bus protection to trip or circuit breaker failure, the bus section overcurrent protection provides back-up protection to the bus section breaker.

4.3.2.3 Zone 132kV Power Transformer Protection

The following protection functions are considered necessary to protect 132/11kV zone substation transformers:

- Transformer Differential Protection – Transformer differential protections provide rapid unit protection for faults occurring within the HV and LV windings and terminals, based on differential current.
- Transformer Restricted Earth Fault Protection – Restricted earth fault protections provide rapid unit protection for sensitive earth faults that occur within the transformer windings, based on differential current.
- Transformer HV back-up Overcurrent Protection – HV back-up protections are three phase overcurrent protections that provide back-up protection to the main transformer differential protection for faults in HV bushings.
- Transformer Neutral Earth Fault Protection – Neutral earth fault protections are single phase overcurrent protections energised by neutral Current Transformers (CTs) that provide back-up protection to the main transformer restricted earth fault protection.
- Transformer Sensitive Earth Fault Protection for Alarms – Sensitive earth fault protections for alarms are single phase overcurrent protections energised by neutral CTs that provide alarms for high resistive earth faults occurring in the 11kV system.
- Transformer Voltage Regulation Relay – Voltage regulation relay devices are used to regulate transformer voltage and prevent either escalation of voltages to harmful levels or reduction of voltage that would cause damage to appliances.
- Transformer Buchholz Protection – For incipient faults that eventuate from within the transformer windings as a result of dielectric breakdown or partial discharge of the windings, Buchholz protections are provided for the main transformer, earthing and auxiliary transformers.
- Transformer Cooling Circuit Protection – Transformer oil and winding temperature detectors are provided, and operate via a temperature regulated cooling control mechanism.

4.3.2.4 Zone 11kV Feeder Protection

- 11kV Group Overcurrent and Earth Fault Protection – The 11kV group protections provide primary protections to the 11kV incoming cable and the 11kV switchgear bus to which 11kV outgoing feeders are connected. The group protections back-up the outgoing feeder overcurrent and earth fault protections.
- Feeder Overcurrent Protection – Three phase inverse time overcurrent protections are provided to mitigate single and multiphase short circuits that occur on overhead lines or underground cables.
- Feeder Earth Fault Protection – Single phase earth fault protection based on inverse characteristics provides expedited fault clearance for faults involving ground, to prevent earth potential rise and damage to assets.

- Sensitive Earth Fault Protection – Vegetation faults involving conductor and ground result in high resistance and low fault current that are generally not picked up by normal earth fault protections. Sensitive earth fault protection provides mitigation against such faults.
- Translay Feeder Protection – Translay unit differential protections based on differential current sensing are provided between zone and distribution substation where a sufficient grading margin between inverse time overcurrent protections cannot be achieved.

4.3.2.5 Underfrequency Load Shedding Protection

Suitably graded load shedding schemes based on underfrequency are installed in zone substations to shed loads in accordance with AEMO and TransGrid's strategic requirement as a response to a major system disturbance adversely affecting the frequency response of the power system.

4.3.2.6 Zone Voltage Regulation Device

Voltage regulation relay devices are used to regulate transformer voltage and prevent either escalation of voltages to harmful levels or reduction of voltage that would cause damage to appliances.

4.3.2.7 Circuit Breaker Fail Protection

The circuit breaker fail protection trips adjoining circuit breaker to disconnect fault source in the event of a mechanical failure with the breaker mechanism. In older assets, this protection is a timer or a combination of an overcurrent relay and a timer. In newer multifunction numerical protection, this function is included as a built-in feature.

4.3.2.8 Alarms and Metering

The alarm and metering panel provides status indication of all the events that occurred in the system. In newer assets, this function is performed by the SCADA automation system. This system provides information to System Control of any abnormalities that would have occurred in the network.

4.3.3 Current Population, Age, and Health Profile

Table 6 provides information about the quantities and health of the zone substation protection system group of assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

From the table, the circuit breaker fail protection, transformer protection, zone AC protection and zone metering protection are in poor health condition. The zone metering and zone AC supervision are being replaced as a part of the larger digital substation strategy. The circuit breaker fail protection in poor condition reside in the zone transformer and the 11kV feeder protection relays.

From Appendix A – for various substation sites, we have identified the zone 11kV feeder protection ABB type SPAJ140C as the asset in very poor health condition. On average, at least 7 assets of this family of relays fail every year. This protection has on average exceeded its useful design life and has been targeted for replacement in this regulatory period at various zone substations. The details of the replacement program for individual sites have been identified in Appendix A – Substation Asset Health Tables.

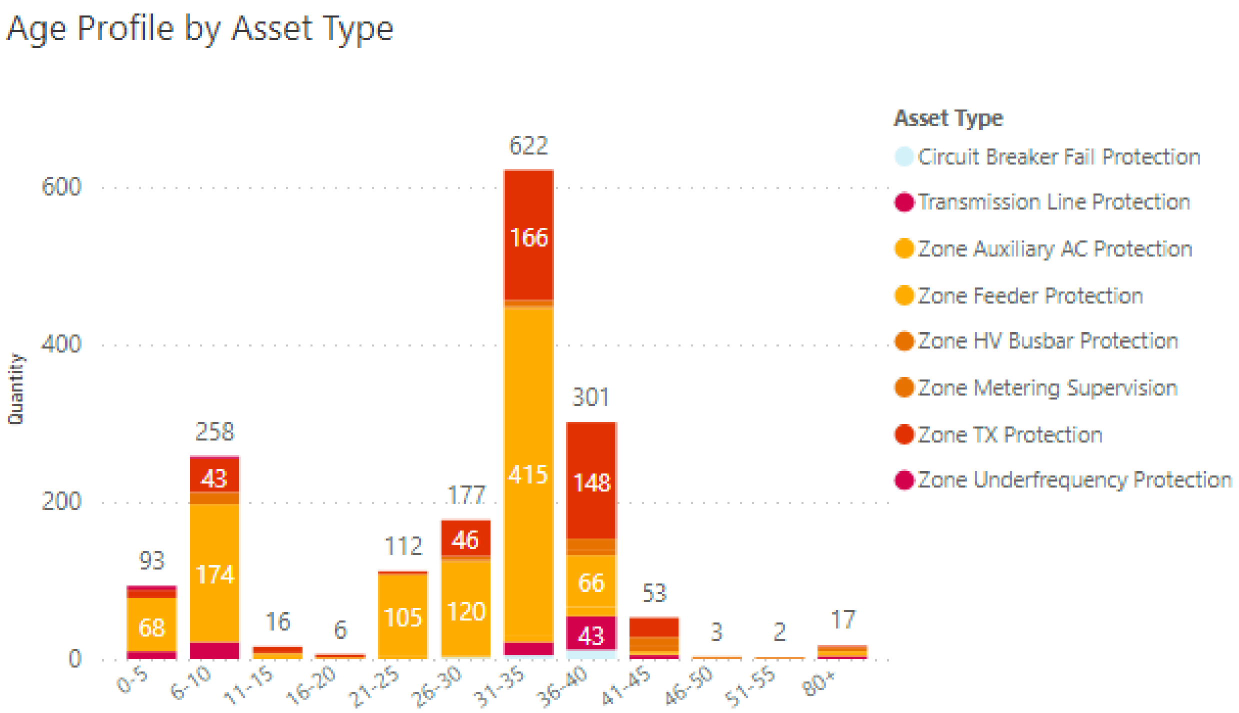
The ABB static transformer differential relay type RADSB has had known failures at two of our zone substations. This asset has exceeded its useful design life by two years on average. This protection has been identified for replacement at a number of zone substations. The details of the replacement program have been identified in Appendix A – Substation Asset Health Tables.

TABLE 6. ASSET POPULATION, AGE, AND HEALTH PROFILE – ZONE SUBSTATION PROTECTION

Asset Specific Plan	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
Protection Systems	1,660	each	30	28	868	38.65	Fair
Circuit Breaker Fail Protection	19	each	30	34	19	2.42	Very Poor
Transmission Line Protection	101	each	28	30	57	37.97	Poor
Zone Auxiliary AC Protection	33	each	28	31	24	23.73	Very Poor
Zone Feeder Protection	961	each	27	26	485	40.79	Fair
Zone HV Busbar Protection	44	each	33	39	17	49.89	Fair
Zone Metering Supervision	38	each	39	37	37	5.66	Very Poor
Zone TX Protection	456	each	34	31	229	37.46	Poor
Zone Underfrequency Protection	8	each	20	6	0	99.88	Very Good

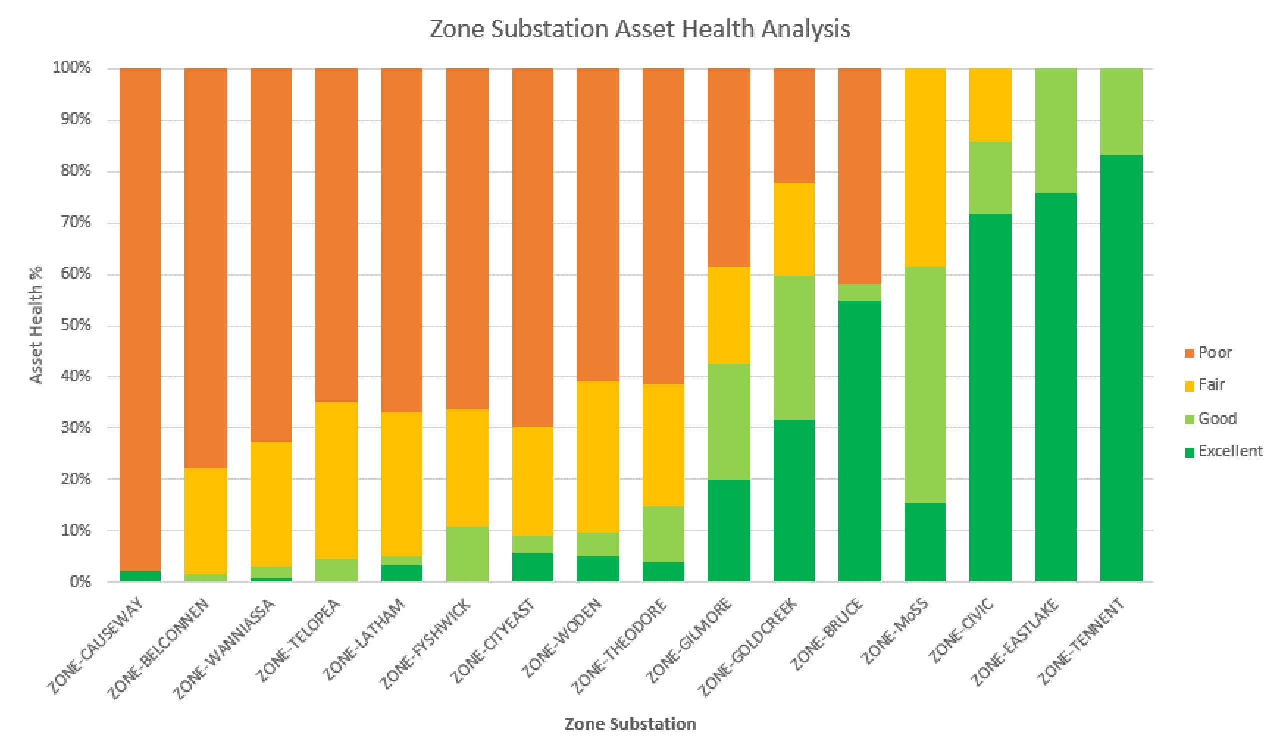
The age profile of existing assets is reflected in Figure 12.

FIGURE 12. ASSET AGE PROFILE CHART (AS AT JULY 2022) – ZONE SUBSTATION PROTECTION



The asset class health profile is summarised in Figure 13. It shows the protection relay asset health summary for each zone substation, with the percentage of Poor, Fair, Good, and Excellent protection relays.

FIGURE 13. ASSET HEALTH PROFILE (AS AT JULY 2022) – ZONE SUBSTATION PROTECTION



4.3.4 Risks and Opportunities

The asset replacement strategy for the five-year period 2024-29 targets replacement of zone feeder and transformer protection relays. Risk factors affecting these relays include known failures, obsolescence, and lack of support. From this analysis, projects to target the poorest health highest risk assets for each substation are proposed for the five-year program.

Accordingly, for feeder protection, City East Zone Substation (ZSS), Woden ZSS and Theodore ZSS have been earmarked for complete feeder bay protection replacement to replace failing ABB relays type SPAJ140C.

For transformer protection, City East ZSS, Gilmore ZSS, Gold Creek, Telopea ZSS, Wanniassa and Latham ZSS have been identified to replace failing and defective ABB transformer differential relay type RADSB.

The strategic approach to the proposed replacement program will be on a systems delivery approach based on digital substation deployment using the IEC 61850 engineering tool as suggested in Section 3.1.

4.3.5 Planned Projects, Replacements and Retirements

Based on the risk rating of assets, individual zone substation projects have been accorded priority risk rating as a method for prioritising project delivery in accordance with the Secondary Systems project delivery framework with strategic alignment to realising a digital substation footprint. Detailed asset health analysis for the relays at each substation and details of the proposed projects are provided in Appendix A – Substation Asset Health Tables.

Accordingly, the following projects define the program of work to replace the high-risk feeder and transformer protection assets:

- City East ZSS 11kV feeder and transformer protection upgrade – 2024-26
- Gilmore ZSS 132kV transformer protection replacement – 2027-28
- Gold Creek ZSS 132 kV transformer protection replacement – 2028-29
- Telopea Park ZSS 132kV transformer protection replacement – 2024-25
- Theodore ZSS 11kV feeder and transformer protection upgrade – 2028-29

- Woden ZSS 11kV feeder protection upgrade – 2026-27
- Latham ZSS 132kV transformer protection replacement – 2027-28
- Wanniassa ZSS 132kV transformer protection replacement – 2028-29.

4.3.6 Asset Management Strategy

Based on the risk management approach adopted to deliver a viable secondary zone protection asset management plan, Evoenergy has chosen to maintain the current risk profile, as presented in Figure 1. This is considered the most viable strategic approach that would provide the following benefits:

- Cost optimisation of OPEX and CAPEX
- Management of asset profile risk and improved future health condition
- Condition monitoring of primary and secondary assets
- Compliance with the NER and the Australian Energy Regulator's (AER) strategic objectives.

While increasing investment to reduce the risk profile appears attractive, the very large step change in the asset replacement program would be difficult to deliver from a resourcing and coordination perspective.

The maintenance strategy is based on the following approach that seeks alignment with the primary equipment condition monitoring program:

- IEC 61850 protection relay maintenance
  - Every eight (8) years along with the primary equipment:
    - Operational check on the protection operation and trip contact.
- Numerical protection relay maintenance
  - Every four (4) years along with the primary equipment:
    - Operational check on the protection operation and trip contact
    - Operational check of circuit breaker failure and intertripping schemes
    - Checking of measurement accuracy of analogue values.
- Static protection relay maintenance
  - Every four (4) years along with the primary equipment:
    - Operational check on the protection operation and trip contact
  - Every eight (8) years along with the primary equipment:
    - Detailed test maintenance/calibration to ensure that the protection is fit for purpose.
- Electromechanical protection relay maintenance
  - Every four (4) years along with the primary equipment:
    - Operational check on the protection operation and trip contact
  - Every eight (8) years along with the primary equipment:
    - Detailed test maintenance/calibration to ensure that the protection is fit for purpose.

4.4. PROTECTION SYSTEMS (DISTRIBUTION) STRATEGY

The protection systems asset class protects distribution assets and includes:

- Distribution 11kV switching station protection
- Distribution 11kV 1,500kVA chamber substation protection
- Distribution11kV 1,500kVA padmount substation protection
- Distribution 11kV <1,000kVA substation protection

- Distribution 22/3.75kV pump station protection.

4.4.1 Asset Class Summary and Objectives

The primary function of protection systems is to limit damage to power system apparatus and to protect the community. Whether the fault or abnormal condition exposes the equipment to excessive voltages or excessive currents, shorter fault times will limit the amount of stress or damage that occurs. Protection devices monitor critical system parameters, detect abnormality and initiate isolation of electrical network elements under pre-defined fault conditions. The successful operation of protection schemes is a crucial element in ensuring community safety, the safety of Evoenergy personnel, and the integrity of equipment.

4.4.2 Asset Types

Evoenergy's distribution protection assets have traditionally incorporated electromechanical feeder protection and early generation static relays for distribution transformers, busbars, lines and other 11kV feeder protection.

Newer generation numerical protection devices have started to be introduced over the last five years. These devices are classified as multifunction IEDs. In addition to incorporating the required protection functions, IEDs also provide control, interlocks (safety), metering, alarm, and monitoring functions.

The functions of assets in this asset class are described in the following sub-sections.

4.4.2.1 Distribution 11kV Switching Station Protection

These assets protect Evoenergy's 11kV switching station assets.

a) 11 kV Busbar Protection

These devices provide 11kV distribution busbar protection. The low impedance busbar protection operates as a unit protection for faults involving the 11kV bus. For faults external to the protected section, a high impedance circuit in the differential circuit prevents any maloperation.

b) Incoming Zone Feeder Translay Protection

Translay devices operate as unit protection, and measure difference of currents between the two ends of the line. This function disconnects the circuit only for faults which occur within the protected section of the 11kV feeder. This protection is provided for critical short distance incoming feeders from the zone where overcurrent protections do not operate.

c) Overcurrent and Earth Protection

Overcurrent and earth fault protections are the primary protection mechanism against short circuits for incoming and outgoing feeders. Where translays are provided, overcurrent and earth fault protection mechanisms act as backups.

4.4.2.2 Distribution 11kV 1,500kVA Chamber Substation Protection

These assets protect Evoenergy's 1,500kVA, 11kV chamber substation assets.

a) Incoming Feeder Protection

Overcurrent and earth fault protections are the primary protection mechanism against short circuits for incoming and outgoing feeders. Where translays are provided, overcurrent and earth fault protection mechanisms act as backups.

b) Transformer Protection

The following types of transformer protections are commonly used for indoor chamber substations:

- Transformer HV Backup Overcurrent Protection – Backup protection to the main transformer for faults in HV bushings is provided by three phase overcurrent devices.
- Transformer Neutral Earth Fault Protection – Neutral earth fault protections are single phase overcurrent protections energised by neutral CTs that provide back-up protection to the main transformer restricted earth fault protection.

- Transformer Voltage Regulation Relay – Voltage regulation relay devices are used to regulate transformer voltage and prevent either escalation of voltages to harmful levels or reduction of voltage that would cause damage to appliances.

In exceptional circumstances of parallel transformer operation, the following additional protections are provided for selective discrimination:

- Transformer Differential Protection – Transformer differential protections provide rapid unit protection for faults occurring within the HV and LV windings and terminals, based on differential current.
- Transformer Restricted Earth Fault Protection – Restricted earth fault protections provide rapid unit protection for sensitive earth faults that occur within the transformer windings, based on differential current.

c) Flop Over Relays

HV and LV AC flop over relays based on undervoltage are provided on critical chamber substations that are configured with a bus section to transfer loads when voltage supply is lost to one side of the bus section breaker.

d) Outgoing LV Feeder Protection

The outgoing LV feeders are protected by a circuit breaker with integrated protection. This item is covered under the Ground Assets Portfolio Strategy.

4.4.2.3 Distribution 11kV 1,500kVA Padmount Substation Protection

The following assets provide protection for 1,500kVA padmount substations.

a) Incoming Feeder Protection

The primary protection mechanism for incoming feeders is overcurrent and earth fault protection.

b) Transformer Protection

The following types of transformer protections are commonly used in indoor chamber substations:

- Transformer HV Backup Overcurrent Protection – Three phase overcurrent protection provide back-up protection to the main transformer differential protection for faults in HV bushings.
- Transformer Neutral Earth Fault Protection – Neutral earth fault protection systems are single phase overcurrent protections that are energised by neutral CTs and provide back-up protection to the main transformer.
- Transformer Voltage Regulation Relay – Voltage regulation relay devices are used to regulate transformer voltage and prevent either escalation of voltages to harmful levels or reduction of voltage that would cause damage to appliances.

c) Outgoing LV Feeder Protection

The outgoing LV feeders are protected by the Merlin Gerin circuit breaker. This item is covered under a separate ASP for LV switchboards.

4.4.2.4 Distribution 11kV <1,000kVA Substation Protection

The following protection functions are considered necessary to protect 1,000kVA chamber and padmount substations:

a) Incoming HV Fuse

A HV fuse is present on the incomer to provide short circuit protection.

b) Outgoing LV Feeder Protection

The outgoing LV feeders are protected by a Merlin Gerin circuit breaker.

4.4.2.5 Distribution 22/3.75kV Pump Station Protection

Some of the 22/3.75kV pump station distribution substations incorporate the following protection devices:

a) Transformer Neutral Earth Fault Protection

Neutral earth fault protections are single phase overcurrent protections energised by neutral CTs that provide earth fault protection to the main 22/3.75kV transformer.

b) Transformer Multifunction Overcurrent Earth Fault Protection

This protection provides mitigation against phase and earth faults on the HV and LV side windings and bushings.

c) Transformer Buchholz Protection

For incipient faults that eventuate from within the transformer windings because of dielectric breakdown or partial discharge of the windings, Buchholz protections are provided for the main transformer, earthing and auxiliary transformers.

d) Transformer Cooling Circuit Protection

Transformer winding temperature detectors are provided and operate via a temperature regulated cooling control mechanism.

4.4.3 Current Population, Age, and Health Profile

The asset age profile shows there are a large number of assets beyond the expected life of 30 years. In the next regulatory period increasing numbers of assets will reach end of life condition and will require replacement.

Table 7 offers a high-level count of distribution protection system assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

The distribution transformer protection has 90 assets which are in poor health condition. Most of these protections are the old legacy GEC-CDG type of relays and the old legacy ASEA RI type of relays.

The old ASEA RI and the GEC CDG electromechanical relays account for 49 such assets in the network and are close to exceeding their useful design life of 40 years.

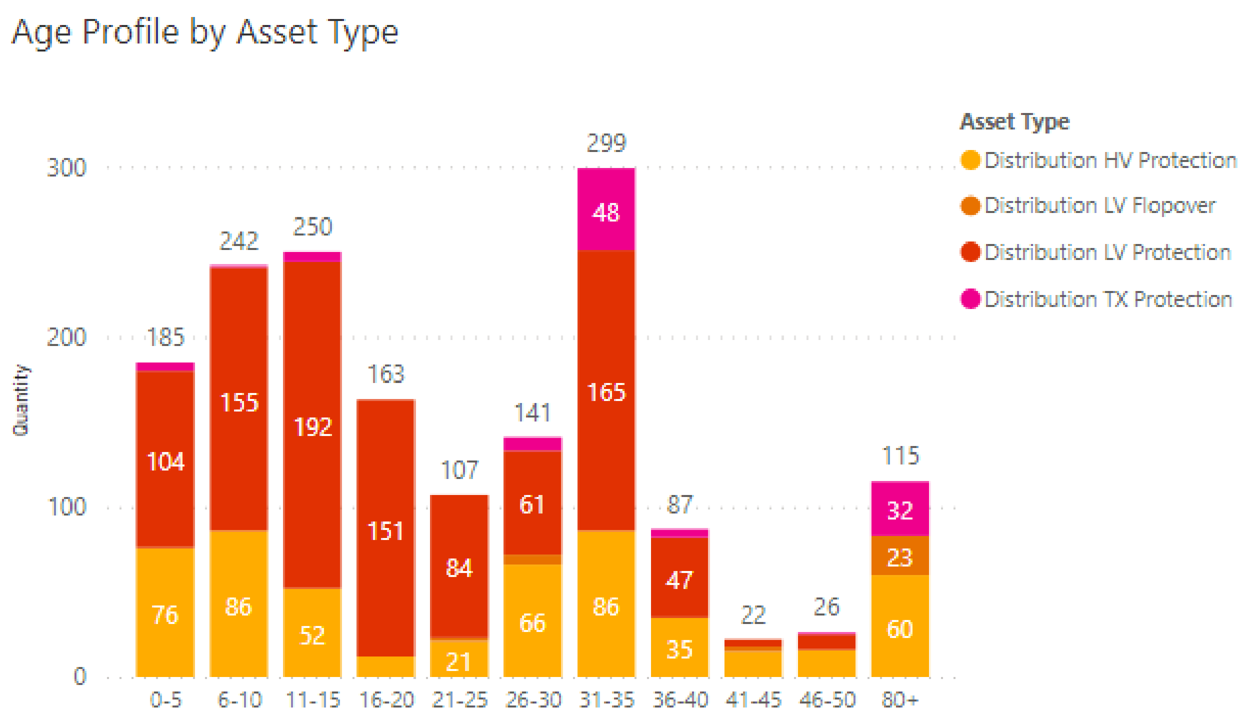
Both these assets have failed in recent times with no manufacturer support and replacement spare parts available. This program targets about 75 such assets around the network for proactive replacement.

TABLE 7. ASSET POPULATION, AGE, AND HEALTH PROFILES – DISTRIBUTION PROTECTION

Asset Specific Plan	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
⊟ **Protection Systems**	1,637	each	30	27	617	58.09	Fair
Distribution HV Protection	525	each	28	33	242	50.39	Fair
Distribution LV Flopover	34	each	30	93	32	8.59	Very Poor
Distribution LV Protection	972	each	31	19	253	68.95	Good
Distribution TX Protection	106	each	37	58	90	12.45	Very Poor

The age profile of existing assets is reflected in Figure 14.

FIGURE 14. ASSET AGE PROFILE CHART (AS AT JULY 2022) – DISTRIBUTION PROTECTION



The vast majority of distribution protection assets are in good or excellent condition. However, given the importance of these assets, those that have been identified with poorer condition ratings should be addressed. The following assets are approaching end of life conditions which should be managed by the preferred asset class strategy:

- Ageing Translay protections
- Ageing distribution protections of old electromechanical type ASEA RI and GEC CDG protections where calibration is steadily being lost or trip contacts are malfunctioning.

