Appendix 1.11: Evoenergy Asset Portfolio Strategy: Zone Substation Assets

Regulatory proposal for the ACT electricity distribution network 2024–29

ZONE SUBSTATION ASSETS

ASSET PORTFOLIO STRATEGIES

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

CONTENTS

EXECUTIVE SUMMARY

Evoenergy's Zone Substation asset portfolio includes a diverse range of electrical equipment. It consists of all primary equipment across multiple voltage levels and some auxiliary equipment. Equipment is supported by and housed within structural infrastructure such as buildings and associated facilities which also form part of this asset portfolio.

Zone substations are the main 'nodes' of Evoenergy's electricity network where transmission or sub-transmission voltage levels are stepped down to High Voltage (HV) distribution level for downstream reticulation to end consumers.

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

- Zone Substation 132kV & 66kV Switchgear
- Zone Substation Auxiliary AC and Generators
- Zone Substation Transformers
- Zone Substation 11kV Switchboard Assembly
- Zone Substation Site and Structures
- Zone Substation Reactive Plants.

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 Zone Substation assets.

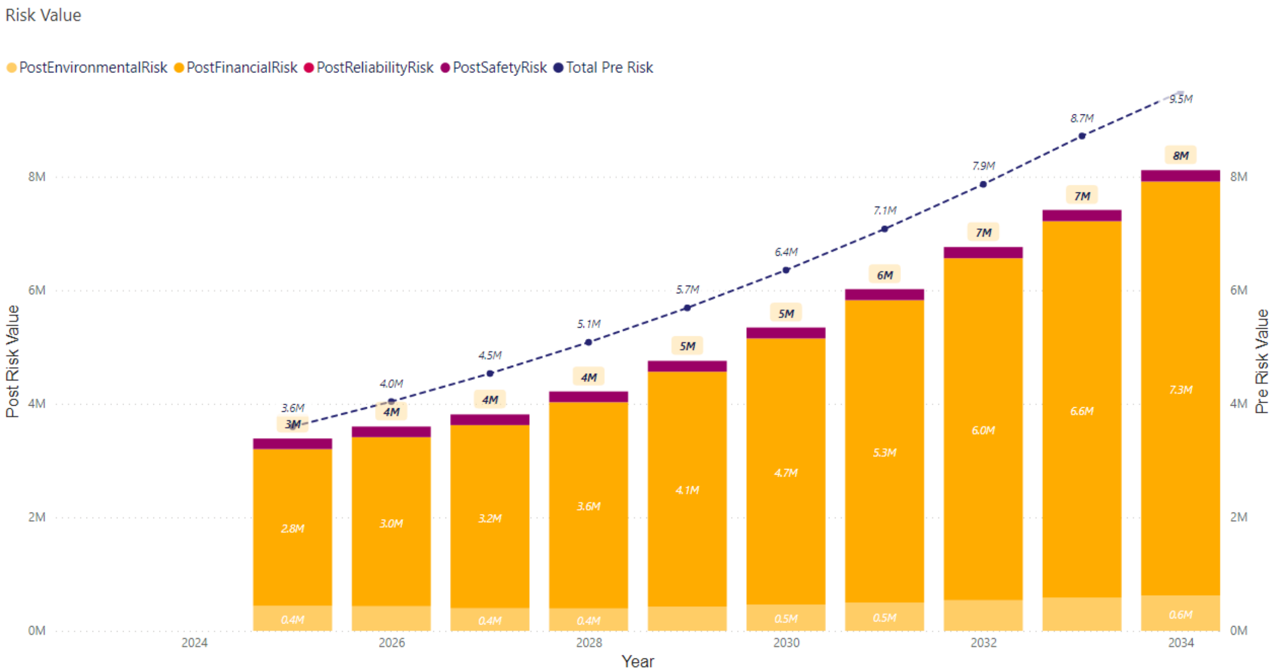
The information in this document is presented in the following structure:

- 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.

The increase in risk over the period is mostly due to aging 132kV switchgear with the risk with this asset group increasing from $1.3M in FY25 to $5.8M in FY34. This is somewhat addressed with the replacement of 6 circuit breakers and refurbishment of 17 circuit breakers in the 2024-29 period, however further replacements of 132kV circuit breakers will become a priority from 2029. Overall given the low failure and incident rate within the Zone Substation asset portfolio and the N-1 redundancy with assets, it is considered acceptable and manageable to increase the risk over the period.

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



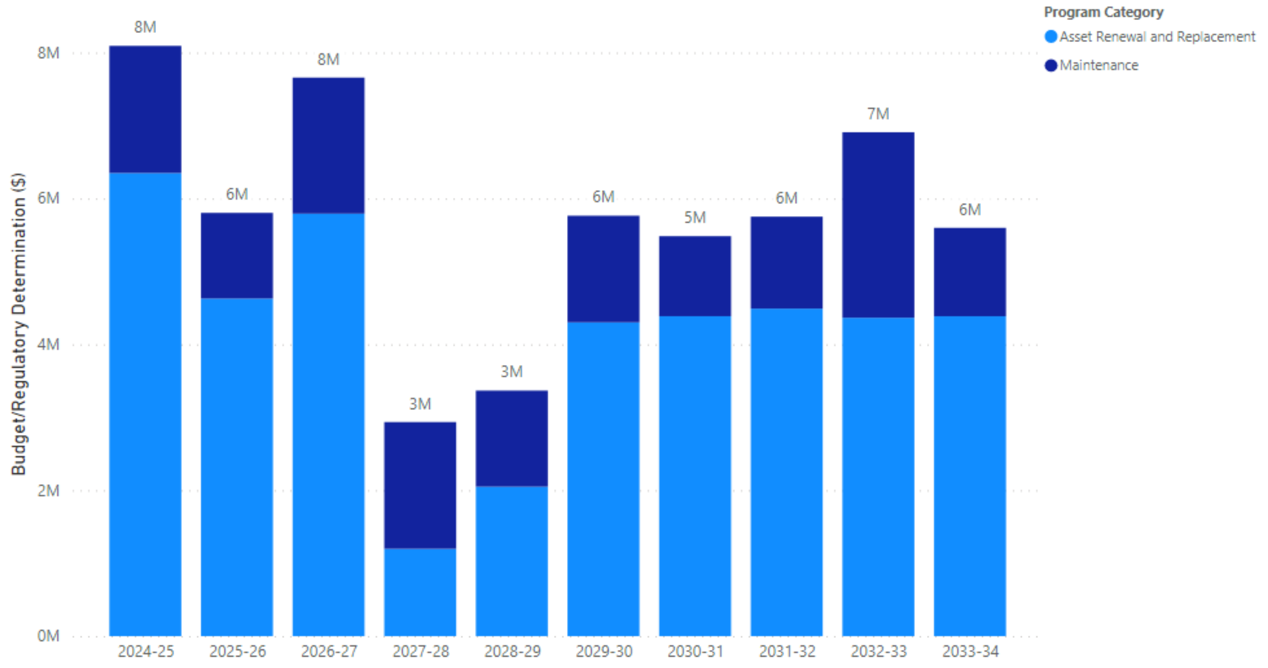
Key components of the program of work to address include:

- Replacement of one (1) 11kV switchboard at Latham Zone Substation (ZSS) and one (1) 11kV switchboards at Wanniassa ZSS
  - Proactive replacement of aged, slow operating, and faulty switchboards to reduce safety and operational risks. This project utilises a demountable structure to house the switchboard and all related components. Switchboards are proposed as single bus arrangement as the least cost and most reliable option.
- Replacement of two (2) 132kV Circuit Breakers at Latham ZSS and four (4) 132kV Circuit Breakers at Wanniassa ZSS
  - Part of the HLR circuit breaker replacement strategy. The purpose is to replace failure-prone circuit breakers at end-of-life.
- Major Refurbishment of 17 132kV Circuit Breakers at four (4) zone substation sites
  - HLR circuit breaker mid-life refurbishment to extend operational life and ensure assets are maintained in a serviceable and reliable state until eventual replacement in future periods.
- Replacement of Power Transformer – No.2 transformer at Telopea Park
  - 40% of all Evoenergy power transformers are older than the stated service life and are displaying signs of insulation deterioration.

- This project aims to proactively replace one of the lowest health-score power transformers within the network. The purpose is to upgrade the security of supply at one of the most critical zone substation locations.
- The transformer will become a network spare for reactive deployment as needed, to mitigate other transformer failure risks and lead time risk with 12-month lead time for a new unit.

The overall 10-year CAPEX and OPEX budget is shown in Figure 2. FY23 dollar figures are used. Overall forecast expenditure for the 2024-29 period is $20M CAPEX and $7.8M OPEX.

FIGURE 2. 10-YEAR ZONE SUBSTATION PORTFOLIO BUDGET (IN FY23 DOLLARS)



1. PURPOSE

The purpose of this document is to detail Evoenergy Zone Substation 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 six of Evoenergy's Zone Substation 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.