4.4.4 Risks and Opportunities

A risk condition-based costing approach has been adopted to determine the optimal recommendation for capital replacement projects and maintenance strategy.

Distribution substation Translay protections from zones will be considered for capital replacement program with a fit for purpose numerical protection. This will account for replacement of copper pilots with optic fibre to facilitate unit line differential protection.

This replacement program will align with the zone feeder protection replacement program.

4.4.5 Planned Projects, Replacements and Retirements

City East zone substation identified for feeder protection replacement comprises of one (1) Translay feeder protection. It is proposed that the corresponding distribution substation Translay be replaced along with the replacement of the pilot cable with optic fibre.

It is envisaged that about 50 older electromechanical and static distribution relays are proposed to be replaced in this upcoming EN24-29 regulatory period.

4.4.6 Asset Management Strategy

Based on the risk management approach adopted to deliver a viable secondary zone protection asset management plan, Evoenergy has chosen to maintain the current risk profile. This is considered the most viable strategic approach that would provide the following benefits:

- Cost optimisation of OPEX and CAPEX
- Management of asset profile risk and improved future health condition
- Condition monitoring of primary and secondary assets
- Compliance with the NER and AER's strategic objectives.

While increasing investment to reduce the risk profile appears attractive, the very large step change in the asset replacement program would be difficult to deliver from a resourcing and coordination perspective.

The maintenance strategy is based on the following approach that seeks alignment with the primary equipment condition monitoring program:

- Numerical protection relay maintenance
  - Every five (5) years along with the primary equipment
    - Operational check on the protection operation and trip contact
    - Operational check of circuit breaker failure and intertripping schemes
    - Checking of measurement accuracy of analogue values
- Static protection relay maintenance
  - Every five (5) years along with the primary equipment
    - Operational check on the protection operation and trip contact
  - Every eight (8) years along with the primary equipment
    - Detailed test maintenance/calibration to ensure that the protection is fit for purpose
- Electromechanical protection relay maintenance
  - Every five (5) years along with the primary equipment
    - Operational check on the protection operation and trip contact
  - Every eight (8) years along with the primary equipment
    - Detailed test maintenance/calibration to ensure that the protection is fit for purpose

4.5. SCADA SYSTEMS STRATEGY

4.5.1 Asset Class Summary and Objectives

SCADA assets provide real-time and historical information for the effective operation and monitoring of the electrical network. SCADA is a key component of the overall electricity network management system.

The SCADA systems asset reporting group is categorised into the following asset groups:

- Remote Terminal Unit (RTU)
- Human Machine Interface (HMI)
- GPS Clock
- Station Controller
- Bay Controller
- Online Condition Monitoring Sensor
- Network Analyser.

The objective of SCADA asset management is to ensure asset maintenance and asset replacement maintains risk exposure at an acceptable and manageable level, whilst at the same time meeting the requirement for greater SCADA penetration into the distribution network. The decisions on the upgrade and extension of the SCADA assets need to be based on balancing the investments against the maintenance costs and the level of risk accepted by the organisation in providing a stable and sustainable electricity supply to its customers.

4.5.2 Asset Types

4.5.2.1 Remote Terminal Unit

The function of the RTU is to provide monitoring and control of electrical network assets within electrical substations. Substation RTUs are connected to Evoenergy's ADMS system through the SCADA communications network providing centralised monitoring and control across Evoenergy's network.

Evoenergy has RTUs installed both within Zone Substations and Distribution Substations.

a) Zone Substation RTUs

All Zone Substations and Zone Switching Stations in Evoenergy's network have an RTU providing local monitoring and control. Technologies and communications interfaces vary between zones based on the age of the RTU and the associated assets that it interfaces with. Older zones will typically have a higher number of hardwired signals wired directly to the RTU from switchgear bays. Newer zones utilise protection relays and other IEDs to convert hardwired signals at the local switchgear bay to digital signals which are then interfaced with the RTU through a local substation ethernet network. This generally means a larger set of signals and more information available via SCADA for newer installations as multiple signals can be provided over a single ethernet connection. Evoenergy currently utilises the IEC 61850 protocol as the standard for exchanging SCADA signals between the RTU and IEDs and the DNP3 protocol as the standard for exchanging signals between the RTU and ADMS.

b) Distribution Substation RTUs

RTUs are increasingly being installed within both chamber and padmount distributions substations and switching stations across Evoenergy's network, providing enhanced remote switching capability and monitoring in Evoenergy's distribution network. Similar to zone substations, age and condition of distribution RTUs vary across Evoenergy's network. Older distribution RTUs utilise hard wired signalling for monitoring and control. Newer distribution RTUs typically utilise a mix of hardwiring and SCADA protocol-based signals over a local ethernet network utilising DNP3 or Modbus.

The number of Distribution Substation RTUs has significantly increased over recent years and is expected to continue increasing in future to support key Evoenergy strategies such as the Reliability Strategy, Quality of Supply Strategy and Distribution System Operator Strategy.

4.5.2.2 Human Machine Interface

The function of the substation HMI is to provide a local monitoring and control of the zone substation SCADA and Automation system. The HMI provides views such as single line diagrams, alarm history, communications statistics and analogue measurement summaries to users to allow local monitoring of substation assets and fault diagnosis. The HMI also provides control capability to select users to allow control of substation assets from a safe location within the substation control room and away from the electrical switchgear. Finally, the local HMI is essential redundancy for Evoenergy's central ADMS SCADA control room system and provides local monitoring and control capability should there be a fault in the ADMS system or communications network.

The HMI system consists of computer hardware which runs the HMI system and software, a touch screen monitor and a keyboard and mouse. Evoenergy's older HMI systems are deployed on standalone Microsoft Windows PCs whereas newer systems are integrated within the RTU providing efficiencies in HMI build and deployment. Older HMI system hardware requires replacement as the components age and exceed their design life.

A HMI is present in each of Evoenergy's zone substations and HV switching stations. This screen allows operators to see the status of all assets in the substation. This includes single line diagrams, event history, active alarms, analog measurements, and status of substation communications.

The HMI can be used to carry out local fault analysis, local testing of substation equipment and can be used to control the assets located in the substation. The introduction of the HMI into the zone substations allows for complete local control of the zone substation in disaster events where communications may be lost between the substation and the control room such as a bushfire or a cyber security incident.

In the event of a loss of communications from the control centre, the HMI can be used to control the substation locally under direction from the control centre. This facility ensures that the substations can be controlled and co-ordinated in a major event, such as a bushfire or a cyber security incident, where some communications links may be impacted.

4.5.2.3 GPS Clock

The function of the GPS clocks is to provide accurate synchronised time sources for the critical geographically separate parts of the SCADA network (data centres, zone substations and HV switching stations). This ensures that SCADA servers are synchronised, events and alarms gathered by RTUs and other devices in zone substations are accurately time-stamped, and the sequence of events can be determined for fault conditions.

For Evoenergy’s newer IEC 61850 zone substation systems the GPS clock is critical for ensuring all IEDs within the substation are synchronised to allow local Automation Schemes to operate effectively.

4.5.2.4 Station Controller

The function of the Station Controller is to manage station level protection and automation schemes which apply to multiple bays. This includes schemes such as circuit breaker failure, automated restoration, under frequency load shedding and power measurement calculations. Station Controllers utilise IEC 61850 GOOSE (Generic Object Oriented Substation Event) and SMV (Sampled Measured Values) for communications between bays to implement these schemes.

Two station controllers of separate manufacturers are implemented per 11kV feeder bay to ensure redundancy requirements for protection functions are met.

4.5.2.5 Bay Controller

The function of the Bay Controller is to manage control, status, and automation of a local switchgear bay. This includes control and indication of primary equipment associated to the bay including circuit breakers, isolators and earth switches. Bay Controllers are deployed in conjunction with No1 and No2 protection relays and therefore do not perform protection functions for the bay. Evoenergy currently has Bay Controllers deployed on each 132kV GIS circuit breaker bay at Eastlake zone substation.

4.5.2.6 Online Condition Monitoring Sensor

Condition monitoring sensors provide real-time feedback on the condition of transformers and switchgear.

This asset class includes the following asset groups:

- GIS Condition Monitor – these assets monitor SF6 pressure in switchgear to alert Evoenergy in case of a failure
- Transformer Condition Monitor – these assets allow Evoenergy to monitor the oil health of transformers.

4.5.2.7 Network Analyser

The function of Network Analysers is to provide monitoring of electrical network assets on the LV side of distribution substations, in order to monitor load and manage power quality issues resulting from disruptive technologies such as grid-connected photovoltaics and battery storage.

This asset class includes the following asset groups:

- Power Quality Meter
- LV Transformer Monitor.

4.5.3 Current Population, Age, and Health Profile

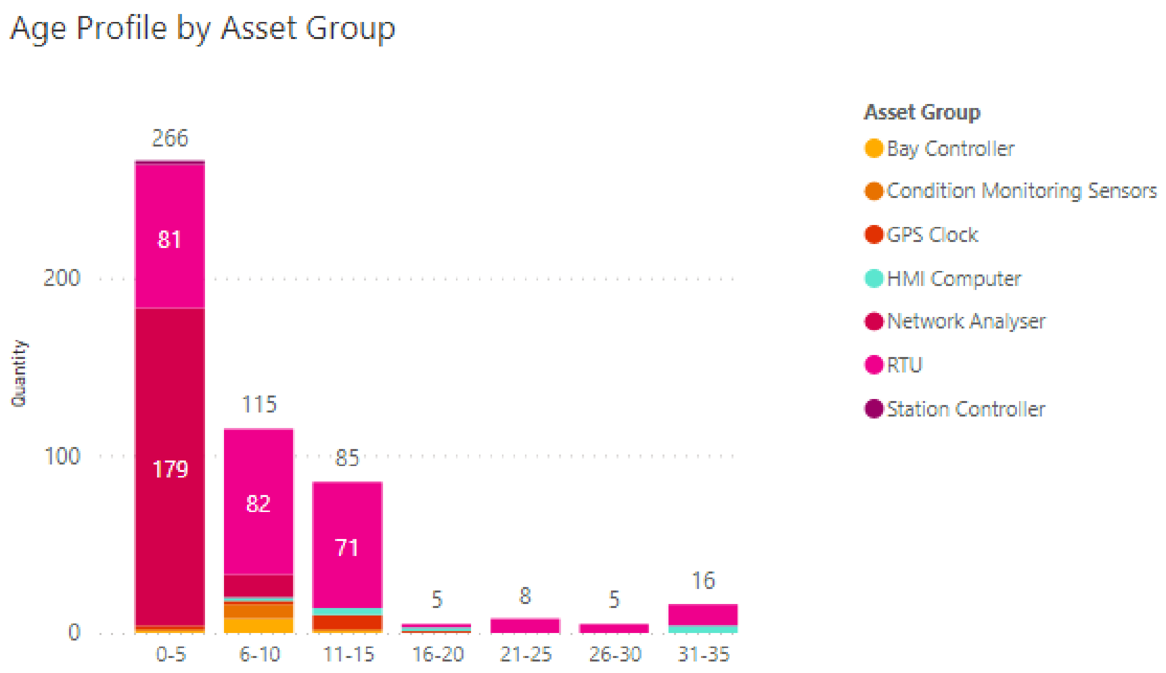
Table 8 offers a high-level count of SCADA system assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

TABLE 8. ASSET POPULATION, AGE, AND HEALTH PROFILE – SCADA SYSTEMS

Asset Group	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
Bay Controller	10	each	15.00	8.00	0	95.60	Very Good
ABB,REC650	10	each	15.00	8.00	0	95.60	Very Good
Condition Monitoring Sensors	10	each	15.00	8.00	0	95.60	Very Good
ABB,MSM	10	each	15.00	8.00	0	95.60	Very Good
GPS Clock	13	each	15.00	7.75	1	82.38	Good
TEKRON,N/A	2	each	15.00	6.00	0	99.00	Very Good
TEKRON,NTS03G	2	each	15.00	2.00	0	100.00	Very Good
TEKRON,TCG-01E	4	each	15.00	11.00	0	86.75	Good
TEKRON,UNKNOWN	5	each	15.00	12.00	1	65.20	Good
HMI Computer	13	each	15.00	46.00	7	40.08	Good
IBM,N/A	2	each	15.00	18.00	2	0.00	Very Poor
LEEDSNORTHRUP,N/A	4	each	15.00	33.00	4	0.00	Very Poor
N/A,N/A	6	each	15.00	10.00	0	86.83	Good
UNKNOWN,UNKNOWN	1	each	15.00	123.00	1	0.00	Very Poor
Network Analyser	196	each	15.00	24.22	4	97.95	Fair
ACCUENERGY,ACC-IIW-D-5A-P2	7	each	15.00	5.00	0	100.00	Very Good
CHK,1APQ45-K1-4G	8	each	15.00	4.00	0	100.00	Very Good
CHK,TXM 302	2	each	15.00	4.00	0	100.00	Very Good
N/A,N/A	4	each	15.00	64.00	2	50.00	Fair
OTS,GEN2	144	each	15.00	4.00	1	99.31	Very Good
PSL,PQUBE	2	each	15.00	7.00	0	99.00	Very Good
PSL,PQUBE3	13	each	15.00	3.00	0	100.00	Very Good
SONEL,PQM-703A	15	each	15.00	4.00	0	100.00	Very Good
UNKNOWN,UNKNOWN	1	each	15.00	123.00	1	0.00	Very Poor
RTU	263	each	15.00	18.29	29	82.99	Good
ABB,540CID01	44	each	15.00	3.00	0	100.00	Very Good
ABB,560CID11	48	each	15.00	6.00	0	99.21	Very Good
ABB,560CMR	2	each	15.00	5.00	0	100.00	Very Good
ABB,COM600	2	each	15.00	3.00	0	100.00	Very Good
ALLENBRADLEY,MICROLOGIX1400	4	each	15.00	11.00	0	86.00	Good
GANTNER,GANTNER	1	each	15.00	7.00	0	99.00	Very Good
GEHARRIS,D25	6	each	15.00	22.00	6	0.00	Very Poor
INVENSYS,SCD5200	97	each	15.00	13.50	5	79.63	Good
LEEDSNORTHRUP,C2025	5	each	15.00	32.00	5	0.00	Very Poor
LEEDSNORTHRUP,C25	2	each	15.00	32.00	2	0.00	Very Poor
LEEDSNORTHRUP,C50	5	each	15.00	25.00	5	0.00	Very Poor
MASCHFABRIKREIN,ECOTPVPDCONTPRO	14	each	15.00	3.00	0	100.00	Very Good
MITS,3311	1	each	15.00	34.00	1	0.00	Very Poor
MITS,MD1000	4	each	15.00	32.00	4	0.00	Very Poor
SCADAPACK,N/A	1	each	15.00	123.00	1	0.00	Very Poor
SCHNEIDER,T300	20	each	15.00	3.00	0	99.95	Very Good
SCHWEITZER,RTAC 3530	6	each	15.00	1.50	0	100.00	Very Good
UNKNOWN,UNKNOWN	1	each	15.00	7.00	0	99.00	Very Good
Station Controller	2	each	15.00	1.00	0	100.00	Very Good
ABB,SSC600	1	each	15.00	1.00	0	100.00	Very Good
SCHWEITZER,SEL3555	1	each	15.00	1.00	0	100.00	Very Good
Total	**507**	**each**	**15.00**	**19.88**	**41**	**88.22**	**Fair**

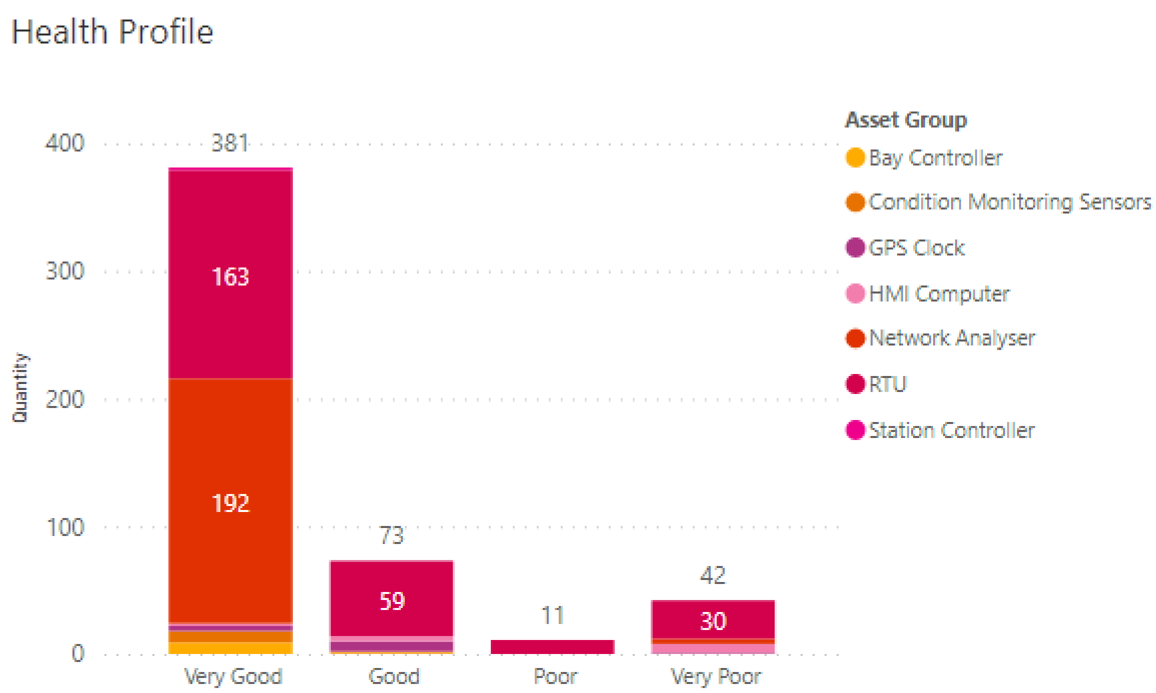
The age profile of this asset class reflects this and is shown in Figure 15.

FIGURE 15. ASSET AGE PROFILE CHART (AS AT JANUARY 2023) – SCADA SYSTEMS



The asset class health profile, as of January 2023, is summarised in Figure 16.

FIGURE 16. ASSET HEALTH PROFILE (AS AT JANUARY 2023) – SCADA SYSTEMS



The current condition of the overall SCADA asset base is generally good. Most assets are in good or very good condition and in the 0-15 years age group. This is primarily due to an accelerated RTU replacement program which Evoenergy undertook in the lead up to the introduction of the new ADMS SCADA system in

2016. This accelerated program was driven by the legacy Conitel2020 SCADA protocol not being supported by Evoenergy's ADMS system.

Evoenergy still has a notable number of assets rated as poor to very poor condition. These assets are generally 20+ years old, installed in older substations and require replacement.

SCADA assets are generally expected to last for at least 15 years prior to performance degradation. Drivers for replacement are generally:

- Unreliable hardware, lower performance, increased numbers of defects, nuisance alarming and higher site attendance requirements for investigation.
- Hardware or software that is no longer supported by the vendor.
- Lack of features that are required in modern deployments.
- Incompatibility with other newer devices installed within the substation, such as 4G modems.
- Older processors and memory are insufficient to handle a larger number of IEDs installed within the substation.
- Absence of required cyber security protection and other modern features.

4.5.4 Risks, Consequences and Mitigations

4.5.4.1 Risks

The key risk associated with the SCADA asset base is the failure of one or more critical SCADA assets and the follow-on consequences of such a failure. Some reasons for the failure of SCADA assets can include:

- Failure of assets due to age or condition
- Failure of assets due to the environment in which they are installed
- Failure of assets with security vulnerabilities in a cyber security incursion (either targeted attack or collateral damage)
- Failure of assets due to errors during implementation and maintenance.

4.5.4.2 Consequences

The key consequences of failed SCADA assets can include:

- Loss of control room monitoring and control of key assets:
    - Increased outage durations during electrical fault restoration activities as switching staff need to carry out operations manually on site rather than remotely.
    - Increased arc flash risks as switching staff are required to carry out operations locally at the switchboard instead of remotely.
    - Reduced efficiencies in carrying out planned and unplanned work due to travel time associated with manually carrying out operations.
    - Reduced alarm visibility and missed critical alarms, resulting in catastrophic failure of assets which could have been prevented if addresses earlier
    - Reduced visibility of the network state, reducing information available to the control room to make key network decisions in real time.
    - Reduced visibility of network loads, resulting in overloading of assets and subsequent asset life reduction or failure
    - Reduced visibility of network voltage, resulting in high or low voltage conditions and associated damage to network and customer equipment.
- Loss of local substation automation schemes:
    - Loss of automated auto reclose functionality at zone substations, resulted in increased outage durations for transient faults.
    - Loss of automated restoration and flopover schemes, resulting in longer outage durations as actions need to be carried out manually.

- Loss of embedded generation monitoring and control:
  - Undesired tripping of the embedded generation system from Evoenergy's network.
  - Unable to disconnect and prevent the generation from operating remotely during emergency conditions.
- Loss of historical load, power quality and asset condition monitoring data:
  - Reduced capability for network planning and optimising augmentation programs at areas of the network reaching thermal limits.
  - Reduced capacity for remote power quality monitoring and proactive action to address emerging power quality issues.
  - Reduced capability for asset health and condition assessment utilising SCADA condition monitoring data, resulting in non-optimal maintenance and replacement programming and failure of assets which could have been prevented if addressed proactively.

4.5.4.3 Mitigations

Some of the mitigation measures Evoenergy currently implements to manage the consequences associated with failed SCADA assets include:

- Targeted asset replacement programs to reduce the frequency and duration of failure:
  - Replacing assets which have reached end of life and have poor condition.
  - Replacing assets which are no longer vendor supported.
  - Replacing assets utilising obsolete technologies.
  - Ensuring adequate spares are available for SCADA devices for unplanned replacement and replacing assets which no longer have adequate spares available.
- Ensuring SCADA assets are installed within the correct environment:
  - Increased SCADA monitoring of site conditions such as the temperature assets are reaching to ensure they are operated within manufacturer specified parameters and action taken where appropriate.
  - Ensuring adequate IP rating protection for SCADA asset enclosures, and controls implemented to protect against elevated temperatures and moisture build up where appropriate.
  - Ensuring adequate vermin protection to protect SCADA assets from failure
- Ensuring cyber security control measures are implemented and regularly reviewed to keep in alignment with best practice:
  - Monitoring vendor cybersecurity vulnerability alerts for SCADA assets and taking appropriate action to resolve such as updating device firmware.
  - Ensuring access to SCADA devices is secure and follows the principle of least privilege access with controlled password access.
  - Implementing configurations within SCADA devices which are in line with best practice and limiting connections, ports, and other communication parameters to only that which is required.
  - Implementing appropriate firewalls and security gateways for any SCADA device interfaces.
  - Implementing intrusion detection for any critical SCADA networks.
- Ensuring SCADA standards, procedures and training are implemented and adequately enforced:
  - Ensuring SCADA staff have the required tools and equipment to carry out work effectively.
  - Ensuring SCADA staff have the necessary training to configure and manage a growing multi-vendor asset base.
  - Ensuring SCADA standards are up to date and followed during design and implementation.
  - Ensuring SCADA procedures are up to date and followed throughout the lifecycle of projects.

4.5.5 Needs, Challenges, and Opportunities

The following needs, challenges and opportunities have been identified for SCADA assets:

- Managing a Rapidly Increasing SCADA Asset Base – An increasing number of sites requiring substation monitoring and control to support Evoenergy's Reliability, Quality of Supply and DSO requirements. This has also resulted in increased effort in managing the asset base, monitoring system health, performing maintenance and resolving defects.
- Accommodating Increasing SCADA Monitoring Business Requirements – An increasing complexity of SCADA implementations and higher numbers of signals required per asset to satisfy Asset Health Condition Monitoring and Reliability Centred Maintenance activities. Required effective management of the increased volume of signals to achieve desired outcomes.
- Transitioning to New SCADA Devices and Technologies – Managing an increasing number of different types of SCADA devices and transitioning to current best practice technologies and systems including IEC 61850.
- Introducing New Automation Schemes – Introducing new automation schemes such as dynamic voltage control, embedded generation dynamic operating envelopes, and fault location/restoration.
- Optimising Legacy SCADA Replacements – Optimising the upgrade of older zone substation and distribution SCADA systems. Coordinating alignment with primary asset and protection system upgrades to improve project efficiencies, provide additional signals and remove requirements for extensive hard wiring.
- Managing Increasing Embedded Generation Penetration – Ensuring SCADA monitoring and control requirements are satisfied in ensure safe operation for synchronous machines, PV, batteries, and other types of embedded generation connected to Evoenergy's network.
- Ensuring Adequate Protection against Cyber Security Risks – Managing cyber security requirements and challenges associated with ensuring SCADA deployments are up to date with industry best practice and any SCADA device vulnerabilities are quickly identified and addressed.

These needs and challenges are explored in the following sub-sections.

4.5.5.1 Managing a Rapidly Increasing SCADA Asset Base

Data and control available through the increase in SCADA assets provides significant benefit in Evoenergy's network operations but also presents the challenge of managing a rapidly increasing asset base going forward. Naturally, with an increasing asset base, the number of issues and defects occurring increases. To help manage this Evoenergy has been refining SCADA standards exploring automated testing methods to improve efficiency and quality in SCADA installation processes to ensure we are able to keep up with network and customer requirements.

A summary of the different type of SCADA enabled sites in Evoenergy's network is provided below.