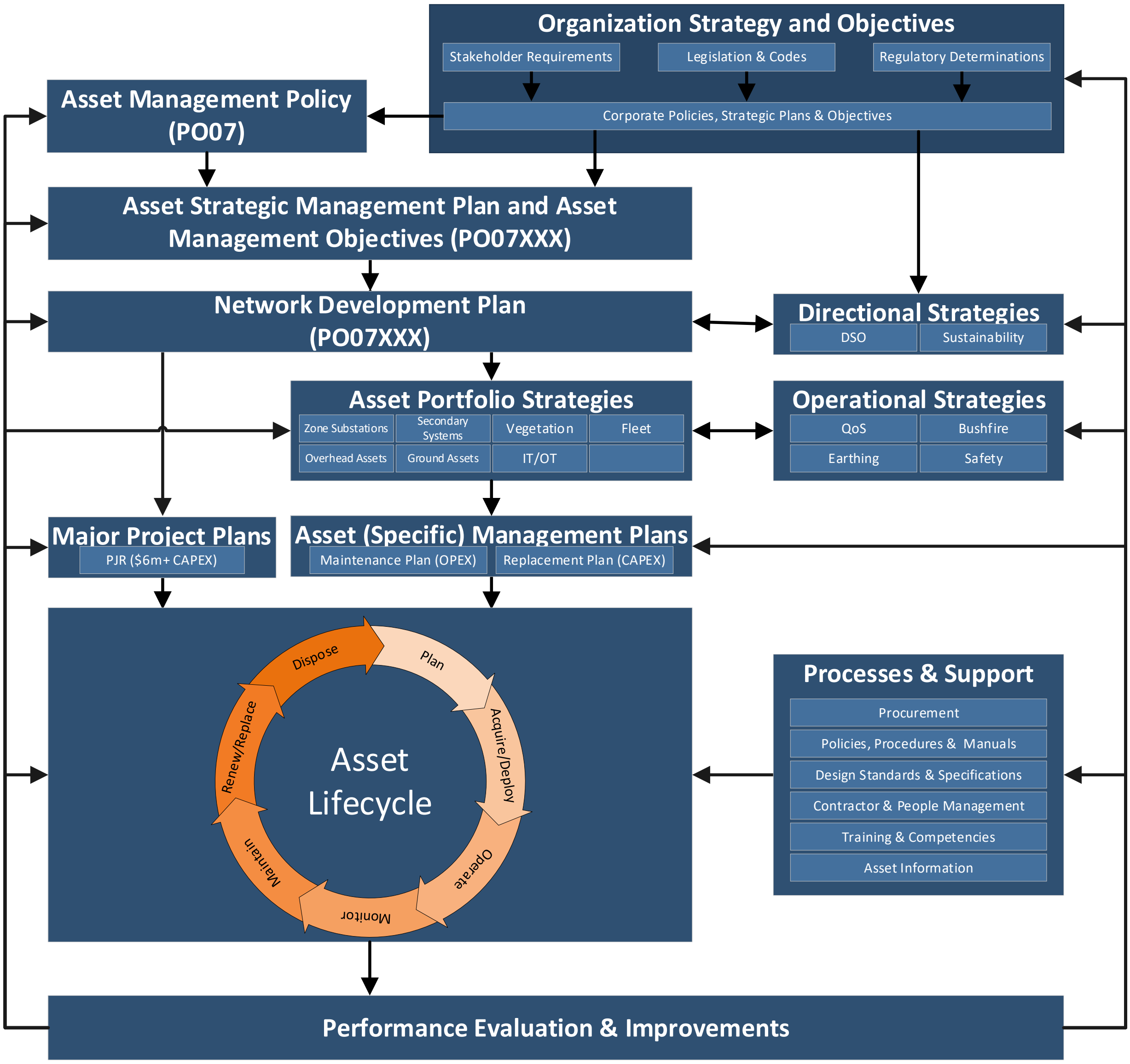
This document links the overarching business objectives and organisational drivers and the low-level operational decisions described in Evoenergy's asset management system.

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.