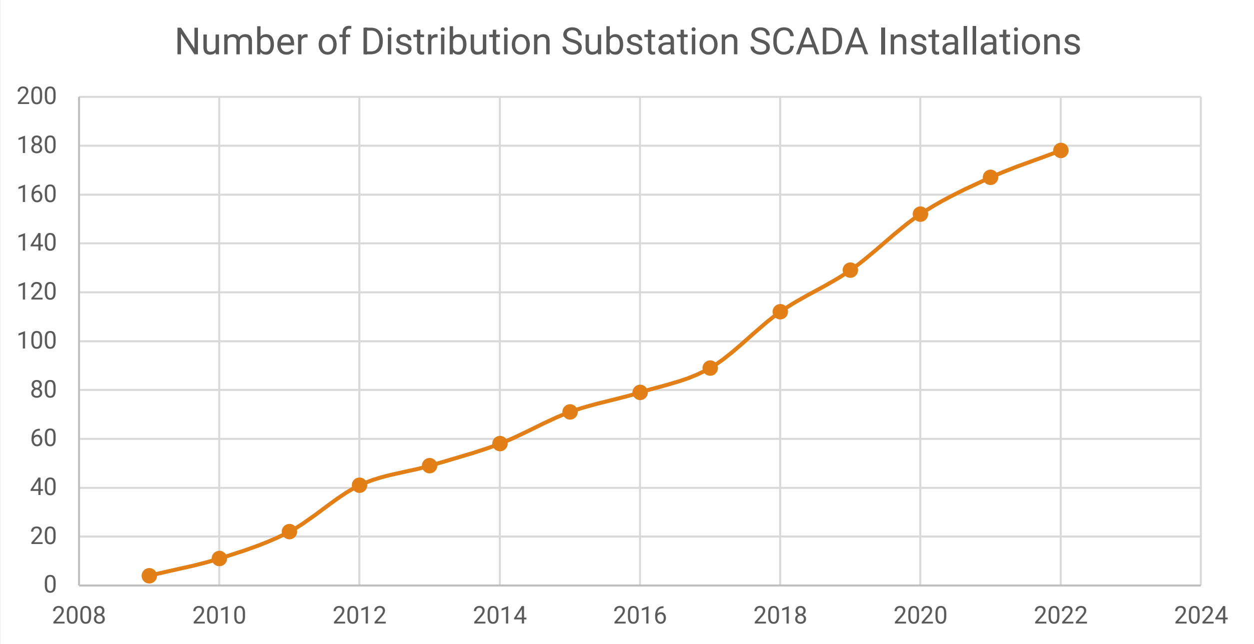
a) Zone Substations

Evoenergy currently has SCADA monitoring and control implemented at all of its 16 zone substations and switching stations. Additional zone substations requiring SCADA are planned at Molonglo, Strathnairn, Mitchell and Curtin zones. Significant primary augmentation works are also planned at Gold Creek which will also require significant SCADA work. Each of these projects will be implemented in alignment with Evoenergy's digital substation strategy utilising the latest IEC 61850 based technologies and equipment and include scope for stations controllers for substation automation.

b) Distribution Substations

Evoenergy currently has 178 SCADA enabled distribution substation and switching station sites. This has been rapidly increasing at a rate of 15-20 sites in recent years driven by strategic business requirements in Evoenergy's Reliability, Quality of Supply and DSO strategies and reduced costs of implementing SCADA associated with newer devices and technologies becoming available in the market. This can be seen in Figure 17.

FIGURE 17. CUMULATIVE NEW AUTOMATED SITES SINCE 2000

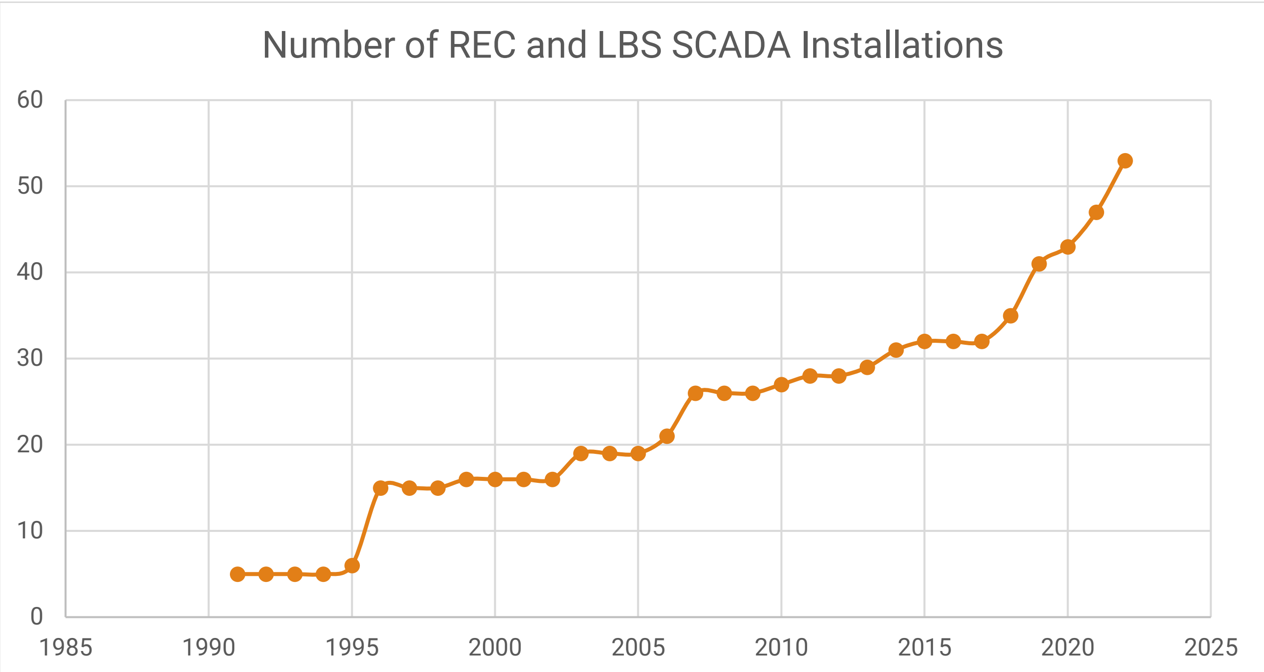


This trend will continue to rapidly increase with all new chamber substations and padmount substations now having at least low voltage SCADA monitoring included in their scope, and some including HV switching and OLTC capabilities.

c) Reclosers and Load Break Switches

Evoenergy currently has SCADA monitoring and control installed on all 45 reclosers and 8 load break switches. This has significantly increased in recent years due to the implementation of a number of network reliability projects, as shown in Figure 18.

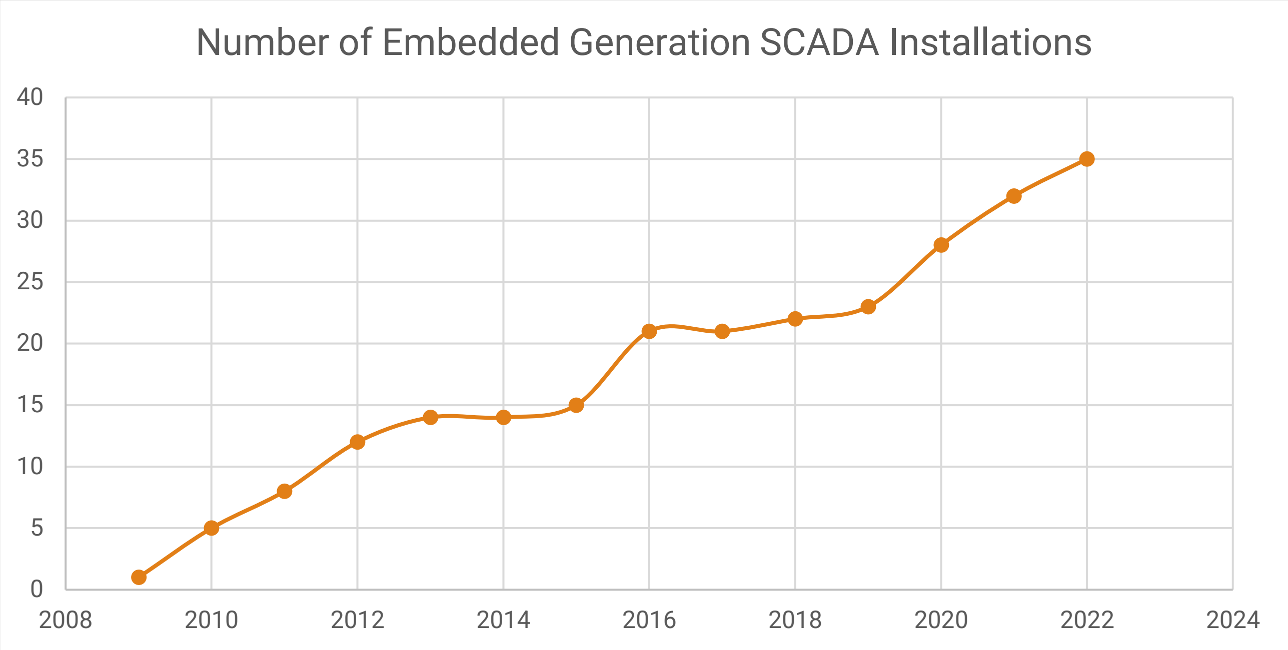
FIGURE 18. NUMBER OF REC AND LBS SCADA INSTALLATIONS



d) Embedded Generation

Evoenergy currently has 35 RTUs installed which are providing monitoring and control of large embedded generation systems connected to Evoenergy's network. This is currently increasing at a steady rate of around 4 per year, as shown in Figure 19.

FIGURE 19. NUMBER OF EMBEDDED GENERATION SCADA INSTALLATIONS



e) Network Analysers

Evoenergy currently has 190 network analysers installed which is inclusive of LV transformer monitors, IoT Monitors and power quality meters. This has been increasing rapidly due to easy to install cost effective devices becoming readily available in the market and strategic drivers to provide increased monitoring and control in the distribution network to help manage challenges such as embedded generation. Evoenergy expects to continue installing approximately 70 low voltage each year over the next regulatory period.

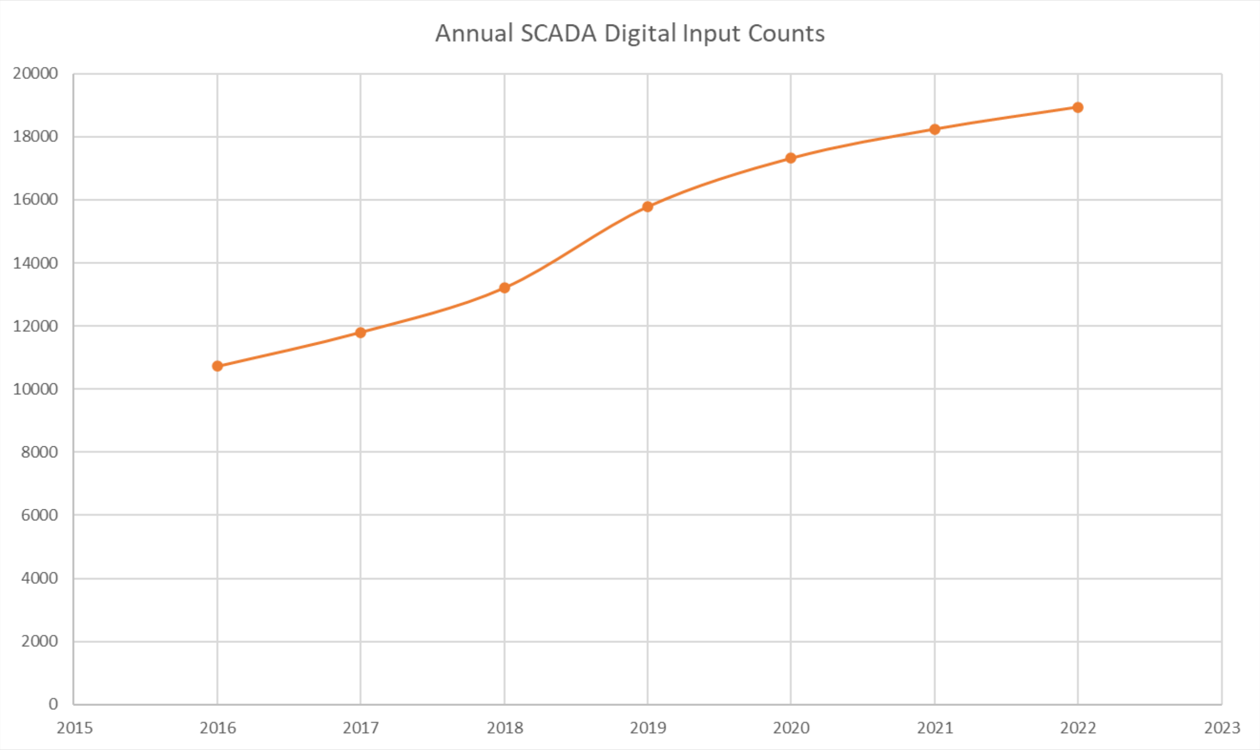
f) Accommodating Increasing SCADA Monitoring Business Requirements

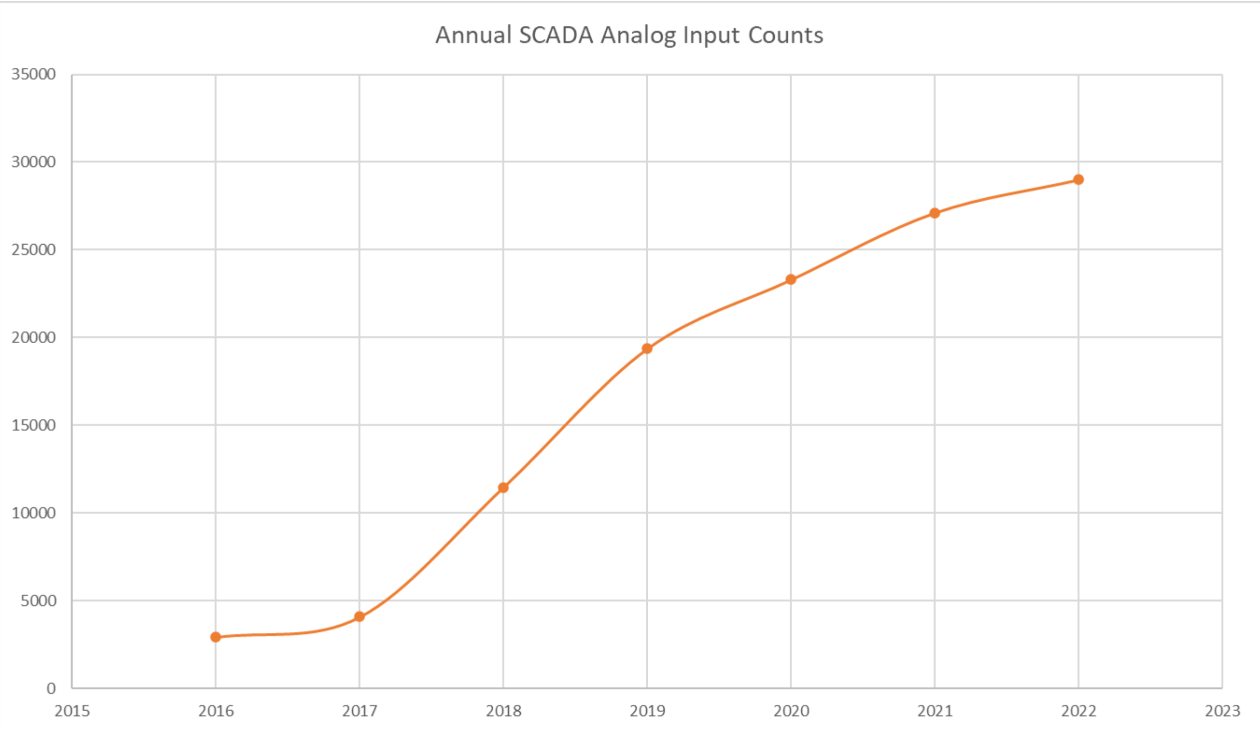
In the past, with older hardwired technologies and slow serial radio communications networks, a typical Evoenergy zone substation would have around 300-400 SCADA signals. This has increased to around 3,000-4,000 in recent years, providing significant capability improvements in network fault diagnosis, asset condition monitoring and load and power quality monitoring activities. The adoption of Evoenergy's Digital Substation Strategy and significant improvements in our SCADA communications networks have supported this transition.

The increased volume of signals does present new challenges in relation to SCADA system management. Time to commission SCADA new assets can take longer due to the number of signals, however Evoenergy has been working on new ways to perform automated testing within a lab environment prior to deployment on site to reduce risks of errors and improve overall efficiency. Standard SCADA templates and device configurations have been implemented so that a 'cookie cutter' approach can be implemented for new assets to the extent this is possible. Additional signals can also mean higher volumes of SCADA alarms and therefore more time required to investigate and resolve defects. Lastly SCADA devices need to have adequate processing power and capability to support the larger signal lists and higher data resolutions.

The following graphs in Figure 20 show the increases in the number of SCADA signals available in Evoenergy's network since the upgrade of our ADMS system in 2016.

FIGURE 20. ANNUAL SCADA DIGITAL AND ANALOG INPUT COUNTS





g) Transitioning to New SCADA Devices and Technologies

In the past Evoenergy was able to manage a small pool of SCADA device types to meet business SCADA requirements. One main type of RTU was utilised across Evoenergy's zone and distribution substations. This provided efficiencies in the management of SCADA assets as skills and equipment were applicable across the asset base. However, equipment was generally suited to zone substation applications and therefore was not as readily deployed on a distribution substation level as the benefits were not always justified against the cost.

In the current environment, many different SCADA devices from different manufactures exist for specialised applications at competitive price points. Devices such as low-cost Internet of Things (IoT) monitors and LV transformer monitors exist which are easily to install and able to readily integrate with utility SCADA systems through typical SCADA protocols such as DNP3. Power quality monitors and low voltage circuit breakers now support ethernet network interfaces and SCADA protocols such as DNP3 and Modbus. These types of devices have provided significant cost-effective opportunities to increase Evoenergy's SCADA monitoring across the network, particularly at a distribution substation level. IEC 61850 based vendor products have now reached maturity and have become standard for Evoenergy zone substation SCADA installations, providing advanced capabilities and efficiencies in SCADA installation and commissioning processes.

The challenge for Evoenergy in adopting new devices and technologies is the installation and ongoing management of what is now a range of different systems. Technicians are now required to be familiar with multiple devices and software tools. Ongoing work is being undertaken by Evoenergy to standardise configurations for different device types, reducing configuration and commissioning work. New devices and technologies are also extensively tested within Evoenergy SCADA and Automation labs before introduction into the network to ensure any device or configuration issues are identified and resolved before on-site commissioning.

h) Introducing New Automation Schemes

Increases in the number of SCADA devices and the types of SCADA signals available in Evoenergy's network has presented the opportunity of implementing more advanced and centralised automation schemes utilising ADMS.

Evoenergy is currently exploring the capability of more sophisticated voltage regulation schemes for zone substations, utilising low voltage and load measurements in the ADMS state estimation function to determine optimal voltage set points at the zone substation to maximise voltage compliance for customers in the LV network. This type of scheme has advantages as it can take into account load and generation changes and modify how the zone substation online tap change operates in real time. This is a key opportunity in addressing some of the voltage swing and compliance impacts due to the significant recent uptake in residential PV and other embedded generation sources.

Evoenergy is also exploring schemes such as automated Fault Location Isolation and Service Restoration (FLISR) which can significantly reduce fault durations on parts of the network where SCADA enabled fault passage indicators and remotely controlled switchgear is available.

Lastly Evoenergy has been refining monitoring and control capabilities for new embedded generation systems such as batteries to ensure they operate safely on Evoenergy's network and provide benefit during network constraints. Evoenergy has been implementing dynamic setpoint limits which automatically determine maximum charge and discharge limits at different points of the day and is now exploring automated methods to call on batteries for grid support during forecast peak demand events via SCADA

i) Optimising Legacy SCADA Replacements

Legacy RTU replacements are often complex and generally involve extensive re-wiring and re-testing work. SCADA outages are also required during replacement work which can also have significant operational impacts to the substation affected.

Evoenergy's current approach to zone RTU replacements it to combine with protection upgrades where practical. This method aligns with our Digital Substation Strategy and allows SCADA signals to be exchanged between the RTUs and relays utilising the substation ethernet network and using protocols such as IEC 61850 and DNP3. As new protection relays are commissioned, they are sequentially interfaced to the new RTU until all available signals are moved across and the legacy RTU can be removed. This method significantly reduces costs of re-wiring, provides more SCADA information and also reduces the impact of SCADA outages as the SCADA upgrade can be undertaken at the same time as the protection upgrades under bay outages.

Similarly for distribution substations, Evoenergy's approach is to align replacement activities with protection, DC system or switchgear replacement activities where possible. This again provides efficiencies in the installation and commissioning processes and reduces the impact on customers as all work can be undertaken during the one outage window.

With the approach of aligning SCADA and protection upgrades it has become important to assess the combined health of the protection, SCADA and communications assets within the substation and use overall secondary system health scores to inform which substations should be targeted for replacement.

j) Increasing Embedded Generation Penetration

Embedded generation poses a number of challenges for the electrical distribution network. The distribution network was designed to deliver reliably generated electricity to predictable loads. With the advent of wind farms, solar farms, rooftop photovoltaic systems and grid scale batteries now feeding into the network, a great deal of complexity and variability is added. Distributors have the challenge of ensuring the network is prepared for and able to adapt to a more dynamic two-way power flow environment.

Maintaining electricity quality of supply within acceptable parameters has become more challenging as embedded generation has increased its penetration into the distribution network. Volage swings in the LV network between the middle of the day (generation peak) and when customers return from work (load peak) are much more significant than in the past. This is particularly the case for customers connected near the end of LV circuits and significant distances from their distribution substation. Harmonics and power factor are also problems which are starting to be observed with increases in residential inverter-based generation. Controls such as effective SCADA monitoring of the low voltage network and utilisation of network storage assets is required to ensure the low voltage feeders are not overloaded and power quality is maintained.

The rate of changes affecting the electricity transmission and distribution industry is increasing rapidly. Government policies such as increased renewable energy targets, emerging technologies such as embedded generation, energy storage and electric vehicles, consumer engagement and driving behavioural changes in how energy is generated and utilised, and changes to tariff structures are all contributing to significant changes in Evoenergy's operating environment. This will all heavily shape how SCADA is applied to manage the electrical network in future.

k) Ensuring Adequate Protection against Cyber Security Risks

Historically, SCADA system cyber security was maintained through physical separation from other networks, and the esoteric nature of the proprietary protocols and software utilised. With increasingly interconnected SCADA and corporate network systems that are connected to the internet, the attack vectors and threats of cyber-attack becomes significantly higher. Additionally off-the-shelf products and standards-based protocols such as DNP3, allow knowledgeable attackers to target SCADA systems. The tools and techniques employed by threat agents are becoming more complex and targeted, hence the risk of disruption when they are successful is increasing in magnitude. The threat of cyber security incursion into the SCADA system must be addressed as an operational priority.

The risk of adverse impacts on SCADA systems from cyber security incursions, either in the form of targeted attacks or unintentional collateral damage, has been increasing in recent years. SCADA systems in particular can no longer rely on physical separation in order to maintain security, and there is a need for mature and considered cyber security measures to be in place to protect critical infrastructure. As electricity networks are classified as critical infrastructure, there are also increasing requirements on distributors to implement Cyber Security practices to meet target AEMO Australian Energy Sector Cyber Security Framework (AESCSF) maturity levels and comply with the SOCI Act.

The risk and consequences of a cyber security breach within an OT/SCADA system are different to those within a corporate IT environment. Safety, system integrity, system availability, and real-time operation are key requirements for OT/SCADA system monitoring and control of critical infrastructure. As a result, response to OT/SCADA system breaches must be rapid and decisive in order to minimise the downtime of monitoring and control functionality, and to lessen the risk of damage to assets and the threat to public safety.

At the device level, RTUs, HMIs and other SCADA assets must be kept up to date to ensure there are no known security vulnerabilities exposed. This is driven by vendor releases and recommendations for software patches and updates, firmware updates, and driver updates as required.

At the accessibility level, access to devices (RTUs and HMIs) must be restricted with appropriate levels of password protection and system restriction as per Evoenergy's IT and OT management standards. User and administrator privileges (for example read-only access or full read-write-execute access) must also be managed accordingly, ensuring a balance between system usability and system security across a number of organisational roles.

Appropriate levels of device and application logging should be in place, in order to allow for intrusion detection procedures to be effective, and to ensure that enough data is available for forensic analysis in the event of a successful or partially successful cyber security event.

Backup strategies should be in place to allow for restoration of individual devices or the full system. This would include such components as RTU configuration files, device drivers, HMI operating systems, and local HMI monitoring and control software.

Finally, communications staff, SCADA support staff and engineering staff should have the appropriate level of cyber security awareness and training in order to conduct their duties in a safe and secure manner, and to ensure timely and appropriate response to a cyber security intrusion.

4.5.6 Planned Projects, Replacements and Retirements

Following is a summary of the projected SCADA augmentation and replacement projects over the next regulatory period.

4.5.6.1 Augmentation Projects

The following network augmentation projects are planned:

a) Molonglo Zone Substation

The new zone substation at Molonglo will require the installation of an IEC 61850 based substation automation system including a zone substation RTU, a HMI, duplicate GPS clocks and duplicate station controllers.

b) Mitchell Zone Substation

The new zone substation at Mitchell will require the installation of an IEC 61850 based substation automation system including a zone substation RTU, a HMI, duplicate GPS clocks and duplicate station controllers.

c) Strathnairn Zone Substation

The new zone substation at Straithnairn will require the installation of an IEC 61850 based substation automation system including a zone substation RTU, a HMI, duplicate GPS clocks and duplicate station controllers.

d) Distribution Substation SCADA

Chamber Substations

Evoenergy has 510 chamber substations within its distribution network with 162 of these having SCADA monitoring and control capability. They are generally located on sites of high local consumption such as data centres, hospitals, large departmental complexes and apartment complexes. It is Evoenergy's current approach to connect all chamber substations to the SCADA network where practical to do so. All new and upgraded chamber substations are currently provisioned as SCADA capable.

Evoenergy's current strategy for adding SCADA to existing distribution substations it to align this with primary switchboard replacement and protection works. Evoenergy is currently planning to replace 4 LV boards and 1 HV board each year, as outlined in the Ground Assets Portfolio Strategy, and will combine these works with installation of new SCADA assets. The new switchboards being procured are all SCADA capable and therefore provide a great opportunity for adding SCADA functionality to the substation.

Padmount Substations

Evoenergy has 2,534 padmount substations, with 39 of these having SCADA monitoring and control capability. These are located in a combination of residential and commercial applications. Evoenergy's current strategy for new padmount substations is for all padmounts to have low voltage SCADA monitoring as minimum. Strategically selected padmounts may also have HV switching capability or OLTC controls where the network benefit for including these is justified.

For existing padmounts, Evoenergy's strategy is to install low-cost low voltage transformer monitors utilising Rogowski coil type sensors. These types of monitors are small and designed for retrofit in existing low voltage equipment. Evoenergy currently has 147 low voltage transformer monitors installed in the network and is expecting to increase this to around 400 by the end of the 19-24 regulatory period. For the EN24-29 regulatory period Evoenergy is planning continue this program and install a targeted 70 monitors per year.

The overall aim is to achieve and maintain 20% of distribution substation with SCADA monitoring capability which will enable accurate state estimation in ADMS and ensure adequate management of network load, power quality, and DER on a low voltage level.

4.5.6.2 Replacement Projects

For zone substations, where practical and possible to do so, SCADA replacements are aligned with protection and communications systems upgrades in alignment with the secondary systems Digital Substation Strategy. An overall assessment of secondary systems asset health for the zone substation, including protection, SCADA, and Communications assets is considered when prioritising which zone substations to target for replacement. Where this approach is taken, protection and SCADA systems are implemented utilising the IEC 61850 standard.

Where it is not effective to combine with protection upgrades, for example if the existing protection system health is okay, SCADA-only upgrades are considered. A SCADA upgrade generally involves replacement of RTUs, HMIs, GPS clocks, and associated networking equipment. Where this approach is taken, assets are developed as IEC 61850 ready so that they are suitable for future transitions to IEC 61850 upgrades later when protection assets require replacements.

For HMI replacements, Evoenergy's current strategy is to utilise inbuilt web HMI functionality within the zone substation RTU rather than deploy a separate HMI such as ClearSCADA, which was done in the past. This removes the need for dedicated HMI software and hardware (often windows based, requiring ongoing security maintenance and patching), and streamlines the development and configuration processes as this can be done in parallel with RTU configuration. Evoenergy's currently utilised ABB and SEL RTAC RTUs support this functionality.

For distribution substations, SCADA asset replacements are targeted based on:

- Assets with Poor health/condition
- Assets with obsolete technology and no longer fit for purpose, including cyber security features and performance
- Assets with outstanding SCADA defects requiring asset replacement to resolve
- Assets with high operational priority and supplying critical loads.

Depending on the overall condition and types of SCADA assets present, distribution substation SCADA replacements can involve:

- Replacement of particular RTU cards such as CPU and power supply cards to extend asset life and reliability
- Replacement of an entire RTU where devices are no longer vendor supported or utilise obsolete technology
- Replacement of an entire SCADA rack, including RTU, SCADA rack, communications equipment, and DC systems where the overall condition of these assets is poor.

Of the 37 SCADA assets currently in poor or very poor condition, these are generally older previous generation devices including:

- Leeds and Northrup HMI computer
- Leeds and Northrup distribution RTUs
- Logica distribution RTUs
- GE Harris zone substation RTUs
- Leeds and Northrup zone substation RTUs
- MITS zone substation RTUs.

Over the 24-29 regulatory period Evoenergy will also have 95 SCD5200 RTUs reaching the end of their 15-year design life. Replacements will be targeted based on RTU health and upgrades to the next generation SCD6000 system will be considered to improve efficiencies in installation and commissioning.

4.5.7 Asset Management Strategy

The asset management strategy for SCADA assets is to maintain the existing organisational risk profile. This is achieved through targeted asset replacement and maintenance activities based on the overall likelihood and consequence of reduced asset performance or total failure. Business and regulatory requirements are carefully considered as part of assessing the overall consequence of failure, in addition to the items outlined in Section 4.5.6.2.

Asset replacement projects are identified annually to ensure replacement activities continue to be aligned with the organisational risk profile. This also allows changes in external risk influences, such as increasing likelihood of cybersecurity attacks, to be considered and asset replacements works adjusted accordingly. Opportunities to provide additional business capability and reduce OPEX expenditure requirements are also considered in SCADA asset replacement works.

SCADA maintenance activities are largely determined by the asset health and performance information provided remotely by these assets. Assets which are performing poorly or have failed are then investigated and resolutions implemented. Some maintenance is also required to keep assets up to date with the latest firmware and security patching to provide additional protection against cybersecurity attacks. This work is steadily increasing as more digital SCADA assets are introduced into the network.

4.6. COMMUNICATIONS SYSTEMS STRATEGY

4.6.1 Asset Class Summary and Objectives

Whilst the primary purpose of the communication systems is to provide enhanced communication capabilities for the critical function of electricity network protection, monitoring and control, the additional business functions supported are also increasing in importance and enhance a range of Evoenergy business functions.

The core of the communications network is based on high-speed optical fibre and a multiservice MPLS network, which provides the ability to utilise the network to include other functionality such as corporate LAN access, remote monitoring of a CCTV network and extending centralised access control to the zone substation sites.

The Communications Systems asset class is categorised into the following asset groups:

- WAN Devices
- Tele-Protection Devices
- Optical Fibre Cables
- Pilot Cables
- Data Radio Systems
- Voice Radio Systems
- LAN Devices
- Media Converters
- Communications Power Supplies
- Communications Conduits and Pits.

The objective of Communications asset management is to ensure asset health monitoring and asset replacement maintains risk exposure at an acceptable and manageable level, whilst at the same time meeting the requirement for additional communications services to support greater SCADA penetration into the distribution network. The decisions on the upgrade and extension of the Communications assets are based on balancing the investments against the maintenance costs and the level of risk accepted by the organisation in providing a stable and sustainable electricity supply to its customers. Opportunities provided by primary asset projects, such as new underground feeders, are utilised for additional underground fibre for key locations with significantly reduced civil costs.

4.6.2 Asset Types

The communications network acts as an interface to facilitate communications between:

- Master control centres and network sites, for:
  - System alarms
  - System event logging
  - Data transfer
  - SCADA control
- Network sites and protection devices, for monitoring of device status and relay settings
- Evoenergy's remote management/access system, PowerSYSTEM Center, and field devices
- Protection devices at different locations for tele-protection
- Corporate networks are zone substations
- IEDs at various networked sites including zone and distribution substations.

4.6.2.1 LAN Devices

Communication switches are widely used in the Evoenergy substation networks, providing network infrastructure to connect IEDs and RTUs and then to link to the station router, Carrier modem, or UHF radio. The following types of switches are used:

- Base Station Ethernet Switches – These devices are located at radio stations and data centres to provide connectivity between the serial UHF radio network (the Digital Data Radio Network (DDRN)) and the Ethernet network for connection to the ADMS master stations. Although they are Ethernet switches, they are behaving as Terminal Servers.
- Distribution Ethernet Switches – These are Ethernet switches used in distribution substations such as padmounts and chamber substations to provide connectivity between devices on the local network.
- Zone Ethernet Switches – These are Ethernet switches used in zone substations to provide connectivity between devices on the local network.

4.6.2.2 Radio Systems

Several digital data radio technologies are deployed throughout Evoenergy's network to provide communication links between the control centres and networked sites in the field, and WAN connectivity. The following types of digital data radio are used:

- Carrier modems
- Microwave radios
- UHF radios.

With the optical fibre installation project completed, the UHF radios (in conjunction with Carrier modems) transitioned from being the primary communications network to providing SCADA connectivity at the distribution substation level (e.g., reclosers, switches, chamber and padmount distribution substations). The UHF radios are now being replaced with Carrier modems.

The digital voice (mobile radio) network provides voice communications for Evoenergy fleet vehicles and portable radios for staff working in the field. This network is used for communications during field operations to/from System Control.

4.6.2.3 Optical Fibre Cables

The optical fibre network is Evoenergy's primary communications system. Several different cabling options are employed, depending on opportunities and geographical requirements:

- Optical Fibre Ground Wire (OPGW)
- Underground optical fibre
- All-Dielectric Self-Supporting (ADSS) optical fibre strung on 11kV overhead distribution lines
- Leased optical fibre from telecommunications providers where Evoenergy fibre is not available. (Note – these are not included in the age/health metrics as they are owned/managed/maintained by external organisations).

4.6.2.4 Media Converters

Media converters are used to connect between communications mediums and between communications protocols, e.g., to connect serial devices (typically RS-422/485) and copper-based Ethernet devices to the local optical fibre network. To reduce copper cabling in substations, media converters are used to provide fibre connectivity to IEDs where required.

4.6.2.5 Pilot Cables

Pilot Cables are legacy copper communications cables used for SCADA communications to some chamber substations, Translay tele-protection for dedicated 11kV distribution cables, and Translay tele-protection for dedicated 132kV underground transmission lines. The pilot cables are either beyond or nearing end of life and will be phased out and replaced with optical fibre (where tele-protection is required) or Carrier modems (for SCADA communications).

4.6.2.6 Communications Power Supplies

DC-DC power supplies installed in the communications panels provide the required DC voltage for communications equipment. Dual A and B supplies are maintained and these are powered from the zone substation DC supplies (typically A and B supplies).

4.6.2.7 Tele-Protection Devices

Tele-Protection is a form of protection where devices are located at both ends of an electricity feeder. They are connected by a communications link and act as one scheme (unit protection) utilising the interconnection link between them. The devices are triggered only for faults detected in the section of feeder line between the two devices. The protection function is triggered when comparative value differentials are exceeded. Evoenergy tele-protection is implemented via one of the following:

- Evoenergy optical fibre links utilising OPGW, ADSS and underground dark fibre
- IEEE C37.94 protocol over the Evoenergy IP MPLS network
- Evoenergy dedicated digital radio
- Copper pilot cable.

For tele-protection devices that operate over pilot cable, alternate protection devices and operation over fibre or radio is proposed.

4.6.2.8 WAN Devices

WAN devices such as routers provide control of IP traffic throughout the network. They are scoped and sized to allow for the operation of several VRFs/VLANs simultaneously, allowing the Evoenergy communications strategy to be implemented. CWDM and DWDM devices are used to leverage multiple services on single or dual core leased fibres from third parties. The following devices are included in this asset type:

- MPLS routers
- DWDM and CWDM optical multiplexers
- A small quantity of legacy routers in distribution substations providing connectivity where a third-party communications medium is used.

4.6.2.9 Communications Conduits and Pits

Communications conduits and pits house communications systems optical fibre cables, fibre splices and service coils to facilitate maintenance and future augmentation. This asset group is not specifically included in the asset age/health metrics as individual conduits are not captured as communications systems assets in our current asset databases. Conduits and pits have a very long life-expectancy and do not require any particular asset management.

4.6.3 Current Population, Age, and Health Profile

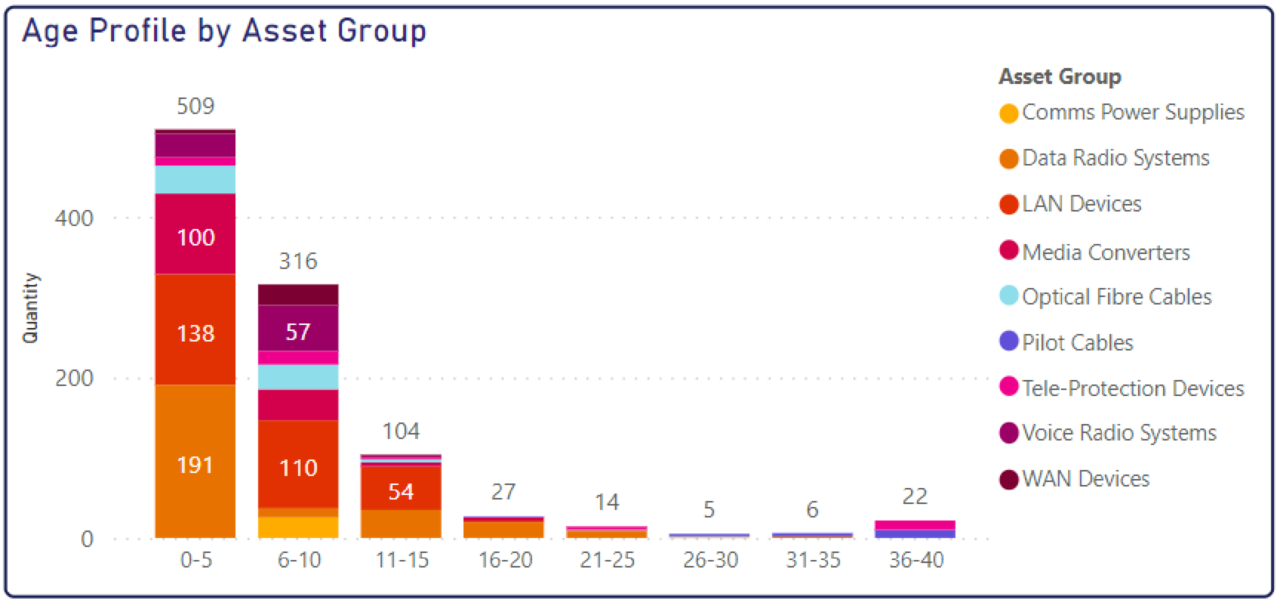
Table 9 offers a high-level count of communications systems assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

TABLE 9. ASSET POPULATION, AGE, AND HEALTH PROFILE – COMMUNICATIONS SYSTEMS

Asset Specific Plan	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
Communications Systems	1,003	each	15	7	115	85.61	Fair
ADSS Optical Fibre	3	each	40	4	0	100.00	Very Good
DWDM Optical Multiplexers	8	each	40	6	0	100.00	Very Good
Underground Optical Fibre	52	each	40	6	0	100.00	Very Good
DMR Gateways	9	each	15	4	0	99.56	Very Good
OPGW Optical Fibre	17	each	40	7	0	99.35	Very Good
Carrier Modems	180	each	7	2	0	99.26	Very Good
DMR Base Stations	4	each	15	6	0	99.25	Very Good
Base Station Ethernet Switches	4	each	15	7	0	99.00	Very Good
Comms Power Supplies	26	each	15	7	0	98.23	Very Good
Routers	26	each	15	8	0	95.46	Very Good
Media Converters	147	each	15	5	4	95.46	Very Good
Distribution Ethernet Switches	189	each	15	6	1	94.97	Very Good
Zone Sub Ethernet Switches	111	each	15	7	1	93.41	Very Good
DMR Mobile Radios	74	each	10	6	0	93.30	Very Good
Tele-Protection Devices	46	each	10	15	19	54.76	Fair
UHF Remote Radios	56	each	10	14	44	17.39	Very Poor
Microwave Radios	24	each	10	10	20	16.67	Very Poor
Pilot Cables	18	each	30	34	17	7.89	Very Poor
UHF Base Stations	9	each	10	20	9	0.00	Very Poor

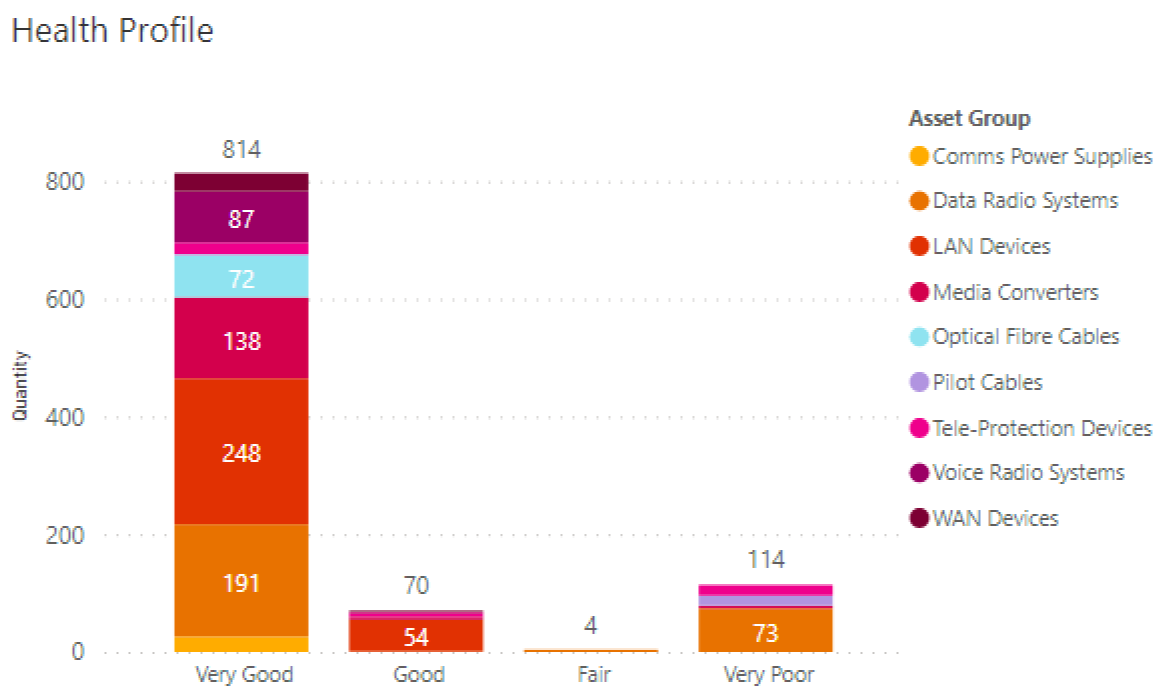
Communications assets vary in age and condition. While the majority of assets are in very good condition, some, such as obsolete pilot cables, tele-protection devices and radio systems, are at their end of life and require replacement. The age profile of this asset class reflects this and is shown in Figure 21.

FIGURE 21. ASSET AGE PROFILE CHART (AS AT SEPTEMBER 2022) – COMMUNICATIONS SYSTEMS



The asset class health profile, as of 2022, is summarised in Figure 22.

FIGURE 22. ASSET HEALTH PROFILE (AS AT JULY 2022) – COMMUNICATIONS SYSTEMS



4.6.4 Risks and Opportunities

The *Core Communications Network* (WAN) connects to Evoenergy zone substations, 132kV switching stations, control centres and data centres. It has the primary function of providing communications service for protection, SCADA, ADMS, operational networks and the corporate network. It is implemented as a multiservice MPLS network.

The *Distribution Communications Network* extends to distribution assets such as field reclosers, automated switches, fault passage indicators, chamber substations, padmount substations and other monitoring devices. The *Distribution Communications Network* endpoints use the DDRN or Carrier modem communications for new sites, or where available, optical fibre.

4.6.4.1 Risks

The most significant element of risk is the reliability consequence associated with communication system failure for one or more sites, resulting in loss of monitoring and control functionality. This risk can result in a number of different outcomes, including catastrophic failure or damage to associated primary assets, cascading outages affecting other parts of the network, extended outages to customers, and offloading generation.

The overarching need of communication asset management is to ensure asset maintenance and asset replacement maintains risk exposure at an acceptable and manageable level, whilst at the same time meeting the requirement for greater communications penetration into the distribution network. The decisions on the upgrade and extension of the communications network are based on balancing the investments against the maintenance costs and the level of risk accepted by the organisation in providing a stable and sustainable electricity supply to its clients.

a) Obsolete UHF Radios

All ageing UHF radios require replacement. In 2022, the age of the oldest remote radios exceeds 30 years with an average age 14 years. In addition, these radios are unencrypted and have other cyber security vulnerabilities that necessitate replacement.

The UHF radio population is used to provide SCADA communications to zone substations, chamber substations, padmount substations, and generator sites. The basic philosophy is to replace the remote radios with 4G modems at distribution sites and fibre at zone substations.

Most distribution sites have 4G coverage, but for some, other technologies such as IoT are being explored. For a few cases, optical fibre is already available on site and will be used as the new communications medium.

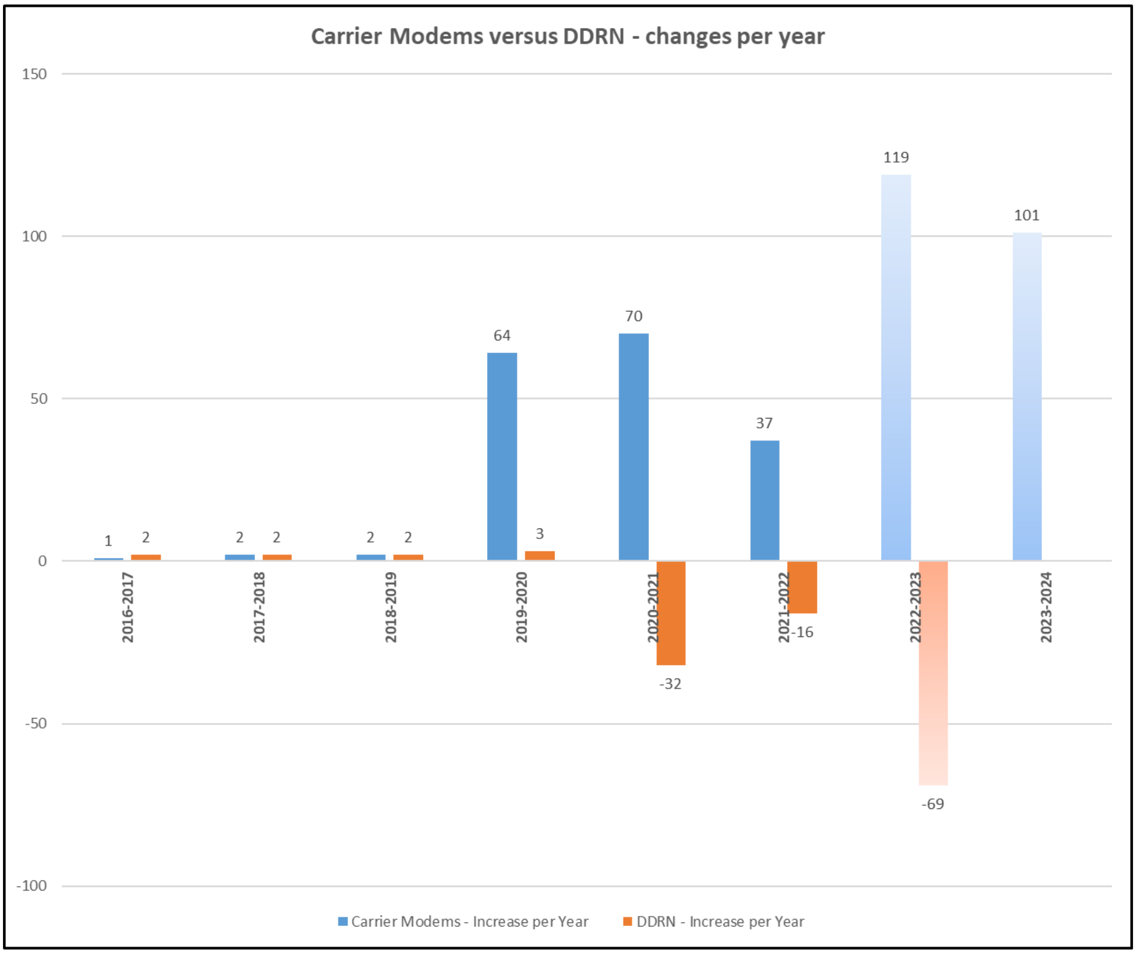
Sites which have legacy serial RTUs such as older zone substations and reclosers have required additional work to develop a solution to work with either 4G or IoT modems.

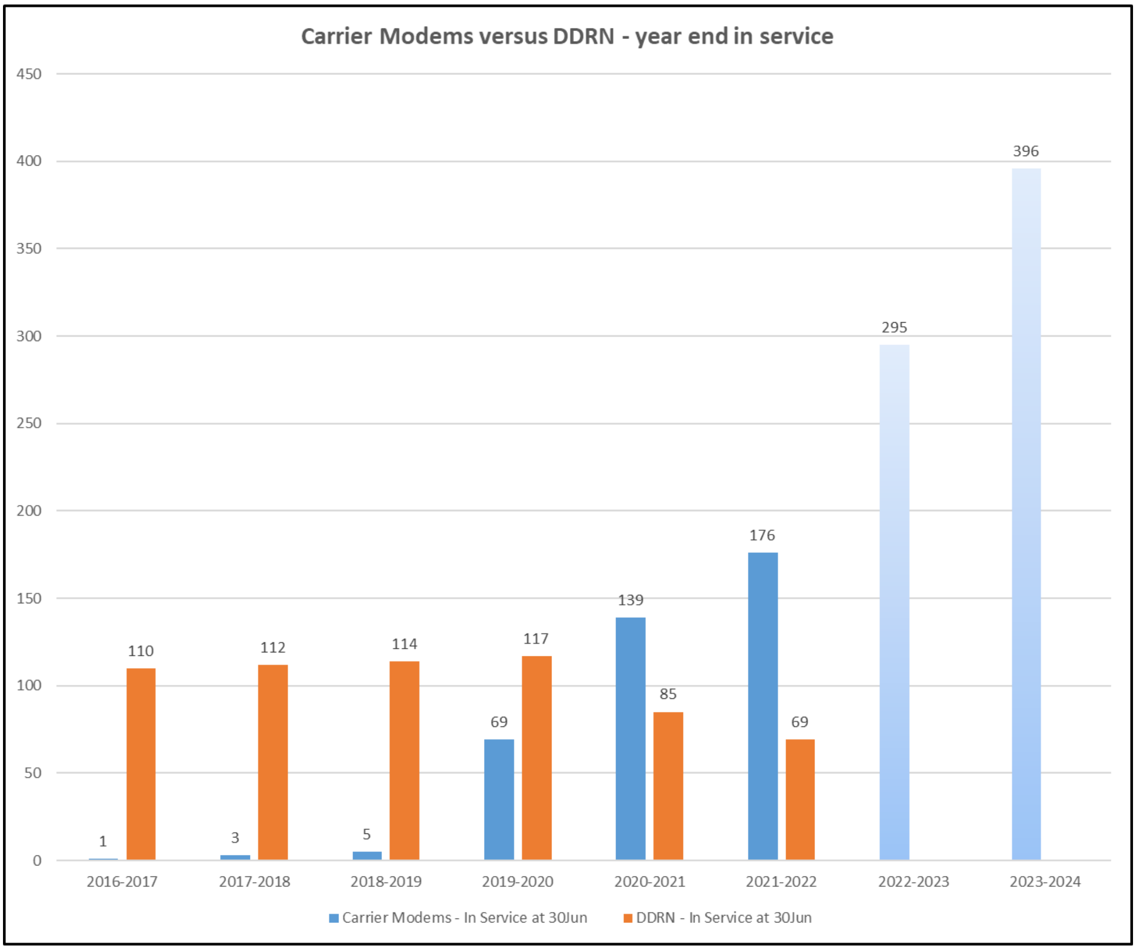
A sizeable proportion of remote radios have been replaced, in particular those without serial communication and with the availability of 4G coverage. The remaining remote radios will be replaced into 2023 as the technical issues are dealt with.