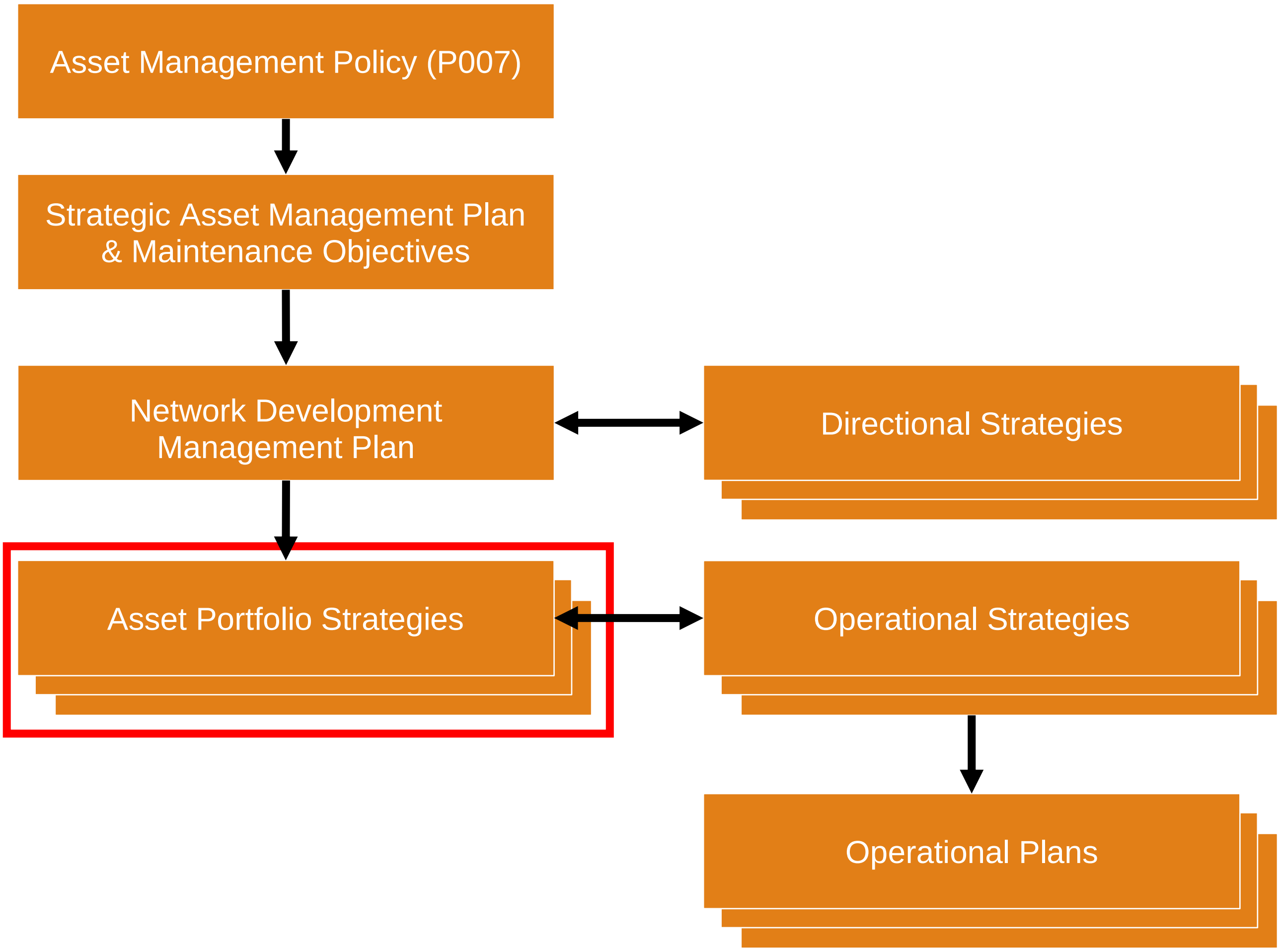
1.2. ASSET MANAGEMENT SYSTEM

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.

Evoenergy's Zone Substation asset portfolio includes a diverse range of electrical equipment. It consists of all primary equipment across multiple voltage levels and auxiliary equipment. Equipment is supported by and housed within structural infrastructure such as buildings and associated facilities which also form part of this asset portfolio.

Zone substations are the main 'nodes' of Evoenergy's electricity network where transmission or sub-transmission voltage levels are stepped down to HV distribution level for downstream reticulation to end consumers. The Zone Substation asset portfolio is high importance for safe and reliable operation of the network.

This portfolio includes the 132kV and 66kV switchgear, transformers, 11kV switchboards, auxiliary power systems, and sites and structures that collectively form Evoenergy's zone substations.

FIGURE 5. ASSET HIERARCHY (ONLY SHOWING THE ASSET CLASSES WITHIN THE ZONE SUBSTATION ASSET PORTFOLIO)

Overhead Assets

Ground Assets

Secondary Systems Assets

Zone Substation Assets

- 132kV and 66kV Switchgear
  - Earth Switches
  - Isolators
  - Surge Diverters
  - Circuit Breakers
- Auxiliary AC and Generators
  - Auxiliary AC Switchboards
  - Standby Generators
  - Automatic Transfer Switches
- Transformers
  - Auxiliary Transformers
  - Earthing Transformers
  - Power Transformer Assembly
  - Instrument Transformers (Zone)
- 11kV Switchboard Assembly
  - Switchboards
  - Circuit Breakers
  - Instrument Transformers
  - Earth/Test Trucks
- Site and Structures
  - General Items Transmission Sites
  - Structures (Zones)
  - Cable Equipment (Zones)
  - Earthing (Zones)
- Reactive Plant
  - Reactors (future)
  - Capacitor Banks (future)

Vegetation and Inspection

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

All these classes have assets that are located within zone substations. This asset portfolio facilitates the safe use of Evoenergy's network systems and converts power from transmission to distribution voltage levels. A more comprehensive breakdown of the asset groups and asset types associated with this asset portfolio is provided in Section 4.

Table 1 provides asset quantities within this portfolio.