UHF Base Stations and associated Base Station Ethernet Switches will be retired once all remote connections have been transferred to the new technology.

A benefit of this technology migration is increased data transmission speeds. The use of individual communications channels will remove the need for collision handling, which will improve throughput and time between SCADA updates to ADMS, offering improvements to operations and data age. At least for non-serial remote devices, the new communications systems will also allow remote management and maintenance via the Secondary Systems Configuration Management (SSCM). With projects in place to replace these radios, the population will be completely decommissioned by 2023/2024. The progress of replacement, including projections, is shown in Figure 23.

FIGURE 23. CARRIER MODEMS VS DDRN – CHANGES PER YEAR AND YEAR END IN SERVICE





b) Distribution Network Monitoring

Responding to the impacts from disruptive technologies (such as PV, other DER, and EVs) will require power quality and SCADA monitoring to be extended to lower parts of the network. The additional network data collected will be provided to ADMS for real-time tactical demand response and stored on a central repository and analysed to enhance network planning and asset management. This will permit improved asset utilisation, more informed decision making on network augmentation and optimised asset maintenance. The Distribution Network Monitoring Program and other initiatives will increase the communications asset base in the *Distribution Communications Network*. Where possible, integrated SCADA devices with a built in carrier modem chip are being used, which don't require any additional communications systems assets in the field, only a SIM card.

The further expansion of the communications network to the distribution level of the electricity network will become a priority. This will enable monitoring and control of the network at the level where the PV, battery and EV network connections are occurring. An example of this is the inclusion of SCADA and a communications modem in every small padmount, which is forecast to result in an additional 80-90 sites per year. The technology used to extend the communications network will vary depending on location, technology coverage and geographical features. Predominantly, carrier networks will be leveraged, but RF mesh and UHF radio may be utilised. Coverage, distance, geography, cost and availability will all be considered for each new site, suburb or region.

c) Lack of Fibre Redundancy to Existing Zone Substations and Reliance on Third-Party Optical Fibre Providers

The aim of the strategy is that Evoenergy has redundant path optical fibre connectivity to each zone substation, because of the importance of these sites to System Control and for protection inter-tripping schemes.

Experience has shown that a single incident, such as civil works digging up a fibre, can easily take down communications to a site unless independent communications paths are provided. Communications to Woden ZSS were cut in 2017 during earthworks around the Canberra Hospital.

Fibre relocations are also becoming more prevalent, with changes in roadways and new building projects, as well as requirements for transmission line undergrounding. With fibre redundancy into Evoenergy's zone substations, these projects are more easily accommodated.

Evoenergy is currently reliant on optical fibre connectivity provided by a telecommunications provider in the ACT. Third-party telecommunication services have proven to be less reliable than the Evoenergy fibre network; within Evoenergy an understanding of the additional importance of fibre networks to protection functionality is well understood. There have been instances, for example in 2021, when the provider completed maintenance on their fibre network and took down Evoenergy's connectivity into Civic zone substation and Evoenergy's Disaster Recovery Facility.

d) Legacy SCADA Systems and Delayed Decommissioning of Zone Substations

A number of legacy SCADA systems are still in service and have required legacy communications systems to remain in place to provide connectivity back to the ADMS network.

As part of our strategy to remove all DDRN data radio systems in 2023, intermediate communications devices will be deployed to allow connectivity between these legacy systems and newer communications devices such as 4G modems.

Some of these legacy SCADA systems use pilot cable for SCADA telemetry communications. Projects to replace the pilot cables with optical fibre are planned (or other technologies such as 4G, where there is no parallel requirement for inter-tripping communications).

The decommissioning of Fyshwick zone (to a switching station) and Causeway zone have been planned for some time. Due to their imminent decommissioning, it has not been prudent to progress replacement of communications equipment at those sites. The decommissioning of Causeway will retire our oldest tele-protection devices.

e) Cyber Security

Communications provides a critical role in the cyber security defence for Evoenergy's OT networks. Network segmentation, establishing perimeter security and appropriate data encryption over public and radio networks is key to the cyber security strategy. The aim is to reduce the threat exposure of the Evoenergy electrical network to communications disruption or malicious operation of SCADA and protection devices.

The risk of adverse impacts on communications systems from cyber security incursions, either in the form of targeted attacks or unintentional collateral damage, has been increasing in recent years. SCADA communication systems in particular can no longer rely on physical separation in order to maintain security, and there is a need for mature and considered cyber security measures to be in place to protect critical infrastructure.

At the device level, switches, routers, terminal servers, radios, base stations, modems and tele-protection devices must be kept up to date to ensure there are no known security vulnerabilities exposed. This is driven by vendor releases and recommendations for software patches and updates, firmware updates, and driver updates as required. It is critical that communications network devices are within vendor support and operating systems are patched. This is particularly important for devices such as MPLS routers and Ethernet switches in the core of the network. Exploits of vulnerabilities in these devices can lead to compromise of the SCADA and ADMS control systems or protection systems.

These core devices (MPLS routers and Ethernet switches) must remain in vendor support. The expected end of support for these devices needs to be factored into replacement programs.

Devices in the *Distribution Communications Network* (UHF radios and Carrier modems) provide SCADA communications to devices such as field reclosers and automated switches. These devices operate over public networks and encryption is required to be implemented and maintained.

4.6.4.2 Opportunities

Evoenergy's high-speed optical fibre and multiservice MPLS network, provides ample opportunity to expand the utilisation of the network to include other desirable functionality. New opportunities are being reviewed.

With the advent of newer technologies being deployed in the network, such as numerical protection relays and other IEDs, there is a growing amount of operational data that can be collected.

a) Civil Projects Providing Fibre Conduiting

A number of the fibre projects planned leverage off civil works and conduits installed as part of other projects, either Evoenergy primary asset projects or external projects. This allows Evoenergy to expand its fibre network at a low cost.

b) Condition Monitoring

Utilising the reach and capacity of the communications network, Evoenergy can leverage additional monitoring capabilities of modern IEDs, such as condition monitoring of primary and secondary assets. This information can be gathered on a real-time basis for analysis and notification of alarm conditions. The data collected will be used to perform condition analysis to aid in the planning of maintenance, augmentation and the eventual replacement of assets.

c) Remote Access of IEDs and RTUs

One of the capabilities of modern RTUs and IEDs is with remote connection and remote management. This capability can be leveraged by Evoenergy with the ability to log into RTUs and IEDs remotely. This will have the following potential use cases:

- The ability to remotely interrogate devices and ensure operation at the designed and configured values
- The ability to download event and disturbance reports remotely. More timely investigation of the cause of faults, and the avoidance of travelling to site.
- The ability to access and leverage condition monitoring information collected by the devices remotely and store/analyse information into central asset management systems.
- The ability to monitor and configure the RTUs and IEDs remotely will improve the management of the devices significantly. Updates and changes to settings will be able to be performed without the need for site visits to carry out the work. This will mean quicker turn-around on operational investigations at a reduced cost (avoidance of travel time to site). This will result in faster turn-around and less exposure to the zone substation sites.

Configuration tasks are subject to thorough testing as part of software development best practices and must be approved in accordance with Evoenergy IT/OT standards before being rolled out to sites. Cyber security has been a major consideration with the implementation of remote access via the SSCM which provides secure, authorised and logged access based on individual role and permissions allocated.

d) **Accommodating Increasing SCADA Monitoring Business Requirements**

As outlined in Section 4.5.5.1, with the increasing number of SCADA monitoring sites, communications to each of these has to increase proportionately.

4.6.5 Planned Projects, Replacements and Retirements

Upcoming projects within the communications systems portfolio include:

- Optical Fibre Augmentation
  - Opportunities for expanding the optical fibre network at a low incremental cost come from projects outside the Secondary Systems area – such as feeder and line upgrades, as well as the government light rail expansion.
  - Evoenergy leverages these projects to expand the fibre network at a fraction of the cost of standalone fibre projects, as the civil works costs are predominantly borne by the other project areas, with only components to link up to the conduit runs and the cost of fibre hauling covered by the communications systems project budget
- Pilot Cable Replacement
  - Pilot cables have been used as a communication medium for a long period of time; some have been in-service for close to 40 years. They are used in providing communications for longitudinal feeder (line) Translay differential protection unit schemes and for SCADA communications to

some chamber substations. Regular testing of in-service pilot cables has indicated a decline in their electrical characteristics, providing a risk of protection mal-operation of protection schemes and loss of SCADA communications.
  - Replacement of existing pilot cable based Translay feeder protection with optical fibre based differential protection is proposed, requiring optical fibre replacement projects.
- Carrier Modem Upgrades and Piloting of New Technology
  - Next generation 5G network mobile network devices for data from the main suppliers are expected to be available soon. Upgrading existing 4G devices to 5G before the 4G network is decommissioned has been forecast towards the end of the period.
  - Some of Evoenergy's assets lie outside the range of 4G coverage and IoT technologies are being explored.
  - Evoenergy has a well-equipped communications lab environment which allows the testing of new devices, support for faults and investigations plus lab-testing of planned network changes. This ensures that innovative technologies can be explored, changes are well tested before implementation and any faults within the network can be replicated and solutions developed within the office environment before deployment on site.
- End of Life Asset Upgrades
  - Communications systems equipment such as LAN and WAN devices, microwave radio links, tele-protection devices and communication DC supplies will be upgraded as they reach end of life to maintain reliability.
- Communications Assets to support Cyber Security improvements
  - As part of the Cyber Security improvements, additional communications gateways are proposed for each Zone substation to provide improved segregation of networks. This is a key component to meet SOCI requirements.
- Monitoring and Reporting
  - As the importance and complexity of the communications network grows, the need to have automated monitoring systems is critical. Evoenergy proposes to expand on the existing SolarWinds platform to provide greater dedicated OT network visibility and monitoring.
  - A proposal to add QR codes to field devices will allow field staff quick access to all the appropriate corporate systems, linked to that individual device, to report defects/incidents, access information such as drawings and device settings/attributes, and allow for remote access, without the need to identify, search and find that device amongst the thousands of installed assets within the relevant databases.
- Protection from Vermin
  - Vermin can quickly cause damage to delicate optical fibre terminations and can go unnoticed until multiple fibre cores are broken. Several failures in recent years have been directly attributed to vermin and projects to uplift physical barriers to exclude vermin entry are underway to protect our valuable assets and maintain reliability and maximise longevity of installed assets.
  - Even with redundant fibre or communications paths into a site, a single rodent can damage all of those incoming connections, prior to any bait taking affect, which can take 24-48 hours.

4.6.5.1 Changes to Zone Substations

There are four zone substations planned to be built by Evoenergy in the coming years.

In order to provide necessary protection and SCADA for these new substations and transmission lines, extensions to the communications network are required and are budgeted for under the corresponding zone installation projects.

- Harman zone substation
  - New OPGW fibre connectivity to Gilmore zone, with a new portion of OPGW from Harman to the Monaro Highway, cutting into the existing OPGW cable at Hindmarsh Drive that runs in a Southerly direction to Gilmore zone

  - New OPGW fibre connectivity to Causeway zone, with a new portion of OPGW from Harman to the Monaro Highway, cutting into the existing OPGW cable at Hindmarsh Drive that runs in a Northerly direction to Canberra Avenue and another new portion of OPGW from Canberra Avenue to Causeway zone
  - New No.1 and No.2 Ethernet switches and associated fibre cabling for the IEC 61850 network
- Molonglo zone substation
  - New fibre connectivity to TransGrid's Stockdill substation, with a new portion of underground fibre from Molonglo to the Whitlam area, cutting into the existing OPGW cable that runs in a North-Westerly direction to Stockdill
  - New fibre connectivity to Woden zone, with a new portion of underground fibre from Molonglo to the Parkway, cutting into the existing OPGW cable that runs in a Southerly direction to Woden zone
  - New No.1 and No.2 Ethernet switches and associated fibre cabling for the IEC 61850 network
- Mitchell zone substation
  - New fibre connectivity cutting into the existing OPGW cable that runs between Bruce switching station and Gold Creek zone
  - New fibre connectivity cutting into the existing underground fibre cable that runs along the light rail between Gold Creek zone and TransACT data centre
  - New No.1 and No.2 Ethernet switches and associated fibre cabling for the IEC 61850 network
- Strathnairn zone substation
  - New fibre connectivity to TransGrid's Stockdill and Canberra substations, cutting into the existing OPGW cable that runs between Canberra and Stockdill
  - New No.1 and No.2 Ethernet switches and associated fibre cabling for the IEC 61850 network.

As part of the decommissioning of the Fyshwick and Causeway zone substations, there will be connectivity installed.

- Fyshwick zone substation
  - Fibre installed with new underground express feeders between Eastlake zone and Fyshwick
  - New tele-protection for the express feeders over fibre
- Causeway zone substation
  - Fibre installed with new underground feeders from Eastlake zone to Telopea zone.

4.6.6 Asset Management Strategy

The communications assets are considered on an individual basis due to the differing technologies utilised in each type of asset. Decisions about replacement or upgrade of the assets will be based on the risk-condition criteria and on the assets' ability to provide required functionality, bandwidth, and performance in compliance with business and regulatory requirements, rather than replacing assets based on their age alone.

Generally, the chosen strategy is to optimise maintenance and strategically replace assets, maintaining the current risk profile. This option takes into consideration each communications asset type and selects the optimal strategy for maintenance. Where existing assets are not capable of providing functionality, or where technology advances in media or protocols render existing assets obsolete, strategic replacement prior to asset end of life is recommended. A greater penetration of communications assets into the distribution network is also pursued as a strategic response to the changing nature of the electrical distribution landscape. This option also considers and aligns with protection, SCADA and other asset enhancement/replacement programs, and delivers efficiencies through combined implementation. Where redundancy exists or there is little impact from an individual device failure, then a number of communications assets are run-to fail based on life-expectancy.

The Secondary Systems communications network supports critical infrastructure and must be secured from unwanted intrusions, and as such, needs to meet the highest security standards. In recent years, there has been an increasing trend towards using IP protocols over electricity utilities' communications networks. To accommodate an open standard protocol such as DNP3 or IEC 61850, the communications system must make allowance for the increased bandwidth requirements with the additional overheads of the new protocol.

The strategy is to improve the communications network performance to meet the needs of the SCADA system and other business requirements. This includes:

- Implementation of interconnected SCADA, protection and communications systems that permit real time network management of dynamic energy flows resulting from the expanding use of distributed energy sources
- Implementation of systems that provide enhanced condition monitoring of electricity network assets to optimise asset management and maximise economic benefits
- Implementation of systems that provide fault location and anticipation of faults in the electricity network
- Provision of a unified communications network capable of servicing the following functions:
    - Substation condition monitoring
    - Zone substation physical security systems
    - Zone substation Voice over IP (VoIP) phones
    - Corporate network presence in zone substations
    - Remote engineering access to protection and other IEDs.

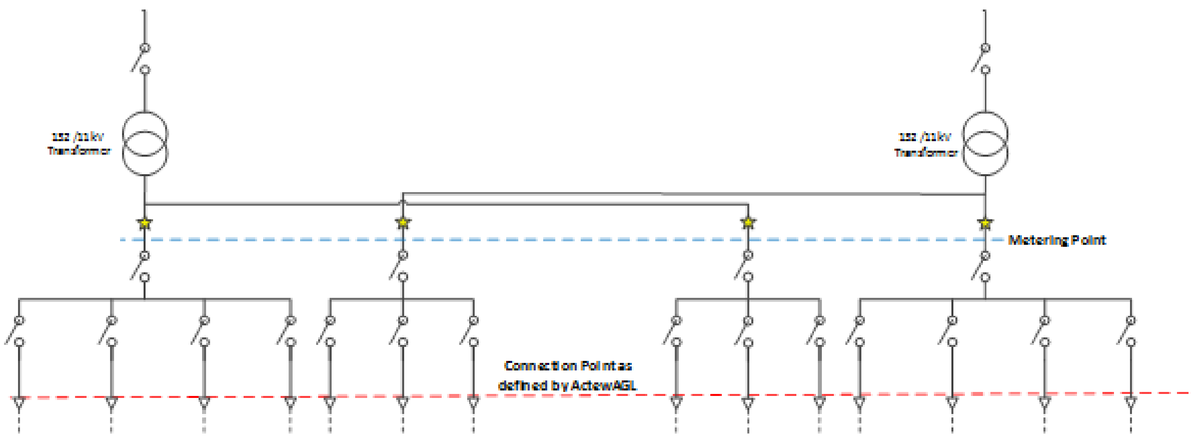
4.7. NEM METERING STRATEGY

NEM metering is installed in Evoenergy's 132/11 kV zone substations. These Type-3 meters provide transmission metering feeding into the AEMO Market Settlement and Transfer Solution (MSATS) system. The meter data allows reconciliation of transmission energy purchases gives an indication of aggregate network losses.

4.7.1 Asset Class Summary and Objectives

A portion of Evoenergy's distribution network performs as a sub-transmission function, providing support to TransGrid's 330kV network, known as dual function assets, as defined in the NER.

FIGURE 24. ZONE SUBSTATION CONNECTION AND METERING POINTS



Evoenergy is the Metering Coordinator (MC) and has appointed a 'Metering Provider B (MPB)' for these connection points between the ACT transmission system and distribution system.

Both Evoenergy and the metering provider have responsibilities under the NER to maintain the Market (or NEM) Metering Systems that are NEM metering installations. There are a total of 56 NEM metering installations distributed across 12 zone substations.

4.7.2 Asset Types

4.7.2.1 NEM Meters

All NEM metering installations within the Evoenergy network are Type 3. The metering installation type is determined by the annual energy flow through the point of connection being metered as shown in Table 10. The revenue metering point shall be located as close to the connection point as practicable.

TABLE 10. NEM METERING INSTALLATION CLASSES

Electricity Flow through the Connection Point per Annum	TYPE 1	TYPE 2	TYPE 3	TYPE 4
	>1,000 GWh	≥100 & ≤1,000 GWh	≥0.75 & ≤100 GWh	<750 MWh

4.7.3 Current Population, Age, and Health Profile

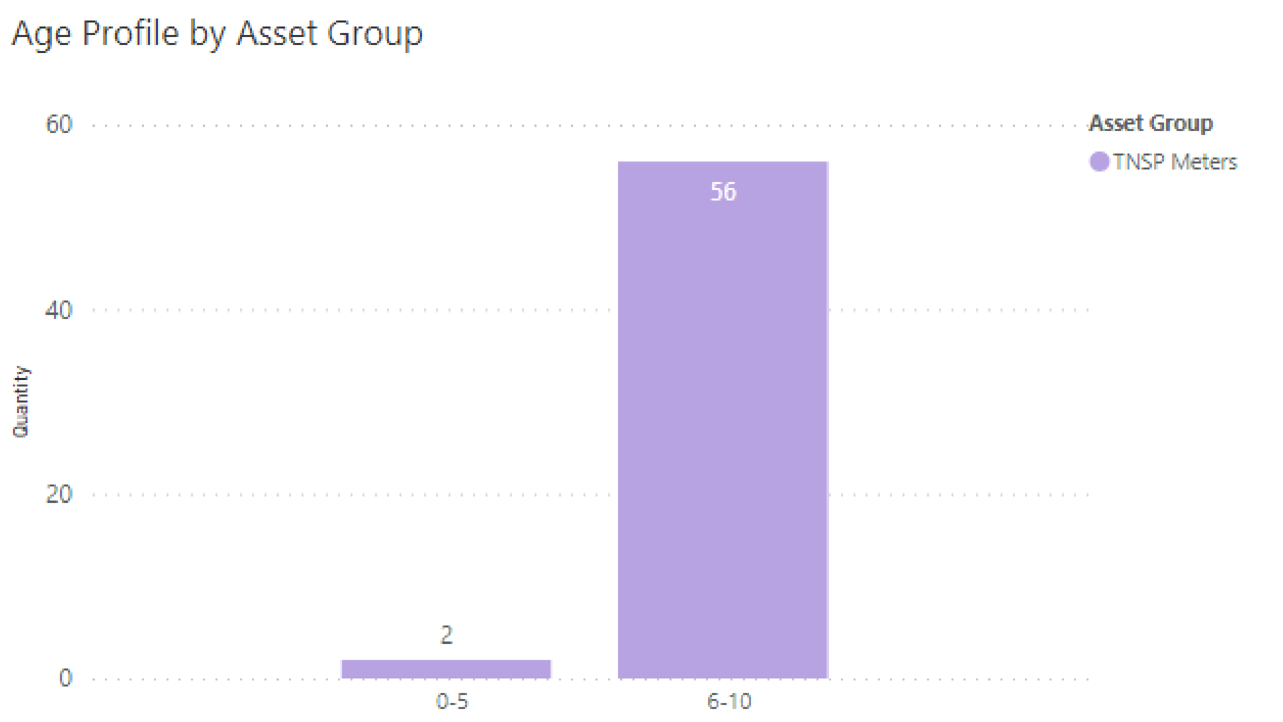
Table 11 offers a high-level count of NEM metering assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

TABLE 11. ASSET POPULATION, AGE, AND HEALTH PROFILE – NEM METERING

Asset Group	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
TNSP Meters	58	each	15.00	7.00	0	94.14	Very Good
EDMI,MK6E	58	each	15.00	7.00	0	94.14	Very Good
Total	**58**	**each**	**15.00**	**7.00**	**0**	**94.14**	**Very Good**

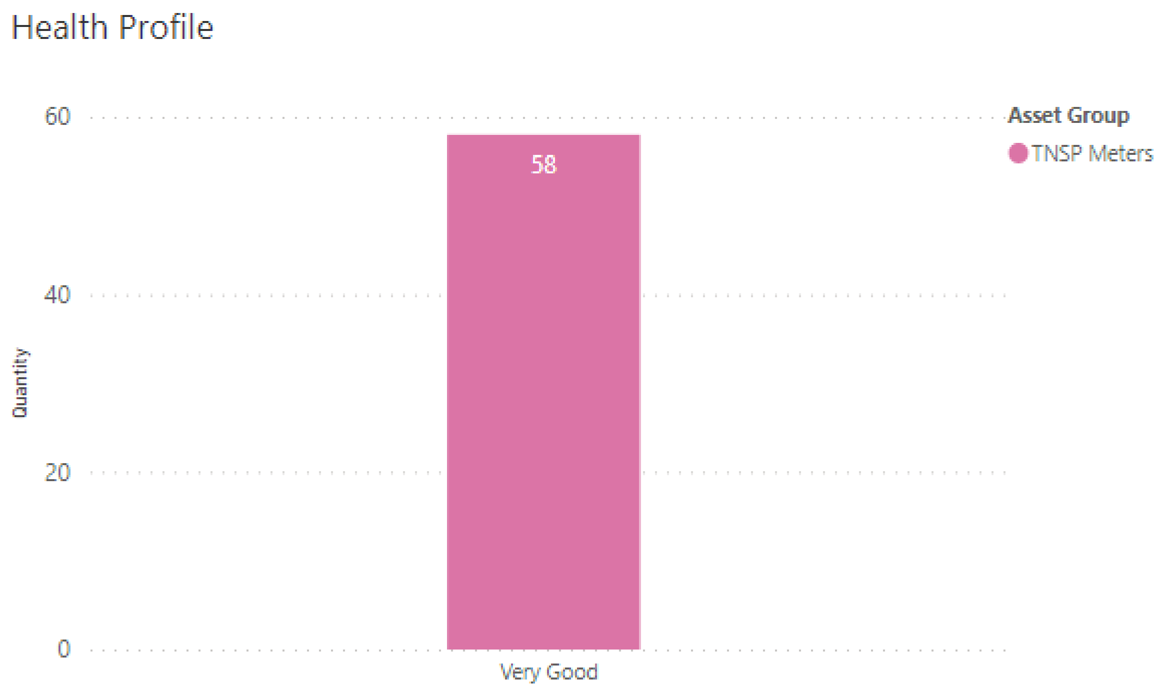
The age profile of this asset class reflects this and is shown in Figure 25.

FIGURE 25. ASSET AGE PROFILE CHART (AS AT JULY 2022) – NEM METERING



The asset class health profile, as of 2022, is summarised in Figure 26.

FIGURE 26. ASSET HEALTH PROFILE (AS AT JULY 2022) – NEM METERING



As all NEM meters are recently installed and have an expected life span of 20 years, all meters are considered to be in an excellent condition. Additionally, with the relatively frequent testing that is required under the NER, any defects are swiftly detected and rectified.

4.7.4 Risks and Opportunities

No risks or opportunities have been identified for this asset class.

4.7.5 Planned Projects, Replacements and Retirements

No planned works have been identified for this asset class.

4.7.6 Asset Management Strategy

The strategy for managing this class is to ensure the following requirements are fulfilled. This is achieved through annual review.

- Maintenance is to be in accordance with the requirements of the NER in all aspects.
- All metering equipment, including temporary installations, must be tested and comply with NER requirements prior to service.
- The frequency of tests and inspections to be in accordance with NER.
- If any non-compliance issue with the NER requirements is found, including the timeliness of tests and inspections, then a plan is to be initiated to rectify the non-compliance at the earliest opportunity. If the issue cannot be rectified within 2 days of detection of the fault then an exemption is to be obtained from the AEMO.
- Work is to be performed in accordance with approved MPB Test Procedures, all of which comply with NER provisions.
- A test plan is to be maintained which efficiently ensures compliance of all installations.

- All energy meters are to be compensated for instrument transformer and other component errors if such compensation can improve the overall metering system error. As detailed in the NER, all such compensations must bring the overall metering system error as close to zero as possible.
- The Metering Data Provider and all participants shall be notified of all work in a timely manner as required by the NER.

5. PROGRAM OF WORK

This section provides a detailed breakdown of quantities and yearly budget per program of work.

5.1. REPLACEMENT PROGRAM

TABLE 12. REPLACEMENT PROGRAM OF WORK YEARLY BUDGET FY25-29

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	BUDGET COST	QTY	TASK COST ($)	QTY	TASK COST ($)
Asset Renewal and Replacement Secondary Systems	**344**	**5,436,831**	**341**	**5,182,890**	**347**	**5,029,461**	**169**	**5,877,345**	**153**	**5,874,281**
Auxiliary DC Supply Systems	**1**	**524,559**	**1**	**524,559**	**1**	**524,559**	**1**	**524,559**	**1**	**524,559**
Replacement	**1**	**524,559**	**1**	**524,559**	**1**	**524,559**	**1**	**524,559**	**1**	**524,559**
EP-01136 - EN24 Auxiliary DC Supply Systems Replacement	1	524,559	1	524,559	1	524,559	1	524,559	1	524,559
EP-01137 - EN29 Auxiliary DC Supply Systems Replacement										
Communications Systems	**2**	**476,518**	**5**	**498,770**	**4**	**508,587**	**5**	**510,551**	**4**	**524,475**
Replacement	**2**	**476,518**	**5**	**498,770**	**4**	**508,587**	**5**	**510,551**	**4**	**524,475**
EP-00975 - 4G to 5G Modem Replacements (EN24 ENARSS COMMS)	1	203,596	1	203,596	1	203,596	1	203,596	1	203,596
EP-00976 - Microwave Radio Link Replacements (EN24 ENARSS COMMS)									1	125,188
EP-00977 - Replace EOL Modems (EN24 ENARSS COMMS)			1	91,628						
EP-00978 - Replace communications WAN devices (EN24 ENARSS COMMS)	1	272,921	1	98,828	1	209,436	1	157,731	1	122,389
EP-00979 - Replace communications DC Supplies (EN24 ENARSS COMMS)			1	31,415	1	31,415	1	39,269		
EP-00980 - Replace communications Tele-Protection devices (EN24 ENARSS COMMS)							1	54,977		
EP-00981 - Replace communications SCADA LAN switch (EN24 ENARSS COMMS)			1	73,302	1	64,140	1	54,977	1	73,302
EP-00985 - EN29-34 Communications Replacement Program (ENARSS Comms)										
Protection Systems	**330**	**3,307,963**	**324**	**3,044,314**	**322**	**2,836,648**	**142**	**3,707,981**	**127**	**3,707,981**
Replacement	**330**	**3,307,963**	**324**	**3,044,314**	**322**	**2,836,648**	**142**	**3,707,981**	**127**	**3,707,981**
EP-00053 - Gilmore ZSS Williamsdale 132kV Line Protection Replacement	**1**	**164,688**								
EP-00056 - Gilmore ZSS Theodore 132 kV Line Protection Replacement	**1**	**97,799**	**1**	**117,358**						
EP-00429 - Theodore ZSS Williamsdale Tee Angle Crossing 132kV Line Protection Replacement	**1**	**171,410**								
EP-00430 - Theodore ZSS Gilmore No.2 132kV Line Protection Replacement	**1**	**171,410**								
EP-00431 - APH Incomer Protection Replacement	**1**	**87,231**								

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	BUDGET COST	QTY	TASK COST ($)	QTY	TASK COST ($)
EP-00432 - S4836 Russell Incomer Protection Replacement	**1**	**73,000**								
EP-00433 - S5185 DFAT Incomer Protection Replacement	**1**	**56,442**	**1**	**90,308**						
EP-00955 - EVENT Belconnen ZSS 11kV Group AG Protection Replacement	**39**	**83,932**								
Feeder Protection Upgrade	10	69,411								
Group Breaker and Bus Coupler Protection Upgrade	2	14,521								
Replace zone sub protection relay	27	0								
EP-00956 - EVENT Belconnen ZSS 11kV Group BG Protection Replacement	**39**	**83,932**								
Feeder Protection Upgrade	10	69,411								
Group Breaker and Bus Coupler Protection Upgrade	2	14,521								
Replace zone sub protection relay	27	0								
EP-00957 - EVENT City East ZSS 11kV and transformer protection upgrade	**172**	**886,924**	**172**	**1,541,362**	**172**	**1,541,362**				
Feeder Protection Upgrade	28	434,231	28	754,639	28	754,639				
Group Breaker and Bus Coupler Protection Upgrade	6	97,333	6	169,152	6	169,152				
Replace zone sub protection relay	132	0	132	0	132	0				
Transformer AVR Upgrade	3	106,782	3	185,574	3	185,574				
Transformer Protection Upgrade	3	248,578	3	431,998	3	431,998				
EP-00958 - EVENT Gilmore ZSS Transformer Protection Replacement							**26**	**1,060,336**		
Replace zone sub protection relay							22	0		
Transformer AVR Upgrade							2	318,620		
Transformer Protection Upgrade							2	741,716		
EP-00959 - EVENT Gold Creek ZSS Transformer Protection Replacement									**25**	**1,060,336**
Replace zone sub protection relay									21	0
Transformer AVR Upgrade									2	318,620
Transformer Protection Upgrade									2	741,716
EP-00960 - EVENT Telopea Park ZSS transformer Protection Replacement	**73**	**1,431,194**								
Replace zone sub protection relay	68	0								
Transformer AVR Upgrade	2	318,620								
Transformer Protection Upgrade	3	1,112,574								
EP-00961 - EVENT Theodore 11kV and Transformer Protection Replacement							**58**	**1,057,141**	**58**	**1,057,141**
Feeder Protection Upgrade							11	381,761	11	381,761
Group Breaker and Bus Coupler Protection Upgrade							4	145,212	4	145,212
Replace zone sub protection relay							39	0	39	0

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	BUDGET COST	QTY	TASK COST ($)	QTY	TASK COST ($)
Transformer AVR Upgrade							2	159,310	2	159,310
Transformer Protection Upgrade							2	370,858	2	370,858
EP-00962 - EVENT Woden ZSS 11kV Protection Replacement			**150**	**1,295,286**	**150**	**1,295,286**				
Feeder Protection Upgrade			30	1,041,165	30	1,041,165				
Group Breaker and Bus Coupler Protection Upgrade			7	254,121	7	254,121				
Replace zone sub protection relay			113	0	113	0				
EP-00963 - EVENT Latham ZSS 132kV Transformer Protection Replacement							**58**	**1,590,504**		
Replace zone sub protection relay							52	0		
Transformer AVR Upgrade							3	477,930		
Transformer Protection Upgrade							3	1,112,574		
EP-00964 - EVENT Wanniassa ZSS Transformer Protection Replacement									**44**	**1,590,504**
Replace zone sub protection relay									38	0
Transformer AVR Upgrade									3	477,930
Transformer Protection Upgrade									3	1,112,574
EP-00984 - EN29-34 Protection Replacement Program										
SCADA Systems	**21**	**$825,084**	**30**	**$927,038**	**26**	**$884,370**	**25**	**$989,062**	**26**	**$884,370**
Replacement	**11**	**1,127,792**	**11**	**1,115,247**	**20**	**1,159,666**	**21**	**1,134,254**	**21**	**1,117,265**
EP-01014 - SCADA EN24 RTU SCD5200 Replacement 54									1	18,898
EP-01015 - SCADA EN24 RTU SCD5200 Replacement 40							1	18,898		
EP-01016 - SCADA EN24 RTU SCD5200 Replacement 46									1	18,898
EP-01017 - SCADA EN24 RTU SCD5200 Replacement 6			1	18,898						
EP-01018 - SCADA EN24 RTU SCD5200 Replacement 32							1	18,898		
EP-01019 - SCADA EN24 RTU SCD5200 Replacement 25					1	18,898				
EP-01020 - SCADA EN24 RTU SCD5200 Replacement 37							1	18,898		
EP-01021 - SCADA EN24 RTU SCD5200 Replacement 29							1	18,898		
EP-01022 - SCADA EN24 RTU SCD5200 Replacement 11					1	18,898				
EP-01023 - SCADA EN24 RTU SCD5200 Replacement 5	1	18,898								
EP-01024 - SCADA EN24 RTU SCD5200 Replacement 43									1	18,898
EP-01025 - SCADA EN24 RTU SCD5200 Replacement 24					1	18,898				
EP-01026 - SCADA EN24 RTU SCD5200 Replacement 41									1	18,898
EP-01027 - SCADA EN24 RTU SCD5200 Replacement 42									1	18,898
EP-01028 - SCADA EN24 RTU SCD5200 Replacement 15					1	18,898				
EP-01029 - SCADA EN24 RTU SCD5200 Replacement 20					1	18,898				
EP-01030 - SCADA EN24 RTU SCD5200 Replacement 13					1	18,898				
EP-01031 - SCADA EN24 RTU SCD5200 Replacement 3	1	18,898								
EP-01032 - SCADA EN24 RTU SCD5200 Replacement 16					1	18,898				

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	BUDGET COST	QTY	TASK COST ($)	QTY	TASK COST ($)
EP-01033 - SCADA EN24 RTU SCD5200 Replacement 53									1	18,898
EP-01034 - SCADA EN24 RTU SCD5200 Replacement 14					1	18,898				
EP-01035 - SCADA EN24 RTU SCD5200 Replacement 21					1	18,898				
EP-01036 - SCADA EN24 RTU SCD5200 Replacement 48									1	18,898
EP-01037 - SCADA EN24 RTU SCD5200 Replacement 51									1	18,898
EP-01038 - SCADA EN24 RTU SCD5200 Replacement 38							1	18,898		
EP-01039 - SCADA EN24 RTU SCD5200 Replacement 17					1	18,898				
EP-01040 - SCADA EN24 RTU SCD5200 Replacement 27							1	18,898		
EP-01041 - SCADA EN24 RTU SCD5200 Replacement 22					1	18,898				
EP-01042 - SCADA EN24 RTU SCD5200 Replacement 7			1	18,898						
EP-01043 - SCADA EN24 RTU SCD5200 Replacement 33							1	18,898		
EP-01044 - SCADA EN24 RTU SCD5200 Replacement 10			1	18,898						
EP-01045 - SCADA EN24 RTU SCD5200 Replacement 18					1	18,898				
EP-01046 - SCADA EN24 RTU SCD5200 Replacement 35							1	18,898		
EP-01047 - SCADA EN24 RTU SCD5200 Replacement 56									1	18,898
EP-01048 - SCADA EN24 RTU SCD5200 Replacement 12					1	18,898				
EP-01049 - SCADA EN24 RTU SCD5200 Replacement 36							1	18,898		
EP-01050 - SCADA EN24 RTU SCD5200 Replacement 23					1	18,898				
EP-01051 - SCADA EN24 RTU SCD5200 Replacement 30							1	18,898		
EP-01052 - SCADA EN24 RTU SCD5200 Replacement 26							1	18,898		
EP-01053 - SCADA EN24 RTU SCD5200 Replacement 1	1	18,898								
EP-01054 - SCADA EN24 RTU SCD5200 Replacement 39							1	18,898		
EP-01055 - SCADA EN24 RTU SCD5200 Replacement 52									1	18,898
EP-01056 - SCADA EN24 RTU SCD5200 Replacement 34							1	18,898		
EP-01057 - SCADA EN24 RTU SCD5200 Replacement 4	1	18,898								
EP-01058 - SCADA EN24 RTU SCD5200 Replacement 47									1	18,898
EP-01059 - SCADA EN24 RTU SCD5200 Replacement 44									1	18,898
EP-01060 - SCADA EN24 RTU SCD5200 Replacement 9			1	18,898						
EP-01061 - SCADA EN24 RTU SCD5200 Replacement 31							1	18,898		
EP-01062 - SCADA EN24 RTU SCD5200 Replacement 45									1	18,898
EP-01063 - SCADA EN24 RTU SCD5200 Replacement 55									1	18,898
EP-01064 - SCADA EN24 RTU SCD5200 Replacement 49									1	18,898
EP-01065 - SCADA EN24 RTU SCD5200 Replacement 8			1	18,898						
EP-01066 - SCADA EN24 RTU SCD5200 Replacement 50									1	18,898
EP-01067 - SCADA EN24 RTU SCD5200 Replacement 19					1	18,898				
EP-01068 - SCADA EN24 RTU SCD5200 Replacement 2	1	18,898								
EP-01069 - SCADA EN24 RTU SCD5200 Replacement 28							1	18,898		

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	BUDGET COST	QTY	TASK COST ($)	QTY	TASK COST ($)
EP-01070 - SCADA EN24 Entire SCADA Rack Replacement 2	1	77,067								
EP-01071 - SCADA EN24 Entire SCADA Rack Replacement 5			1	77,067						
EP-01072 - SCADA EN24 Entire SCADA Rack Replacement 8							1	77,067		
EP-01073 - SCADA EN24 Entire SCADA Rack Replacement 11									1	77,067
EP-01074 - SCADA EN24 Entire SCADA Rack Replacement 12									1	77,067
EP-01075 - SCADA EN24 Entire SCADA Rack Replacement 7					1	77,067				
EP-01076 - SCADA EN24 Entire SCADA Rack Replacement 3	1	77,067								
EP-01077 - SCADA EN24 Entire SCADA Rack Replacement 1	1	77,067								
EP-01078 - SCADA EN24 Entire SCADA Rack Replacement 4			1	77,067						
EP-01079 - SCADA EN24 Entire SCADA Rack Replacement 9							1	77,067		
EP-01080 - SCADA EN24 Entire SCADA Rack Replacement 10							1	77,067		
EP-01081 - SCADA EN24 Entire SCADA Rack Replacement 6					1	77,067				
EP-01082 - SCADA EN24 City East ZSS RTU & HMI Replacement	1	281,447	1	281,447						
EP-01083 - SCADA EN24 Theodore ZSS RTU & HMI Replacement			1	281,447	1	281,447				
EP-01084 - SCADA EN24 Latham ZSS RTU & HMI Replacement							1	562,896		
EP-01085 - SCADA EN24 Wanniassa ZSS RTU & HMI Replacement									1	562,896
EP-01087 - SCADA EN24 Gold Creek ZSS HMI Replacement					1	201,413				
EP-01088 - SCADA EN24 Belconnen ZSS RTU & HMI Replacement	1	281,447	1	281,447						
EP-01089 - SCADA EN24 Civic ZSS RTU & HMI Replacement	1	239,208								
EP-01090 - SCADA EN24 Eastlake ZSS RTU & HMI Replacement					1	239,208				
EP-01091 - SCADA EN24 Gilmore ZSS RTU Replacement							1	37,795		
EP-01092 - SCADA EN24 Telopea ZSS RTU Replacement									1	75,590
EP-01093 - SCADA EN24 Angle Crossing ZSS RTU Replacement							1	18,898		
EP-01120 - SCADA EN24 GPS Clock Replacement 1			1	22,283						
EP-01123 - EN29-34 SCADA Replacement Program (ENARSS SCADA)										
EP-01182 - SCADA EN24 GPS Clock Replacement 2									1	22,283
NEM Metering										
Replacement										
EP-01134 - FY31-32 Replace NEM Meter										
Augmentation Capex Secondary Systems	**14**	**1,972,872**	**13**	**1,605,171**	**10**	**1,047,296**	**16**	**2,610,645**	**13**	**2,011,792**
Communications Systems	**5**	**772,243**	**5**	**691,986**	**4**	**709,002**	**5**	**835,127**	**4**	**811,163**
Install	**5**	**772,243**	**5**	**691,986**	**4**	**709,002**	**5**	**835,127**	**4**	**811,163**

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	BUDGET COST	QTY	TASK COST ($)	QTY	TASK COST ($)
EP-00967 - Vermin Protection for Communications (EN24 ENAA Comms)	1	16,209	1	16,209	1	16,209	1	16,209	1	16,209
EP-00968 - Communications Test Lab (EN24 ENAA Comms)	1	67,401	1	67,401	1	67,401	1	67,401	1	67,401
EP-00969 - Network Monitor Comms Pilot (EN24 ENAA Comms)	1	16,209	1	16,209	1	16,209	1	16,209	1	16,209
EP-00970 - ZSS Cyber Security Gateways (EN24 ENAA Comms)	1	530,408								
EP-00971 - Fibre UG Kings Av to National Library (EN24 ENAA Comms)	1	142,017	1	568,067						
EP-00972 - Fibre UG Canberra Metro Stage 2A Civic to Commonwealth Av (EN24 ENAA Comms)					1	609,184	1	261,079		
EP-00973 - Fibre UG Canberra Metro Stage 2B Commonwealth Av to Woden (EN24 ENAA Comms)							1	474,230	1	711,345
EP-00974 - QR Codes for Asset Management (EN24 ENAA Comms)			1	24,102						
EP-00986 - EN29-34 Communications Augmentation Program (ENAA Comms)										
SCADA Systems	**9**	**1,200,629**	**8**	**913,184**	**6**	**338,294**	**11**	**1,775,518**	**9**	**1,200,629**
Install	**9**	**1,200,629**	**8**	**913,184**	**6**	**338,294**	**11**	**1,775,518**	**9**	**1,200,629**
EP-01001 - SCADA EN24 City East ZSS AG Group Control Panel	1	287,445								
EP-01002 - SCADA EN24 Theodore ZSS AG Group Control Panel			1	287,445						
EP-01003 - SCADA EN24 Latham ZSS AG Group Control Panel							1	287,445		
EP-01004 - SCADA EN24 Wanniassa ZSS AG Group Control Panel									1	287,445
EP-01005 - SCADA EN24 Gilmore ZSS AG Group Control Panel							1	287,445		
EP-01006 - SCADA EN24 City East ZSS BG Group Control Panel	1	287,445								
EP-01007 - SCADA EN24 City East ZSS CG Group Control Panel	1	287,445								
EP-01008 - SCADA EN24 Gilmore ZSS BG Group Control Panel							1	287,445		
EP-01009 - SCADA EN24 Latham ZSS BG Group Control Panel							1	287,445		
EP-01010 - SCADA EN24 Latham ZSS CG Group Control Panel							1	287,445		
EP-01011 - SCADA EN24 Theodore ZSS BG Group Control Panel			1	287,445						
EP-01012 - SCADA EN24 Wanniassa ZSS BG Group Control Panel									1	287,445
EP-01013 - SCADA EN24 Wanniassa ZSS CG Group Control Panel									1	287,445
EP-01094 - SCADA EN24 Automation Systems Lab Development and Integration	1	28,150	1	28,150	1	28,150	1	28,150	1	28,150
EP-01095 - SCADA EN24 FY24/25 RTU Installation LV SWBD Upgrade 1	1	49,613								

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	BUDGET COST	QTY	TASK COST ($)	QTY	TASK COST ($)
EP-01096 - SCADA EN24 FY24/25 RTU Installation LV SWBD Upgrade 2	1	49,613								
EP-01097 - SCADA EN24 FY24/25 RTU Installation LV SWBD Upgrade 3	1	49,613								
EP-01098 - SCADA EN24 FY24/25 RTU Installation LV SWBD Upgrade 4	1	49,613								
EP-01099 - SCADA EN24 FY25/26 RTU Installation LV SWBD Upgrade 1			1	49,613						
EP-01100 - SCADA EN24 FY25/26 RTU Installation LV SWBD Upgrade 2			1	49,613						
EP-01101 - SCADA EN24 FY25/26 RTU Installation LV SWBD Upgrade 3			1	49,613						
EP-01102 - SCADA EN24 FY25/26 RTU Installation LV SWBD Upgrade 4			1	49,613						
EP-01103 - SCADA EN24 FY26/27 RTU Installation LV SWBD Upgrade 1					1	49,613				
EP-01104 - SCADA EN24 FY26/27 RTU Installation LV SWBD Upgrade 2					1	49,613				
EP-01105 - SCADA EN24 FY26/27 RTU Installation LV SWBD Upgrade 3					1	49,613				
EP-01106 - SCADA EN24 FY26/27 RTU Installation LV SWBD Upgrade 4					1	49,613				
EP-01107 - SCADA EN24 FY27/28 RTU Installation LV SWBD Upgrade 1							1	49,613		
EP-01108 - SCADA EN24 FY27/28 RTU Installation LV SWBD Upgrade 2							1	49,613		
EP-01109 - SCADA EN24 FY27/28 RTU Installation LV SWBD Upgrade 3							1	49,613		
EP-01110 - SCADA EN24 FY27/28 RTU Installation LV SWBD Upgrade 4							1	49,613		
EP-01111 - SCADA EN24 FY28/29 RTU Installation LV SWBD Upgrade 1									1	49,613
EP-01112 - SCADA EN24 FY28/29 RTU Installation LV SWBD Upgrade 2									1	49,613
EP-01113 - SCADA EN24 FY28/29 RTU Installation LV SWBD Upgrade 3									1	49,613
EP-01114 - SCADA EN24 FY28/29 RTU Installation LV SWBD Upgrade 4									1	49,613
EP-01115 - SCADA EN24 FY28/29 RTU Installation HV SWBD Upgrade									1	111,694
EP-01116 - SCADA EN24 FY27/28 RTU Installation HV SWBD Upgrade							1	111,694		

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	BUDGET COST	QTY	TASK COST ($)	QTY	TASK COST ($)
EP-01117 - SCADA EN24 FY26/27 RTU Installation HV SWBD Upgrade					1	111,694				
EP-01118 - SCADA EN24 FY25/26 RTU Installation HV SWBD Upgrade			1	111,694						
EP-01119 - SCADA EN24 FY24/25 RTU Installation HV SWBD Upgrade	1	111,694								
EP-01132 - EN29-34 SCADA Augmentation Program										
Reliability and Quality Improvements Secondary Systems	**2**	**685,758**	**1**	**434,188**	**2**	**806,710**	**3**	**1,058,280**	**2**	**806,710**
Protection Systems	**1**	**251,570**			**1**	**372,522**	**2**	**624,091**	**1**	**372,522**
Replacement	**1**	**251,570**			**1**	**372,522**	**2**	**624,091**	**1**	**372,522**
EP-00054 - EN24 Telopea ZSS Voltage Regulation Upgrade	1	251,570								
EP-01124 - EN29 Voltage Regulation Upgrade										
EP-01125 - EN24 Theodore ZSS Voltage Regulation Upgrade					1	372,522				
EP-01127 - EN24 Latham ZSS Voltage Regulation Upgrade							1	372,522		
EP-01128 - EN24 Wanniassa ZSS Voltage Regulation Upgrade									1	372,522
EP-01129 - EN24 Gilmore ZSS Voltage Regulation Upgrade							1	251,570		
SCADA Systems	**1**	**434,188**	**1**	**434,188**	**1**	**434,188**	**1**	**434,188**	**1**	**434,188**
Replacement	**1**	**434,188**	**1**	**434,188**	**1**	**434,188**	**1**	**434,188**	**1**	**434,188**
EP-01130 - EN24 SCADA Distributed Network Monitoring (DER)	1	434,188	1	434,188	1	434,188	1	434,188	1	434,188
EP-01131 - EN29 SCADA Distributed Network Monitoring (DER)										

5.2. MAINTENANCE PROGRAM

TABLE 13. MAINTENANCE PROGRAM OF WORK YEARLY BUDGET FY25-29

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	BUDGET COST	QTY	TASK COST ($)	QTY	TASK COST ($)
Maintenance Secondary Systems	**975**	**1,950,293**	**931**	**2,059,907**	**804**	**2,137,164**	**904**	**2,271,845**	**958**	**2,301,627**
Auxiliary DC Supply Systems	**308**	**178,604**	**394**	**237,972**	**332**	**199,790**	**418**	**264,670**	**345**	**203,867**
Condition Monitoring	**296**	**170,000**	**297**	**171,231**	**305**	**181,079**	**310**	**187,234**	**299**	**173,693**
-	**296**	**170,000**	**297**	**171,231**	**305**	**181,079**	**310**	**187,234**	**299**	**173,693**
Inspect zone sub battery			1	1,231	9	11,079	14	17,234	3	3,693

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	BUDGET COST	QTY	TASK COST ($)	QTY	TASK COST ($)
Test distribution sub battery - capacity test	248	60,512	248	60,512	248	60,512	248	60,512	248	60,512
Test zone sub battery - capacity test	48	109,488	48	109,488	48	109,488	48	109,488	48	109,488
Planned Maintenance	12	8,604	97	66,741	27	18,711	108	77,436	46	30,174
-	12	8,604	97	66,741	27	18,711	108	77,436	46	30,174
Maintain distribution sub battery charger	12	8,604	58	41,586	18	12,906	108	77,436	7	5,019
Test zone sub battery charger			39	25,155	9	5,805			39	25,155
Communications Systems	**2**	**222,880**	**2**	**222,880**	**2**	**222,880**	**2**	**222,880**	**2**	**222,880**
Planned Maintenance	**1**	**156,600**	**1**	**156,600**	**1**	**156,600**	**1**	**156,600**	**1**	**156,600**
EP-01147 - Communications Planned Maintenance EN24-29 (ENMSS Comms)	1	156,600	1	156,600	1	156,600	1	156,600	1	156,600
EP-01148 - Communications Planned Maintenance EN29-34 (ENMSS Comms)										
Unplanned Maintenance	1	66,280	1	66,280	1	66,280	1	66,280	1	66,280
EP-01149 - Communications Unplanned Maintenance EN24-29 (ENMSS Comms)	1	66,280	1	66,280	1	66,280	1	66,280	1	66,280
EP-01150 - Communications Unplanned Maintenance EN29-34 (ENMSS Comms)										
Protection Systems	**663**	**819,121**	**533**	**795,393**	**468**	**836,858**	**482**	**832,685**	**609**	**849,296**
Condition Monitoring	**52**	**28,652**	**52**	**28,652**	**52**	**28,652**	**52**	**28,652**	**52**	**28,652**
-	**52**	**28,652**	**52**	**28,652**	**52**	**28,652**	**52**	**28,652**	**52**	**28,652**
Inspect zone substation	52	28,652	52	28,652	52	28,652	52	28,652	52	28,652
Planned Maintenance	**611**	**790,469**	**481**	**766,741**	**416**	**808,206**	**430**	**804,033**	**557**	**820,644**
-	**611**	**790,469**	**481**	**766,741**	**416**	**808,206**	**430**	**804,033**	**557**	**820,644**
Maintain distribution protection relay	469	513,973	192	178,173	165	225,786	110	95,147	264	257,184
Maintain protection relay	142	276,496	289	588,568	251	582,420	320	708,886	293	563,460
SCADA Systems	**1**	**591,793**	**1**	**665,767**	**1**	**739,741**	**1**	**813,715**	**1**	**887,689**
Unplanned Maintenance	**1**	**591,793**	**1**	**665,767**	**1**	**739,741**	**1**	**813,715**	**1**	**887,689**
EP-01164 - SCADA EN24 Maintenance	1	591,793	1	665,767	1	739,741	1	813,715	1	887,689
EP-01171 - SCADA EN29 Maintenance										
NEM Metering	**1**	**137,895**	**1**	**137,895**	**1**	**137,895**	**1**	**137,895**	**1**	**137,895**
Condition Monitoring	**1**	**137,895**	**1**	**137,895**	**1**	**137,895**	**1**	**137,895**	**1**	**137,895**
-	**1**	**137,895**	**1**	**137,895**	**1**	**137,895**	**1**	**137,895**	**1**	**137,895**
Test NEM metering	1	137,895	1	137,895	1	137,895	1	137,895	1	137,895

5.3. LONG-TERM FORECAST

Table 14 presents the high level 10-year long term forecast from FY24/25 to FY33/34.