TABLE 1. POPULATION OF ZONE SUBSTATION ASSETS – SUMMARY

ASSET GROUP	ASSET CLASS	QUANTITY	QUANTITY (UNIT)
Zone Substation 132kV & 66kV Switchgear	132kV & 66kV Earth Switches	37	Each
	132kV & 66kV Isolators	149	Each
	132kV & 66kV Surge Diverters	99	Each
	132kV & 66kV Circuit Breakers	68	Each
	Gas Insulated Switchgear (CB)	11	Each
	Gas Insulated Switchgear (GIS)	18	Each
Zone Substation Auxiliary AC and Generators	Auxiliary AC Switchboards	16	Each
	Standby Generators	14	Each
	Automatic Transfer Switches	14	Each
Zone Substation Transformers	Auxiliary Transformers	23	Each
	Earthing Transformers	29	Each
	Power Transformer Assembly	161	Each
	Instrument Transformers (Zone)	368	Each
Zone Substation 11kV Switchboard Assembly	Zone 11kV Switchboards	30	Each
	Zone 11kV Earth/Test Trucks	58	Each
	Zone 11kV Circuit Breakers	359	Each
	Zone 11kV Instrument Transformers	46	Each
Zone Substation Site and Structures	General Items Transmission Sites	16	Each
	Earthing (Zones)	16	Each
	Structures (Zones)	10	Each
Zone Substation Reactive Plant	Reactors (future)	0	Each
	Capacitor Banks (future)	0	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
Protection Relays	All zone substation elements are protected by protection relays. Each zone substation element has relevant protection applied to it based on the application and its role in power system operations. These assets are maintained alongside primary equipment.
SCADA	All events and other critical parameters inclusive of equipment statuses are monitored by SCADA systems.
DC Auxiliary Systems	Auxiliary DC battery systems provide auxiliary power to the control and motor circuits of the primary equipment.

ASSOCIATED ASSET CLASS	DESCRIPTION OF RELATIONSHIP
Communication systems	Communication systems form the backbone of information transfer, protection tripping logics, and channels for providing transmission line unit protection.
NEM Metering	Sub-transmission energy metering is provided for the purpose of NEM metering at the 11kV transformer connections at all 132kV/11kV zone substations (noting the Fyshwick 66kV/11kV zone substation is metered at the upstream Transgrid bulk supply point). The total of all the metered value is an indication of the total transmission supply to Evoenergy's distribution network.

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 Zone Substation 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 zone substation asset objectives.

TABLE 3. ZONE SUBSTATION ASSET OBJECTIVES

ASSET MANAGEMENT OBJECTIVES	ZONE SUBSTATION ASSET OBJECTIVES
Operate and maintain our network safely	- Embed and integrate safety culture, strategies, and initiatives - In conjunction with the requirements of AS5577: ENSMS, the Formal Safety Assessments (FSAs) have identified electricity network hazards, especially pertaining to the zone substation asset portfolio that could cause or contribute to an incident - Risk control measures and treatments appropriately identified and evaluated in accordance with methodologies

Meet our network reliability targets	- 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 AEMO (including expected maximum current flow, at any point)
	- Manage transformer approaching end of life (EOL)
	- Maintain N-1 service levels for 132kV assets

ASSET MANAGEMENT OBJECTIVES	ZONE SUBSTATION ASSET OBJECTIVES
Manage our network for the least total lifecycle cost	- Continue to implement Reliability Centered Maintenance (RCM) in order to maximise reliable service life of assets. This results in improved condition monitoring practices and life-extending refurbishment works.
Manage and invest in our network using prudent risk management approaches	- Maintain earthing compliance through efficient investment - Proactively identify earthing risks - Manage the ageing population of power transformers - Manage the deteriorating 11kV switchboards at Latham and Wanniassa - Effectively address the poor reliability of 132kV HLR circuit breakers - Address non-compliant AC switchboards and sub-circuits (to AS 3000 standards) - Address the DC auxiliary concerns regarding redundancy (single battery bank sites) and fire-rating levels of battery rooms
Deliver sustainable and cost-efficient network investments	- Actively planning for the net-zero carbon future - Monitoring strategies in place to proactively detect QoS issues to inform network planning and to detect issues - Maintain engineering controls, namely adequate transformer oil bunding and noise pollution mitigation
Operate an AMS that satisfies the needs of our stakeholders	- Optimise and manage our network asset management strategy to achieve asset longevity, cost reductions, and to maintain network reliability service levels
Manage opportunities and drive continuous improvement	- An increase in the number of customer solar panels is having an impact on the required tapping range of power transformers. This is being monitored and is considered when ordering new transformers. - Opportunities exist to manage ageing power transformers with online condition monitoring devices. To this end, dissolved gas analysers are being systematically fitted to existing transformers and are being specified on new transformers. - All 33 132kV circuit breakers (HLR type) are approaching end of life and have been experiencing multiple in-service failures. To delay replacement activities, an annual CAPEX refurbishment program has been established to increase reliability and postpone expenditure.