TABLE 14. HIGH LEVEL LONG-TERM BUDGET FORECAST

EXPENDITURE CATEGORY	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34
Asset Renewal and Replacement Secondary Systems	**5,436,831**	**5,182,890**	**5,029,461**	**5,877,345**	**5,874,281**	**6,395,591**	**6,901,304**	**7,583,205**	**7,307,758**	**7,375,373**
Auxiliary DC Supply Systems	524,559	524,559	524,559	524,559	524,559	529,690	559,117	647,399	617,971	617,971
Communications Systems	476,518	498,770	508,587	510,551	524,475	1,018,045	1,119,849	1,231,834	1,355,018	1,490,519
Protection Systems	3,307,963	3,044,314	2,836,648	3,707,981	3,707,981	3,641,052	3,894,853	3,721,500	3,728,513	3,500,001
SCADA Systems	1,127,792	1,115,247	1,159,666	1,134,254	1,117,265	1,206,805	1,327,485	1,460,232	1,606,256	1,766,882
NEM Metering	0	0	0	0	0	0	0	522,240	0	0
Augmentation Capex Secondary Systems	**1,972,872**	**1,605,171**	**1,047,296**	**2,610,645**	**2,011,792**	**2,031,256**	**2,234,380**	**2,457,818**	**2,703,599**	**2,973,959**
Communications Systems	772,243	691,986	709,002	835,127	811,163	925,234	1,017,758	1,119,534	1,231,486	1,354,636
SCADA Systems	1,200,629	913,184	338,294	1,775,518	1,200,629	1,106,022	1,216,622	1,338,284	1,472,113	1,619,323
Reliability and Quality Improvements Secondary Systems	**685,758**	**434,188**	**806,710**	**1,058,280**	**806,710**	**994,724**	**994,724**	**994,724**	**994,724**	**994,724**
Protection Systems	251,570	0	372,522	624,091	372,522	374,455	374,455	374,455	374,455	374,455
SCADA Systems	434,188	434,188	434,188	434,188	434,188	620,269	620,269	620,269	620,269	620,269
Maintenance Secondary Systems	**1,950,293**	**2,059,907**	**2,137,164**	**2,271,845**	**2,301,627**	**2,560,542**	**2,693,615**	**2,717,288**	**2,910,540**	**2,659,616**
Auxiliary DC Supply Systems	178,604	237,972	199,790	264,670	203,867	191,281	220,920	222,319	267,093	186,815
Communications Systems	222,880	222,880	222,880	222,880	222,880	222,880	222,880	222,880	222,880	222,880
Protection Systems	819,121	795,393	836,858	832,685	849,296	1,027,430	1,015,445	980,010	1,070,779	784,715
SCADA Systems	591,793	665,767	739,741	813,715	887,689	981,056	1,096,475	1,154,184	1,211,893	1,327,311

EXPENDITURE CATEGORY	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	FY 29-30	FY 30-31	FY 31-32	FY 32-33	FY 33-34
NEM Metering	137,895	137,895	137,895	137,895	137,895	137,895	137,895	137,895	137,895	137,895

Appendix A – SUBSTATION ASSET HEALTH TABLES

The following sections describe the criteria used to assess asset condition, health, remaining life, capability score, safety score, obsolescence score, and risk rating; and provide asset health tables and proposed risk treatment for zone substation assets.

ASSET CONDITION PROFILE

The asset health assessment has been performed by applying an age- and condition-based deterioration curve for individual assets and averaging the condition for assets within each manufacturer/model protection relay family.

Protection relay condition assessments are made during the planned maintenance inspection cycle with the following factors considered:

- Calibration drift,
- Tripping function,
- Power supply calibration,
- Indications, and
- Controls functional.

The condition assessment is via a condition scorecard and formula within Cityworks. Fault and defect history is also captured in Cityworks.

Condition assessment and fault history are analysed across protection relay families and where demonstrated performance issues are evident, a deterioration factor has been applied to the health assessment.

ASSET HEALTH

Asset health is characterised as one of the following:

- Excellent – based on no known failures and having been installed in the last five years with operations as benchmarked in the manufacturer's specification
- Good – based on no known failures and having been in service for about seven to ten years with operations as benchmarked in the manufacturer's specification
- Fair – provided they have been in service for ten to fifteen years with operations as close as possible to the benchmark in accordance with the manufacturer's specification allowing for minor tolerances
- Poor – based on failures and calibration drift over consecutive maintenance cycles.

REMAINING LIFE

The remaining life of the asset has been derived from the difference of its useful engineering life to its service life to date.

CAPABILITY SCORE

The capability score of an asset is a measure of the ability of the asset under question to meet the National Electricity Rules and the Energy Regulator's de facto requirements. In some cases such as monitoring functions, it refers to its ability to perform the complete function and further value addition.

As measured on a scale of 1 to 5:

- 5 – Refers to meeting the NER obligations

- 4 – Refers to meeting NER obligations with some compromise
- 3 – Refers to meeting the basic specification but not satisfying the NER requirements
- 2 – Refers to not meeting the specification but good enough to perform the basic functions
- 1 – Refers to devices not in accordance with the current industry standards.

SAFETY SCORE

The safety score of a device implies the capability of the device to provide protection to personnel while performing maintenance work, or to the environment from bushfire mitigation.

Some of the attributes of devices to provide safety of personnel relates to:

- Providing live sequence protection to personnel performing overhead line glove and barrier works
- Providing arc flash mitigation to personnel performing switchgear maintenance
- Duplicated transmission line protections to provide bushfire mitigation.

As an example, if a device has been accorded a safety score of 5, it implies that it can provide live sequence protection and arc flash mitigation as the modern numerical protections such as SEL351S and ABB REF615. Similarly, duplicated transmission line protections such as SEL411L and MiCOM P545 provide unit protections for transmission line and score a 5 on their safety capability.

Conversely, electromechanical protections such as the CDG and old static legacy protections such as the Nilstat, Asea type RAZFE, RAZOG, and the Siemens 7SL24 relays score 1 on their capability due to their inability to provide safety to personnel and the environment.

OBSOLESCENCE SCORE

The obsolescence score of an asset describes how much an asset is outdated. The score is measured using various obsolescence factors including:

- Whether a vendor is still producing an asset
- Whether a spare device is available for an asset
- Whether vendor support is still available for an asset.

RISK RATING

Risk rating is computed from an addition of equal weighted average of health, safety, capability, obsolescence, and the remaining life of the asset.

An asset with an excellent health, a high remaining life of more than 20 years with adequate safety and NER compliance will score medium to low on the risk rating.

Conversely, an asset with poor health, not supported by the manufacturer, with hardly any remaining life and non-NER compliance will score a very high-risk rating.

CITY EAST ZONE SUBSTATION

TABLE 15. CITY EAST CURRENT ASSET CONDITION

Protection Scheme Type	Model	Asset Count	Asset Health	Implementation Date	Remaining Life (Years)	Capability Score	Safety Score	Obsolescence Score	Risk Rating
Circuit Breaker Fail Protection	RMS 2C	3	Poor	28/06/1991	-0.4	2	5	0	High
Remote Terminal Unit	ABB 560CMR	2	Good	25/06/2018	11.53	4	5	5	Low
	INVENSYS SCD5200	3	Good	1/07/2011	4.56	3	3	5	Medium
	MITS MD1000	1	Poor	1/01/1991	-15.89	1	2	0	Very High
Transmission Line Protection	SCHNEIDER MICOM-P545	2	Excellent	25/05/2018	16.45	5	5	5	Low
	SCHWEITZER SEL411L	2	Excellent	25/05/2018	16.45	5	5	5	Low
Zone Auxiliary AC Protection	FG WILSON ATI-V502	1	Fair	11/07/2008	6.6	0	0	5	High
	RMS 2P	2	Poor	13/05/1983	-8.51	4	5	0	Medium
Zone Feeder Protection	ABB SPAJ-140C	25	Poor	4/08/1992	-9.3	2	0	3	High
	ESP K4	3	Poor	2/06/1979	-2.45	1	1	0	Very High
	GEC CDG	32	Poor	14/02/1989	7.23	2	0	0	Very High
	GEC HO4	2	Fair	18/09/1991	9.82	2	2	0	High
	GEC MCGG	18	Poor	19/06/1989	-2.42	2	2	0	High
	GEC MCSU	10	Fair	20/02/1989	-2.75	2	0	0	Very High
	GEC MVAJ	6	Poor	19/06/1989	-2.42	2	5	5	Medium
	NILSEN ITP	4	Poor	20/10/1989	-2.09	2	0	0	Very High
	RMS 2C	8	Poor	20/06/1991	-0.43	2	5	0	High
	RMS 2T	9	Poor	19/06/1989	-2.42	2	2	3	High
	SCHNEIDER MICOM-P142	1	Good	2/12/2014	12.98	5	5	5	Low
Zone HV Busbar Protection	GEC FAC34	2	Poor	19/06/2015	33.52	5	5	0	Medium
Zone Metering Supervision	ESP K4L	1	Poor	18/05/1979	-2.49	1	1	0	Very High
	RMS 2P	1	Poor	12/05/1989	-2.53	4	5	0	Medium
Zone TX Protection	ABB RADSB	3	Poor	28/06/1991	-0.4	2	3	0	High
	ABB RAYA	3	Poor	7/04/1988	-3.62	3	5	0	High
	ABB TapChanger Relay	1	Poor	5/12/1995	14.02	0	0	5	High
	ESP GP1	4	Fair	28/06/1991	9.6	5	5	5	Low
	ESP GP2	1	Fair	5/12/1995	14.02	5	5	5	Low
	ESP GP3	3	Fair	28/06/1991	9.6	5	5	5	Low
	GEC CAG	3	Fair	28/06/1991	9.6	2	3	5	Medium
	GEC CDG	2	Poor	28/06/1991	9.6	2	0	0	Very High
	GEC MCGG	1	Fair	5/12/1995	4.02	2	2	0	High
	GEC VAJX11/CAA41	3	Poor	15/12/1986	5.07	2	3	5	Medium
	MORSMITT DB-D125V	6	Excellent	4/05/2018	26.39	5	5	5	Low
	QUALITROL AKM	6	Fair	12/07/1979	-2.34	4	5	5	Low
	REINHAUSEN RS1000	2	Fair	28/06/1991	9.6	4	5	5	Low
	REYROLLE 4C21	9	Fair	12/07/1988	-3.36	2	3	0	High
	RMS 2C	2	Poor	15/12/1986	-4.93	2	5	0	High
	RMS 2HS10	9	Poor	15/12/1986	-4.93	2	5	5	Medium
	RMS 2V48	1	Poor	12/03/1992	0.3	5	5	5	Low
Zone Underfrequency Protection	SCHNEIDER MICOM-P142	1	Good	2/02/2020	18.14	5	5	5	Low
	SCHWEITZER SEL351A	1	Excellent	2/02/2020	18.14	5	5	5	Low

Table 15 indicates the current asset condition. Based on the asset condition, the following class of protection assets have unacceptable poor condition with limited or no serviceable life left in them:

- Zone Feeder Protection: The feeder protections are a combination of old electromechanical and failing static relays that have exceeded their serviceable life by 4 years with no available spares. These schemes cannot provide arc flash or live line sequence protections and leave the crew vulnerable.
- Zone transformer main protections have exceeded their serviceable life by 4 years with no available spares.

Based on the above credible evidence in Table 15, a risk treatment to replace the assets has been presented in terms of tranches of projects. The 132kV transmission line protections have recently been replaced and have been excluded from the scope of works.

Proposed Asset Risk Treatment

It is proposed to stand-up projects to replace the following:

- Project – Replace City East ZSS 11kV Feeder and Transformer Protection
  - 34-Feeder Bay Overcurrent and Earth Fault Protection with duplicated devices
    - 6-Group Breaker Overcurrent and Earth Fault Protection with duplicated devices

– 3-Bus Coupler with duplicated controllers

– 3-132/11kV Zone Power Transformer Protection with duplicated devices.

This project is recommended for implementation in the regulatory period 2024-26 as they are reasonably high priority second-tier high risk assets.

GILMORE ZONE SUBSTATION

TABLE 16. GILMORE CURRENT ASSET CONDITION

Protection Scheme Type	Model	Asset Count	Asset Health	Implementation Date	Remaining Life (Years)	Capability Score	Safety Score	Obsolescence Score	Risk Rating
Circuit Breaker Fail Protection	RMS 2C	6	Poor	18/06/1987	-4.42	2	5	0	High
Remote Terminal Unit	INVENSYS SCD5200	3	Good	1/07/2008	1.57	3	3	5	Medium
Transmission Line Protection	ABB RAZFE	4	Poor	15/08/1987	-4.27	2	2	0	High
	SIEMENS 7SL24	4	Poor	15/08/1987	-4.27	2	2	0	High
Zone Auxiliary AC Protection	FG WILSON ATI-V502	1	Fair	30/05/2008	6.48	0	0	5	High
	RMS 2P	2	Poor	20/08/1987	-4.25	4	5	0	Medium
Zone Feeder Protection	NILSEN ITP	2	Poor	18/06/1987	-4.42	2	0	0	Very High
	RMS 2T	7	Poor	18/06/1987	-4.42	2	2	3	High
	SCHNEIDER MICOM-P142	18	Good	5/08/2014	12.65	5	5	5	Low
	SCHNEIDER MICOM-P545	1	Excellent	5/08/2014	12.65	5	5	5	Low
	SCHWEITZER SEL351A	19	Excellent	5/08/2014	12.65	5	5	5	Low
Zone HV Busbar Protection	GEC FAC34	4	Poor	17/06/1987	5.57	5	5	0	Medium
Zone Metering Supervision	ESP K4	4	Poor	5/07/1987	5.62	1	1	0	Very High
	ESP K4L	1	Poor	5/07/1987	5.62	1	1	0	Very High
	RMS 2P	1	Poor	12/08/1989	-2.28	4	5	0	Medium
Zone TX Protection	ABB RADSB	2	Poor	10/06/1987	-4.45	2	3	0	High
	ABB RAYA	2	Poor	10/06/1987	-4.45	3	5	0	High
	ARIC TTC	2	Fair	10/06/1987	5.55	3	5	5	Low
	ESP GP1	4	Fair	10/06/1987	5.55	5	5	5	Low
	ESP GP3	2	Fair	10/06/1987	5.55	5	5	5	Low
	GEC CAG	2	Fair	10/06/1987	5.55	2	3	5	Medium
	GEC MCGG	2	Good	10/06/1987	-4.45	2	2	0	High
	REINHAUSEN RS1000	2	Fair	10/06/1987	5.55	4	5	5	Low
	REYROLLE 4C21	6	Fair	10/06/1987	-4.45	2	3	0	High

Table 16 indicates the current asset condition. Based on the asset condition, the following class of protection assets have unacceptable poor condition with limited or no serviceable life left in them:

- Zone transformer main protections have exceeded their serviceable life by 4 years with no available spares.

Based on the above credible evidence in Table 16, a risk treatment to replace the assets has been presented in terms of tranches of projects.

Proposed Asset Risk Treatment

It is proposed to stand-up projects to replace the following:

- Project – Replace 132kV Protections
  - 2-132/11kV Transformer Protection with duplicated devices.

This Project is considered for the financial year 2027-28.

GOLD CREEK ZONE SUBSTATION

TABLE 17. GOLD CREEK CURRENT ASSET CONDITION

Protection Scheme Type	Model	Asset Count	Asset Health	Implementation Date	Remaining Life (Years)	Capability Score	Safety Score	Obsolescence Score	Risk Rating
Circuit Breaker Fail Protection	RMS 2C	2	Poor	20/02/1994	2.24	2	5	0	High
Remote Terminal Unit	ABB 560CMR	2	Good	1/02/2017	10.14	4	5	5	Low
	LEEDSNORTHRUP UNKNOWN	2	Poor	1/01/1991	-15.89	1	2	0	Very High
	OTHER OTHER	1	Poor	1/01/1991	-15.89	1	2	0	Very High
Transmission Line Protection	SCHNEIDER MICOM-P545	2	Excellent	22/11/2018	16.94	5	5	5	Low
	SCHWEITZER SEL411L	2	Excellent	22/11/2018	16.94	5	5	5	Low
Zone Auxiliary AC Protection	FG WILSON ATI-V502	1	Fair	22/07/2008	6.63	0	0	5	High
	RMS 2P	2	Poor	25/02/1994	2.25	4	5	0	Medium
Zone Feeder Protection	RMS 2T	4	Poor	20/06/1994	2.57	2	2	3	High
	SCHNEIDER MICOM-P142	25	Good	6/03/2017	15.23	5	5	5	Low
	SCHWEITZER SEL351A	29	Excellent	6/03/2017	15.23	5	5	5	Low
Zone HV Busbar Protection	GEC FAC34	2	Poor	24/02/1994	12.25	5	5	0	Medium
Zone Metering Supervision	ESP K4	5	Poor	20/01/1994	12.16	1	1	0	Very High
	RMS DAVG	1	Poor	25/02/1994	2.25	0	0	5	High
Zone TX Protection	ABB ABB-BETA	2	Fair	25/02/1994	12.25	3	5	5	Low
	ABB RADSB	2	Poor	25/02/1994	2.25	2	3	0	High
	ABB RAYA	2	Poor	25/02/1994	2.25	3	5	0	High
	ESP GP2	2	Fair	25/02/1994	12.25	5	5	5	Low
	ESP GP3	2	Fair	25/02/1994	12.25	5	5	5	Low
	GEC CAG	2	Fair	25/02/1994	12.25	2	3	5	Medium
	GEC MCGG	2	Fair	25/02/1994	2.25	2	2	0	High
	QUALITROL AKM	4	Fair	17/04/1997	15.39	4	5	5	Low
	REYROLLE 4C21	6	Fair	25/02/1994	2.25	2	3	0	High

Table 17 indicates the current asset condition. Based on the asset condition, the following class of protection assets have unacceptable poor condition with limited or no serviceable life left in them:

- Zone transformer main protections that have a remaining life of 2 years with no available spares.

Based on the above credible evidence in Table 17, a risk treatment to replace the assets has been presented in terms of tranches of projects.

Proposed Asset Risk Treatment

It is proposed to stand-up projects to replace the following:

- Project – 132kV Protection Replacement
  - 2-132/11kV Zone Power Transformer Protection with duplicated devices.

This project is suggested for the financial year 2028-29.

TELOPEA PARK ZONE SUBSTATION

TABLE 18. TELOPEA PARK CURRENT ASSET CONDITION

Protection Scheme Type	Model	Asset Count	Asset Health	Implementation Date	Remaining Life (Years)	Capability Score	Safety Score	Obsolescence Score	Risk Rating
Remote Terminal Unit	INVENSYS SCD5200	4	Good	1/07/2015	8.55	3	3	5	Medium
	MITS MD1000	1	Poor	1/01/1991	-15.89	1	2	0	Very High
Transmission Line Protection	DEWAR 695	5	Poor	6/04/1990	-1.63	4	5	5	Low
	DEWAR DM1200	1	Fair	6/04/1990	-1.63	2	5	5	Medium
	GEC MBCI	3	Poor	15/01/1987	-4.84	2	2	5	Medium
	GEC MRTP	3	Poor	15/01/1987	-4.84	2	5	5	Medium
	GEC MVAJ	3	Poor	15/01/1987	-4.84	2	5	5	Medium
	REYROLLE F8H	3	Poor	15/01/1987	5.16	2	5	0	High
	REYROLLE SOLKORRF	6	Poor	15/01/1987	-4.84	3	2	0	High
Zone Auxiliary AC Protection	RMS 2P	2	Poor	12/08/1987	-4.27	4	5	0	Medium
Zone Feeder Protection	ABB SPAJ-140C	3	Poor	13/10/2017	15.84	2	0	3	High
	GEC HO4	6	Fair	20/02/1989	7.25	2	2	0	High
	GEC MCGG	6	Poor	8/03/1995	3.28	2	2	0	High
	GEC MCSU	23	Fair	20/02/1989	-2.75	2	0	0	Very High
	NILSEN ITP	41	Poor	20/02/1989	-2.75	2	0	0	Very High
	REYROLLE F8H	1	Poor	3/05/1991	9.44	2	5	0	High
	RMS 2T	18	Poor	17/03/1995	3.31	2	2	3	High
	RMS 6R	1	Poor	3/05/1991	-0.56	2	5	5	Medium
	SCHNEIDER MICOM-P120	1	Good	8/03/1995	-6.72	3	5	5	Low
Zone Metering Supervision	ESP K4	3	Poor	7/11/1986	4.97	1	1	0	Very High
Zone TX Protection	ABB RADSB	3	Poor	4/06/1991	-0.47	2	3	0	High
	ABB RAYA	3	Poor	7/04/1988	-3.62	3	5	0	High
	ABB TapChanger Relay	2	Poor	16/10/1986	4.91	0	0	5	High
	ESP GP1	6	Fair	4/06/1990	8.53	5	5	5	Low
	ESP GP3	4	Fair	4/06/1990	8.53	5	5	5	Low
	GEC CAG	3	Fair	4/05/1991	9.45	2	3	5	Medium
	GEC MCGG	3	Fair	4/05/1991	-0.55	2	2	0	High
	GEC VAJX11/CAA41	3	Poor	4/05/1991	9.45	2	3	5	Medium
	QUALITROL AKM	6	Fair	16/10/1986	4.91	4	5	5	Low
	REINHAUSEN RS2001	1	Poor	4/05/1991	9.45	4	5	5	Low
	REYROLLE 4C21	5	Fair	4/06/1991	-0.47	2	3	0	High
	REYROLLE F8H	9	Poor	4/05/1991	9.45	2	5	0	High
	SYRLEC BLRMU	3	Fair	16/10/1986	-5.09	3	5	0	Medium

Table 18 indicates the current asset condition. Based on the asset condition, the following class of protection assets have unacceptable poor condition with limited or no serviceable life left in them:

- Zone transformer main protections have exceeded their serviceable life by 3 years with no available spares.

Based on the above credible evidence in Table 18, a risk treatment to replace the assets has been presented in the proposed asset risk treatment.

Other assets in this substation are being replaced in the current EN19-24 regulatory period.

Proposed Asset Risk Treatment

It is proposed to stand-up a project to replace the ageing transformer protections. This project is currently being implemented in the regulatory period.

- Project – 132 kV Transformer Protection Replacement
  - 3-132kV Transformer protection upgrade with duplicated devices.

This project is proposed to be implemented in the financial year 2024-25.

THEODORE ZONE SUBSTATION

TABLE 19. THEODORE CURRENT ASSET CONDITION

Protection Scheme Type	Model	Asset Count	Asset Health	Implementation Date	Remaining Life (Years)	Capability Score	Safety Score	Obsolescence Score	Risk Rating
Circuit Breaker Fail Protection	RMS 2C	2	Poor	29/03/1989	-2.65	2	5	0	High
Remote Terminal Unit	INVENSYS SCD5200	3	Good	1/07/2011	4.56	3	3	5	Medium
Transmission Line Protection	ABB RAZFE	2	Poor	18/05/1989	-2.51	2	2	0	High
Zone Auxiliary AC Protection	RMS 2P	3	Poor	29/03/1989	-2.65	4	5	0	Medium
Zone Feeder Protection	GEC MCSU	2	Fair	27/02/1989	-2.73	2	0	0	Very High
	NILSEN ITP	13	Poor	27/02/1989	-2.73	2	0	0	Very High
	RMS 2T	12	Poor	29/03/1989	-2.65	2	2	3	High
	SCHNEIDER MICOM-P142	2	Good	25/03/2014	12.29	5	5	5	Low
	SCHWEITZER SEL351A	2	Excellent	25/03/2014	12.29	5	5	5	Low
Zone HV Busbar Protection	GEC FAC34	2	Poor	29/03/1989	7.35	5	5	0	Medium
Zone Metering Supervision	ESP K4	4	Poor	29/03/1989	7.35	1	1	0	Very High
Zone TX Protection	ABB RADSB	2	Poor	21/08/1990	-1.25	2	3	0	High
	ABB RAYA	2	Poor	21/08/1990	-1.25	3	5	0	High
	ARIC TTC	2	Fair	21/08/1990	8.75	3	5	5	Low
	ESP GP2	4	Fair	21/08/1990	8.75	5	5	5	Low
	ESP GP3	2	Fair	21/08/1990	8.75	5	5	5	Low
	GEC CAG	2	Fair	21/08/1990	8.75	2	3	5	Medium
	GEC MCGG	2	Good	21/08/1990	-1.25	2	2	0	High
	REINHAUSEN RS1000	2	Fair	21/08/1990	8.75	4	5	5	Low
	REYROLLE 4C21	4	Fair	21/08/1990	-1.25	2	3	0	High
	REYROLLE F8H	4	Poor	23/03/1989	7.34	2	5	0	High
Zone Underfrequency Protection	SCHNEIDER MICOM-P142	1	Good	4/10/2018	16.81	5	5	5	Low
	SCHWEITZER SEL351A	1	Excellent	4/10/2018	16.81	5	5	5	Low

Table 19 indicates the current asset condition. Based on the asset condition, the following class of protection assets have unacceptable poor condition with limited or no serviceable life left in them:

- Zone Feeder Protection: The feeder protections are old failing static relays that have exceeded their serviceable life by 3 years with no available spares. These schemes cannot provide arc flash or live line sequence protections and leave the crew vulnerable.
- Zone transformer main protection that has exceeded its remaining serviceable life by almost 2 years with no available spares.

Based on the above credible evidence in Table 19, a risk treatment to replace the assets has been presented in terms of tranches of projects.

Proposed Asset Risk Treatment

It is proposed to stand-up projects to replace the ageing transformer protections:

- Project-1 – 11kV Protection Replacement
  - 22-Feeder Bay Overcurrent and Earth Fault Protection with duplicated devices
  - 4-Group Breaker Overcurrent and Earth Fault Protection with duplicated devices
  - 2-Bus Coupler with duplicated controllers
  - 2-132/11kV Zone Power Transformer Protection with duplicated devices.

This project is proposed to be implemented in the financial year 2027-29.

WODEN ZONE SUBSTATION

TABLE 20. WODEN CURRENT ASSET CONDITION

Protection Scheme Type	Model	Asset Count	Asset Health	Implementation Date	Remaining Life (Years)	Capability Score	Safety Score	Obsolescence Score	Risk Rating
Remote Terminal Unit	INVENSYS SCD5200	4	Good	1/07/2012	5.56	3	3	5	Medium
Transmission Line Protection	ABB RAZFE	2	Poor	8/04/1983	-8.61	2	2	0	High
	ECNSW ECNSWST07-5921E	3	Poor	19/06/1986	4.58	0	0	5	High
	GEC ALSTOM MICOM-P545	1	Excellent	10/12/2020	18.99	5	5	5	Low
	GEC MCTI	1	Poor	7/06/1990	-1.46	2	5	5	Medium
	NREC PCS-931	1	Excellent	10/12/2020	18.99	5	5	5	Low
	REYROLLE HTYPE	2	Poor	19/06/1990	8.57	2	2	0	High
	RMS 2C	2	Poor	4/09/1987	-4.21	2	5	0	High
Zone Auxiliary AC Protection	RMS 2P	2	Poor	13/04/1983	-8.6	4	5	0	Medium
Zone Feeder Protection	ABB ASEA RI	8	Poor	8/09/1986	4.8	2	2	0	High
	ABB SPAJ-140C	31	Poor	26/11/1991	-9.99	2	0	3	High
	GEC CAG	3	Fair	8/09/1986	4.8	2	3	5	Medium
	GEC CDG	20	Poor	16/02/1989	7.24	2	0	0	Very High
	GEC MCGG82	19	Poor	2/12/1993	2.02	0	0	0	Very High
	GEC MCGG22	27	Fair	4/06/1993	1.53	2	0	0	Very High
	GEC MCSU	20	Fair	2/12/1993	2.02	2	0	0	Very High
	RMS 2C	8	Poor	4/09/1987	-4.21	2	5	0	High
	RMS 2T	13	Poor	8/09/1986	-5.2	2	2	3	High
	SCHNEIDER MICOM P142	5	Good	4/01/2018	16.06	5	5	5	Low
	SCHWEITZER SEL351A	6	Excellent	4/01/2018	16.06	5	5	5	Low
Zone HV Busbar Protection	ABB REF615	1	Excellent	15/04/2021	19.33	5	5	5	Low
	GE MFAC34	1	Excellent	15/04/2021	19.33	5	5	5	Low
	SCHWEITZER SEL351S	1	Excellent	15/04/2021	19.33	5	5	5	Low
	SCHWEITZER SEL587Z	1	Excellent	15/04/2021	19.33	5	5	5	Low
Zone Metering Supervision	ESP K4	3	Poor	22/03/1983	1.34	1	1	0	Very High
	ESP K4L	1	Poor	22/03/1983	1.34	1	1	0	Very High
Zone TX Protection	ABB RAYA	1	Poor	26/06/1987	-4.4	3	5	0	High
	ESP GP1	5	Fair	27/06/1991	9.59	5	5	5	Low
	ESP GP3	3	Fair	27/06/1991	9.59	5	5	5	Low
	QUALITROL AKM	3	Fair	9/04/1983	1.39	4	5	5	Low
	REINHAUSEN RS1000	3	Fair	27/06/1991	9.59	4	5	5	Low
	REYROLLE 2C21	9	Poor	8/09/1986	-5.2	2	3	0	High
	RMS 2T	3	Poor	4/09/1987	-4.21	2	2	3	High
	RMS 2V16	2	Poor	22/10/2003	1.89	4	5	5	Low
	RMS 2V48	1	Poor	26/06/1987	-4.4	5	5	5	Low
Zone Underfrequency Protection	SCHWEITZER SEL351	1	Excellent	4/01/2018	16.06	5	5	5	Low
	SCHNEIDER MICOM P142	1	Good	4/01/2018	16.06	5	5	5	Low

Table 20 indicates the current asset condition. Based on the asset condition, the following class of protection assets have unacceptable poor condition with limited or no serviceable life left in them:

- Zone Feeder Protection: The feeder protections are a combination of old electromechanical and failing static relays that have exceeded their serviceable life by 4 years with no available spares. These schemes cannot provide arc flash or live line sequence protections and leave the crew vulnerable.

Based on the above credible evidence in Table 20, a risk treatment to replace the assets has been presented in terms of tranches of projects.

Proposed Asset Risk Treatment

A current ongoing 132kV project is in an advanced state of implementation and is replacing:

- 3-132kV Transmission lines
- 2-132kV HV Busbar Protection
- 3-132/11kV Transformer Protections
- 6-11kV Group breakers
- 3-11kV bus couplers.

It is proposed to stand-up a project to replace the following:

- Project – 11kV Protection Replacement – Priority-2
  - 30-Feeder Bay Overcurrent and Earth Fault Protection with duplicated devices

- Implement 11kV arc flash low impedance bus protection
- Advanced underfrequency load shedding scheme to align with AEMO's latest mandate.

This project is proposed to be implemented in the financial year 2026-27.

LATHAM ZONE SUBSTATION

TABLE 21. LATHAM CURRENT ASSET CONDITION

Protection Scheme Type	Model	Asset Count	Asset Health	Implementation Date	Remaining Life (Years)	Capability Score	Safety Score	Obsolescence Score	Risk Rating
Remote Terminal Unit	ABB COM600	1	Excellent	9/10/2000	-6.14	5	5	5	Low
	INVENSYS SCD5200	2	Good	1/07/2000	-6.41	3	3	5	Medium
Transmission Line Protection	ABB RAZOG	1	Poor	9/04/1979	-12.6	2	2	0	High
	ECNSW ECNSWSTO7-592IE	2	Poor	19/06/1986	4.58	0	0	5	High
	SCHNEIDER MICOM-P545	1	Excellent	8/10/2020	18.82	5	5	5	Low
	SCHWEITZER SEL411L	1	Excellent	8/10/2020	18.82	5	5	5	Low
Zone Auxiliary AC Protection	FG WILSON ATI-V502	1	Fair	27/06/2008	6.56	0	0	5	High
	RMS 2P	2	Poor	20/01/1992	0.16	4	5	0	Medium
Zone Feeder Protection	ABB SPAJ-140C	22	Poor	19/02/1999	-2.77	2	0	3	High
	GEC KCEG140	24	Fair	19/02/1999	-2.77	3	2	0	High
	GEC MCGG	8	Poor	19/11/1998	6.98	2	2	0	High
	GEC MCSU	8	Fair	20/10/1992	0.91	2	0	0	Very High
	RMS 2C	16	Poor	19/02/1999	7.23	2	5	0	High
	RMS 2P	1	Poor	12/05/1989	-2.53	4	5	0	Medium
	RMS 2T	6	Poor	15/04/1999	7.38	2	2	3	High
	RMS 6R	15	Poor	19/02/1999	7.23	2	5	5	Medium
Zone HV Busbar Protection	AEI FV2	2	Fair	5/03/1971	-20.68	5	5	0	Medium
Zone Metering Supervision	ESP K4	1	Poor	6/05/1982	0.47	1	1	0	Very High
	ESP K4L	1	Poor	6/05/1982	0.47	1	1	0	Very High
Zone TX Protection	ABB RAYA	1	Poor	7/04/1988	-3.62	3	5	0	High
	ESP GP1	1	Fair	11/09/1986	4.81	5	5	5	Low
	ESP GP3	1	Fair	11/09/1986	4.81	5	5	5	Low
	GEC CAG	1	Fair	11/09/1986	4.81	2	3	5	Medium
	GEC CDG	1	Poor	11/09/1986	4.81	2	0	0	Very High
	GEC MCGG	2	Fair	11/09/1986	-5.19	2	2	0	High
	GEC VAJH	8	Poor	11/09/1986	4.81	2	3	0	High
	GEC VAJX11/CAA41	1	Poor	11/09/1986	4.81	2	3	5	Medium
	QUALITROL AKM	2	Fair	2/05/1982	0.46	4	5	5	Low
	REINHAUSEN RS1000	3	Fair	11/09/1986	4.81	4	5	5	Low
	REYROLLE 4C21	14	Fair	11/09/1986	-5.19	2	3	0	High
	REYROLLE F8H	1	Poor	11/09/1986	4.81	2	5	0	High
	RMS 2C	2	Poor	11/09/1986	-5.19	2	5	0	High
	RMS 2T	3	Poor	11/09/1986	-5.19	2	2	3	High
	RMS 2V16	2	Poor	7/04/1988	-13.62	4	5	5	Low
	RMS 2V48	1	Poor	7/04/1988	-3.62	5	5	5	Low
	ROTOTHERM ROTOTHERM	4	Fair	30/03/1981	-0.63	4	5	5	Low
	SPRECHER & SCHUH RZE	1	Fair	2/05/1982	0.46	0	0	5	High
	SYRLEC BLRMU	3	Fair	30/03/1981	-10.63	3	5	0	Medium
	WEIR 1DE	4	Fair	11/09/1986	4.81	4	5	5	Low
	WEIR 3DE	2	Fair	11/09/1986	4.81	4	5	5	Low
Zone Underfrequency Protection	SCHNEIDER MICOM-P142	1	Good	10/05/2017	15.41	5	5	5	Low
	SCHWEITZER SEL351A	1	Excellent	10/05/2017	15.41	5	5	5	Low

Table 21 indicates the current asset condition. Based on the asset condition, the following class of protection assets have unacceptable poor condition with limited or no serviceable life left in them:

- Zone Feeder Protection: The feeder protections are a combination of old electromechanical and failing static relays that have exceeded their serviceable life by 3 years with no available spares. These schemes cannot provide arc flash or live line sequence protections and leave the crew vulnerable.
- Zone transformer main protections that have far exceeded their serviceable life by 7 years with no available spares.

- The Group-AG switchboard has issues with arc venting and louvres and exhibits enormous partial discharge risks that could present safety issues to maintenance personnel.

Based on the above credible evidence in Table 21, a risk treatment to replace the assets has been presented in terms of tranches of projects.

Proposed Asset Risk Treatment

It is proposed to stand-up projects to replace the following:

Project-1 tranche is considered for the current regulatory period and expected to be completed by 2023.

- Project-1 – Replace 132kV Protections – Priority-2
  - 2-132kV/11kV Transformer Protection with duplicated devices.

  This project is proposed for implementation in the financial year 2027-28.
- Project-2 – Primary Equipment Replacement
  - Replace Group-AG switchboard inclusive of protections.

Project-2 is envisaged to occur in the financial year 2028-29. This has been identified in the zone substation portfolio strategy.

WANIASSA ZONE SUBSTATION

TABLE 22. WANIASSA CURRENT ASSET CONDITION

Protection Scheme Type	Model	Asset Count	Asset Health	Implementation Date	Remaining Life (Years)	Capability Score	Safety Score	Obsolescence Score	Risk Rating
Remote Terminal Unit	INVENSYS SCD5200	3	Good	1/07/2011	4.56	3	3	5	Medium
Transmission Line Protection	ABB RAZFE	2	Poor	4/09/1987	-4.21	2	2	0	High
Zone Auxiliary AC Protection	RMS 2P	2	Poor	29/09/1981	-10.13	4	5	0	Medium
Zone Feeder Protection	ABB ASEA RI	4	Poor	8/09/1993	11.79	2	2	0	High
	ABB SPAJ-140C	22	Poor	15/02/1989	-12.76	2	0	3	High
	GEC CDG	46	Poor	15/02/1989	7.24	2	0	0	Very High
	GEC HO4	4	Fair	13/12/1990	9.06	2	2	0	High
	RMS 2C	22	Poor	15/02/1989	-2.76	2	5	0	High
	RMS 2T	6	Poor	8/09/1993	1.79	2	2	3	High
Zone HV Busbar Protection	GEC FAC34	2	Poor	9/07/1981	-0.35	5	5	0	Medium
Zone Metering Supervision	ESP K4	1	Poor	1/07/1981	-0.37	1	1	0	Very High
	ESP K4L	1	Poor	1/07/1981	-0.37	1	1	0	Very High
Zone TX Protection	ABB ASEA RI	2	Poor	8/09/1986	4.8	2	2	0	High
	ABB RADSB	1	Poor	27/06/1991	-0.41	2	3	0	High
	ABB RAYA	2	Poor	26/06/1987	-4.4	3	5	0	High
	ESP GP1	1	Fair	13/10/1987	5.9	5	5	5	Low
	ESP GP3	2	Fair	13/10/1987	5.9	5	5	5	Low
	GEC CAG	3	Fair	8/09/1986	4.8	2	3	5	Medium
	GEC CDG	1	Poor	27/06/1991	9.59	2	0	0	Very High
	QUALITROL AKM	4	Fair	30/03/1981	-0.63	4	5	5	Low
	REINHAUSEN RS1000	3	Fair	8/09/1986	4.8	4	5	5	Low
	REYROLLE 4C21	14	Fair	8/09/1986	-5.2	2	3	0	High
	RMS 2T	2	Poor	20/06/1991	-0.43	2	2	3	High
	RMS 2V16	1	Poor	26/06/1987	-14.4	4	5	5	Low
	ROTOTHERM ROTOTHERM	1	Fair	30/03/1981	-0.63	4	5	5	Low
	WEIR 1DE	4	Fair	8/09/1986	4.8	4	5	5	Low
	WEIR 3DE	2	Fair	8/09/1986	4.8	4	5	5	Low
Zone Underfrequency Protection	SCHNEIDER MICOM-P142	1	Good	22/06/2018	16.52	5	5	5	Low
	SCHWEITZER SEL351	1	Excellent	22/06/2018	16.52	5	5	5	Low

Table 22 indicates the current asset condition. Based on the asset condition, the following class of protection assets have unacceptable poor condition with limited or no serviceable life left in them:

- Zone Feeder Protection: The feeder protections are a combination of old electromechanical and failing static relays that have exceeded their serviceable life by 3 years with no available spares. These schemes cannot provide arc flash or live line sequence protections and leave the crew vulnerable.
- Zone transformer main protections that have far exceeded their serviceable life by 7 years with no available spares.

\- The Group-AG switchboard has issues with arc venting and louvres and exhibits enormous partial discharge risks that could present safety issues to maintenance personnel.

Based on the above credible evidence in Table 22, a risk treatment to replace the assets has been presented in terms of tranches of projects.

Proposed Asset Risk Treatment

It is proposed to stand-up projects to replace the following:

Project-1 tranche is considered for the current regulatory period and expected to be completed by 2023.

- Project-1 – Replace 132kV Protections – Priority-2
  - 2-132kV/11kV Transformer Protection with duplicated devices.

  This project is proposed for implementation in the financial year 2028-29.
- Project-2 – Primary Equipment Replacement
  - Replace Group-AG switchboard inclusive of protections.

Project-2 is envisaged to occur in the financial year 2025-26. This has been identified in the zone substation portfolio strategy.

All other protection assets are being replaced in the current regulatory period EN19-24.

Appendix B – ZONE SUBSTATION PROTECTION RISK ASSESSMENT

TABLE 23. ZONE SUBSTATION PROTECTION UPGRADE PROGRAM RISK ASSESSMENT

ZONE SUBSTATION PROTECTION UPGRADE PROGRAM RISK ASSESSMENT										OPTION RESIDUAL RISK
RISK STATEMENT	EXISTING IMPACT	LIKELIHOOD	CONSEQUENCE	RATING	TREATMENT WITH THE PROGRAM	LIKELIHOOD	CONSEQUENCE	RATING	RISK CATEGORISATION	PROTECTION UPGRADE WITH DUPLICATE PROTECTION
		UNTREATED RISK				TREATED RISK				
1. Health and Safety In Evoenergy zone substations there are a number of protection schemes with aged and old-technology relays with slow clearance. Therefore, exposure of public and workers to fault energy and earth potential rise.	**Injuries** Risk of injury to staff is minimal due to slow fault clearance, non-detection of faults or non-redundant scheme protection failure. Similarly, Exposure of public to earth potential rise hazards.	Likely	Major	High	The replacement numerical duplicate relays will reduce the risk of slow clearing of faults and therefore the exposure of public and workers to fault energy and earth potential rise hazard	Rare	Minor	Low	Safety	Low Risk
2. Damage to the environment Oil leak due to the uncleared/undetected transformer faults Bushfire risk due to slow fault clearance resulting conductor damages.	**Oil leak / fire** With non-redundant scheme and aged relays, slow fault clearance can damage power transformers with oil leaks and overhead conductors which can initiate bush fire	Likely	Major	High	Rapid and reliable clearing of faults will reduce the fault energy to which the network is exposed with reduced cumulative thermal and mechanical wear and damage to the equipment carrying the fault current. This in particular will result in reduced stress on power transformers supplying the fault current and also reduce the likely hood of bonds & conductors being burnt off in the overhead distribution network	Rare	Minor	Low	Environment	Low Risk

3. Damage to Reputation 4. Disruption to operation 5. Financial damage, losses/costs Failure/slow fault clearance due to non-redundant protection or aged relay will lead to extended load interruption by backup/remote protection operation. This may also cause the equipment damage due to slow fault clearance.	**Transformer failure or Zone Substation blackout** Extended load interruption due to slow clearance and non-operation.	Likely	Major	High	Numerical relays provide flexibility, accuracy & performance as well as adding additional functionality and ability for faster electrical fault clearance. Immediate remote indication of fault type and fault current which can be provided by numerical protection will enhance critical operational decision in reducing the interruption time. Detailed fault record connected to SCADA system assists with the investigation of fault incidents, providing the better understanding. This leads to more efficient remedial actions resulting in enhance safety and reliability of network at lower cost.	Rare	Negligible	Low	Customer	Low Risk

GLOSSARY

TERM	DEFINITION
AC	Alternating Current
ACT	Australian Capital Territory
ADMS	Advanced Distribution Management System. Combined SCADA, Distribution Management and Outage Management System.
ADSS	All-Dielectric Self-Supporting optical fibre cable
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AESCSF	Australian Energy Sector Cyber Security Framework
ALARP	As Low As Reasonably Practical
AMS	Asset Management System
AS	Australian Standards
ASP	Asset Specific Plan
BOP	Bushfire Operations Plan
CAPEX	Capital Expenditure
CCTV	Closed Circuit Television
CT	Current Transformer
CWDM	Coarse Wave Division Multiplexing, technology that combines multiple signals at various wavelengths over a single fibre core or pair of cores
DC	Direct Current
DDRN	Digital Data Radio Network, the name given to the legacy UHF radio system used for data communications at Evoenergy
DER	Distributed Energy Resource
DGA	Dissolved Gas Analysis
DMR	Digital Mobile Radio
DNP3	Distributed Network Protocol 3. A communications protocol used in SCADA systems.
DSO	Distribution System Operator
DWDM	Dense Wavelength Division Multiplexing. A method of combining multiple optical signals in a single optical fibre using different light wavelengths.
ENSMS	Electricity Networks Safety Management System
EPR	Earth Potential Rise
ESB	Energy Security Board
EV	Electric Vehicle
FCI	Fault Current Indicator
FLISR	Fault Location, Isolation, and Service Restoration
FMECA	Failure Modes Effects and Criticality Analysis

TERM	DEFINITION
FSA	Formal Safety Assessment
GIS	Gas Insulated Switchgear
GOOSE	Generic Object Oriented Substation Event
GPS	Global Positioning System. Used as an accurate time source.
HMI	Human Machine Interface
HV	High Voltage
I/O	Input / Output
IACS	Industrial Automation and Control Systems
ICCP	Inter Control Centre Protocol
IEC	International Electrotechnical Commission
IEC 61850	An international standard defining communication protocols for IEDs at substations
IED	Intelligent Electronic Device. Includes modern microprocessor-based numerical relays that perform multiple protection and control functions, as well as self-monitoring.
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
IP	Internet Protocol
ISO	International Organization for Standardization
ISP	Integrated System Plan
IT	Information Technology
LAN	Local Area Network
LED	Light Emitting Diode
LV	Low Voltage
MED	Major Event Day
MPB	Metering Provider B
MPLS	Multi-Protocol Label Switching
MSATS	Market Settlement and Transfer Solution
MV	Medium Voltage
NEM	National Electricity Market
NER	National Electricity Rules
NiCad	Nickel Cadmium batteries
NPV	Net Present Value
OCB	Oil Circuit Breaker
OH&S	Occupational Health and Safety
OLTC	On Load Tap Changer
OPEX	Operational Expenditure
OPGW	Optical Fibre Ground Wire

TERM	DEFINITION
OT	Operational Technology
PC	Personal Computer
PCB	PolyChlorinated Biphenyls
PERA	Purdue Enterprise Reference Architecture
PJR	Project Justification Report
PV	Photovoltaic
QoS	Quality of Supply, Quality of Service
RCM	Reliability Centered Maintenance
RF	Radio Frequency
RPN	Risk Priority Number
RTU	Remote Terminal Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAMP	Strategic Asset Management Plan
SCADA	Supervisory Control And Data Acquisition
SEF	Sensitive Earth Fault
SF6	Sulfur hexafluoride, used as an electrical insulator and arc suppressant in Gas Insulated Switchgear.
SMV	Sampled Measured Values
SOCI	Security of Critical Infrastructure
SSCM	Secondary Systems Configuration Management, system providing secure access and management to field IEDs
STPIS	Service Target Performance Incentive Scheme
SWMS	Safe Work Method Statement
TNSP	Transmission Network Service Provider
TOBAN	Total Fire Ban
UHF	Ultra High Frequency
UTR	Utilities Technical Regulator
VAR	Volt-Ampere Reactive
VCB	Vacuum Circuit Breaker
VLAN	Virtual Local Area Network
VoIP	Voice over Internet Protocol
VRF	Virtual Routing and Forwarding
VT	Voltage Transformer
WAN	Wide Area Network
ZSS	Zone Substation

REFERENCE DOCUMENTS

DOCUMENT NAME	DOCUMENT NUMBER	VERSION	PUBLISH DATE
Asset Management Strategy	PO0746	10	14/08/2020
Asset Management Objectives	PO0744	5	07/10/2018

VERSION CONTROL

VERSION	DETAILS	RELEASE DATE
0.1	Initial Draft for internal review	7 October 2022
1.0	Release for regulatory proposal EN 2024–29.	19 January 2023

DOCUMENT CONTROL

DOCUMENT OWNER	PUBLISH DATE	REVIEW DATE
Group Manager Network Services	19 January 2023	19 January 2025