Evoenergy needs to assess its risk exposure, plan its investment to address those risks to as low as reasonably practicable (ALARP), 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 document systematically describe Evoenergy's approach in addressing these requirements via its Asset Management System, pertaining to its zone substation asset portfolio.

3.1. POWER TRANSFORMER ASSET CONDITION STRATEGY

Evoenergy has an ageing population of zone substation power transformers, with approximately 40% of Evoenergy power transformers older than the stated service life. A proactive condition monitoring strategy and reactive asset replacement strategy is being implemented as deemed prudent to manage increasing risk with the aging asset base and increasing risk of asset failure. These strategies are as follows.

a) Programmed condition monitoring

Power transformers have a 3-step active condition monitoring process that leads to asset replacement or retirement. Initially the insulating oil is sampled annually, and when a Degree of Polymerization (DP) test returns a value of less than 450, an intrusive sample test is triggered. The transformer is subject to this intrusive paper sample test every 4 years until a value of less than 250 is reached. At this point, the last step is taken, resulting in the transformer being replaced. In some cases, refurbishment can be a viable option however this is rarely a risk-free solution that has considerable costs and logistical impediments.

b) Online condition monitoring

This strategy implements online condition monitoring practices by way of installing dissolved gas analysers on at-risk transformers older than 40 years. These analysers trigger an alarm in real-time when gas threshold levels are breached, thus indicating an impending transformer fault or issue. These units operate in the background and can sample the transformer oil as frequently as 20-minute intervals.

c) Reactive asset replacement – provisioning a system spare

To complete this strategy, it is proposed to create a network spare power transformer that will be available for reactive replacement within a reasonable timeframe in the event of a transformer failure. This is considered prudent as approximately 40% of all Evoenergy power transformers are older than the stated service, and procurement lead times for a replacement power transformer are approximately 12 months. Not having a system spare power transformer would result in loss of N-1 zone substation power transformer contingency for 12 months (or longer) and this is considered an unacceptable risk to system security.

The system spare power transformer will be provisioned by replacing an existing low-condition power transformer with a new unit. The old unit will be stored and maintained as a system spare. Currently, the best candidate for this replacement is Telopea zone Tx2, planned in FY2025-26. Refer to section 4.4.5.2 for further site selection and project justification.

3.2. 11KV SWITCHBOARD REPLACEMENT STRATEGY

The current strategy for planned 11kV switchboard replacements are to install a stand-alone demountable building housing the new switchboard. The feeders will then be cut-over from an existing switchboard, and then this board will be decommissioned. This then enables subsequent replacement activities to occur within the existing zone switchroom once the old switchboard is removed.

To address operational, reliability, and safety risks, the below listed 11kV switchboards have been earmarked for proactive replacement within the 2024-29 period utilising a demountable solution:

- Wanniassa 11kV switchboard BG (1970; Email J-Type)
- Latham 11kV switchboard BG (1970; Email J-Type).

After these replacement projects have been completed, the following switchboards will be replaced (in future periods) utilising the existing 11kV switchroom:

- Wanniassa 11kV switchboard AG (1970; Email J-Type)
- Latham 11kV switchboard AG (1970; Email J-Type).

These four switchboards have low arc-flash safety levels, slow operations, ageing protection, and routinely have shutter-related issues causing circuit breakers to jam during a rack-in procedure. Further, condition monitoring is not feasible due to 11kV cable pitch terminations and physical logistical impediments.

3.3. 132KV CIRCUIT BREAKER ASSET REFURBISHMENT AND REPLACEMENT STRATEGY

A strategy has been implemented to replace 132kV HLR circuit breakers from the network beginning within the EN24 regulatory period. There are currently 32 of these in operation, with a failure rate of approximately one per year. However due to the cost, time, and resource consuming nature of this work, a maximum two circuit breakers are planned to be replaced per financial year, beginning in FY25.

In the interim, an asset refurbishment plan has been implemented in order to reduce the risk of failure and increase the reliability of these assets. This work includes condition assessment, timing, speed, and travel measurements, as well as part-replacement. Replacement parts often include main-charging springs, clutch components, dampeners, gauges, and grommets/gaskets. Systematic refurbishment works commenced in 2021 and a further 17 refurbishments are planned for the 2024-29 period.

4. ASSET CLASS STRATEGIES

4.1. CONTEXT

This section describes how the major asset classes introduced in Section 2 are managed throughout their respective lifecycles. 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.

Each zone substation in Evoenergy's network supplies, on average, 14,300 customers. These substations are part of the 132kV transmission network in the ACT, serving the entire ACT electricity supply and forming part of the NSW transmission network, as such it is critical that zone substation assets continue to operate safely and reliably. However, these assets also tend to be high-value but low-volume.

There are opportunities where assets can be monitored by making ongoing condition assessments. In doing so, assets can be proactively managed, costs can be kept to a minimum, and risk can be maintained to acceptable levels. This is Evoenergy's preferred strategy, where it is applicable. Where assets are found to present unacceptable levels of risk, Evoenergy refurbishes or replaces these assets.

4.2. ZONE SUBSTATION 132KV & 66KV SWITCHGEAR STRATEGY

Zone substation 132kV and 66kV switchgear assets are installed in all of Evoenergy's zone substations and 132kV switching stations. These substations each supply 14,300 customers on average and form part of the 132kV transmission network in the ACT and NSW. This equipment is required to switch, protect, isolate and earth electrical networks and plant. Their reliable operation is fundamental to the safe and reliable operation of the network.

4.2.1 Asset Class Summary and Objectives

The 132kV and 66kV switchgear at Evoenergy zone substations and switching stations are categorised into the following asset groups:

- 132kV & 66kV Outdoor Circuit Breakers
- 132kV & 66kV Outdoor Air Insulated Switchgear
- 132kV GIS Modular Switchgear.

4.2.1.1 132kV & 66kV Outdoor Circuit Breakers

Circuit breakers perform load and fault switching functions for the network. As they clear network faults, and minimise the fault current magnitude and duration, they are critical to maintain the safety of employees, members of the public and to protect assets both within zone substations and on the interconnected network. They also provide essential means for planned load switching to allow network reconfiguration for maintenance access to assets.

Circuit breakers perform the load and fault (protection initiated) switching of 132kV and 66kV circuits. They have an interdependency on the associated protection relays in the Secondary Systems Asset Portfolio.

4.2.1.2 132kV & 66kV Outdoor Air Insulated Switchgear

This asset group is made up of isolators, earth switches, and surge arrestors. Air Insulated Switchgear (AIS) assets are installed in all of Evoenergy's 132kV/11kV and 66kV/11kV zone substations and 132kV switching stations. This equipment is required to isolate, protect, and earth electrical plant and networks. Their consistent operation is fundamental to the safe and reliable operation of the network.

AIS assets form the majority of the 132kV and 66kV outdoor equipment installed in zone substations. As an asset class they perform functions that are essential to the reliable and safe operation of the zone substations and the wider network. The high-level functions of this asset class are:

- Connecting transmission lines with major zone substation assets such as power transformers
- Monitoring of network power flow for load management, control, and protection purposes
- Providing safe access to network plant and equipment for maintenance
- Protection of high value assets from potentially damaging transient overvoltages.

4.2.1.3 132kV GIS Modular Switchgear

Gas Insulated Modular Switchgear (GIS) in zone substations and switching stations provide the primary system interface between the 132kV sub-transmission network and zone substation power transformers. GIS is a modular alternative to conventional outdoor switchgear. Control, protection, switching, and isolation of electrical plant and networks is performed by GIS. These assets also interface with control and protection schemes both inside and outside the zone substation.

Included are components such as circuit breakers, Voltage Transformers (VTs), Current Transformers (CTs), isolators, earth switches and busbars (for GIS only). The key characteristic of GIS is that all the primary conductors and switchgear elements are completely enclosed in an earthed metallic structure. The structure uses sulfur hexafluoride (SF6) gas as the insulating medium. This allows each type of enclosed switchgear to effectively use the smallest possible footprint.

4.2.2 Asset Types

4.2.2.1 132kV & 66kV Outdoor Circuit Breakers

Circuit breakers perform on-load and fault switching functions. Through their ability to clear network faults, and to minimise both fault current magnitude and duration, they perform a critical function to maintain the safety of employees, members of the public and for our assets both within zone substations and on the interconnected network. They are also used for planned load switching to allow network reconfiguration for maintenance access to assets.

The circuit breaker asset group includes:

- SF6 Live Tank Circuit Breakers
- SF6 Dead Tank Circuit Breakers
- Oil-filled Circuit Breakers.

d) SF6 Live Tank Circuit Breakers

These circuit breakers utilise SF6 gas as their insulating and arc quenching medium. They have a more modern design compared with minimum-oil breakers, have fewer deterioration drivers and are less maintenance intensive. While an internal flashover would still cause an explosion risk, the likelihood of this is relatively low due to the use of SF6 gas instead of oil. Risks are further mitigated through the fitment of pressure relief mechanisms.

Live tank circuit breakers don’t have fitted CTs but they usually have separate post-type CTs installed immediately beside them.

e) SF6 Dead Tank Circuit Breakers

The interrupter design, insulating medium, and operation of dead tank circuit breakers is very similar to that of their live tank counterparts.

The key differences between the two types are as follows:

- The interrupter in the dead tank type is enclosed within an earthed metal tank pressurised with SF6 gas, whereas a live tank type has the interrupter housed in an insulating casing which is at line potential

- Dead tank circuit breakers have CTs installed internally in the bushing turrets.

Evoenergy also has one legacy type dead tank circuit breaker (Belconnen 2EB), characterised by its dual-pressure SF6 design. This breaker requires an air-compressor to maintain a higher gas pressure in one of its chambers to aid with arc quenching. This type of circuit breaker has been phased out over time and replaced with modern types of dead tank circuit breakers as described above.

f) Oil-Filled Circuit Breakers

Oil-filled circuit breakers are the oldest type in the Evoenergy network. These vary in age from 31 to 63 years old (as of 2022). Insulating oil is used as the insulation and arc quenching medium. This function is heavily reliant on gas generated by the arcing within the oil that occurs during contact separation to complete an opening operation.

Due to their design, failure conditions can present a high risk of explosion and fire with widespread resultant risk to personnel and adjacent assets.

Oil-filled circuit breakers are vulnerable to a wide range of deterioration drivers and, accordingly, they are maintenance intensive compared with modern alternatives.

4.2.2.2 132kV & 66kV Outdoor Air Insulated Switchgear

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

a) 132kV & 66kV Earth Switch

Earth switches are required to operate only for maintenance access. When needed, they are ‘closed’ on to the high voltage circuit concerned. For normal network operation they have no electrical connection to the high voltage circuits. Therefore, given also that earths can be applied by other means, the reliability of earth switches is less than that of circuit breakers and instrument transformers.

Earth switches play no part in in connection or disconnection of load for switching or fault clearance. They provide an efficient and safe mechanism to connect an out of service (isolated) line to earth. Their function is less critical than circuit breakers and instrument transformers as other means for applying earths are available (e.g., portable earths). However, for issues of practicality, safety, and cost, they are not preferred.

Earth switches have a simple design and have no graded insulation system. As such, their modes of failure are typically benign and present a low level of risk. They are subject to a program of planned maintenance which incorporates some condition monitoring activities on a four yearly basis.

b) 132kV & 66kV Isolator

Isolators provide a safe and efficient way to isolate 132kV and 66kV assets within zone substations for access and maintenance purposes.

Isolators (like earth switches) do not switch loads or clear faults. Rather, they provide a safe and efficient means for the electrical isolation of network assets for physical access. Their function is less critical than the circuit breakers and instrument transformers as other means of achieving isolations are available (such as the removal of connections). For issues of practicality, safety and cost, this is not preferred.

Isolators are required to remain in service (closed) continuously usually only being operated (opened and closed) for maintenance activities on other assets. They require a high degree of reliability in terms of their current carrying capacity (in the closed state). Given, however, that circuit isolations can be obtained by other methods, their required operational reliability is less than that of the circuit breakers and instrument transformers.

Isolators have a simple design and have no graded insulation system. As such their modes of failure are typically benign and present a low level of risk. They are subject to a program of planned maintenance which incorporates some condition monitoring activities on a four-yearly basis.

c) 132kV & 66kV Surge Diverter

Surge diverters protect key assets from transient overvoltage conditions such as lightning impulses. They operate to divert any transient overvoltages to earth thereby limiting the voltage across network assets to safe levels. Their function is important to protect highly costly and critical assets.

Whilst the incidence of transient overvoltages due to lightning is low, a high degree of reliability is required of surge diverters to mitigate the risk of major damage to high value assets that they protect. Surge diverters are required to remain in service continuously to protect network assets.

Surge diverters are maintained and their condition assessed when the associated major plant (usually a power transformer) is maintained. Maintenance typically consists of cleaning of the insulating casing. A condition assessment consists of an inspection and measurement of insulation resistance (for each individual segment). For those surge diverters of “gapped” type, internal construction moisture ingress can lead to their explosive failure. Following various replacement activities, Evoenergy’s network consists of modern zinc oxide types which do not have this vulnerability.

4.2.2.3 132kV GIS Modular Switchgear

GIS is used to control, protect, switch and isolate electrical plant and networks. This asset is indoor 132kV switchgear currently used at Evoenergy’s East Lake zone substation. The switchgear includes components such as circuit breakers, VTs, CTs, isolators, earth switches, and busbars.

GIS in zone substations and switching stations provide the primary system interface between the 132kV sub-transmission network and zone substation power transformers. This asset and its components also interface with control and protection schemes both inside and outside the zone substation.

SF6 insulated modular switchgear is comprised of multiple components, as listed below. Their descriptions and functions are similar to their gas, oil, and air insulated counterparts described within Section 4.2.1.

4.2.3 Current Population, Age, and Health Profile

4.2.3.1 132kV & 66kV Outdoor Circuit Breakers

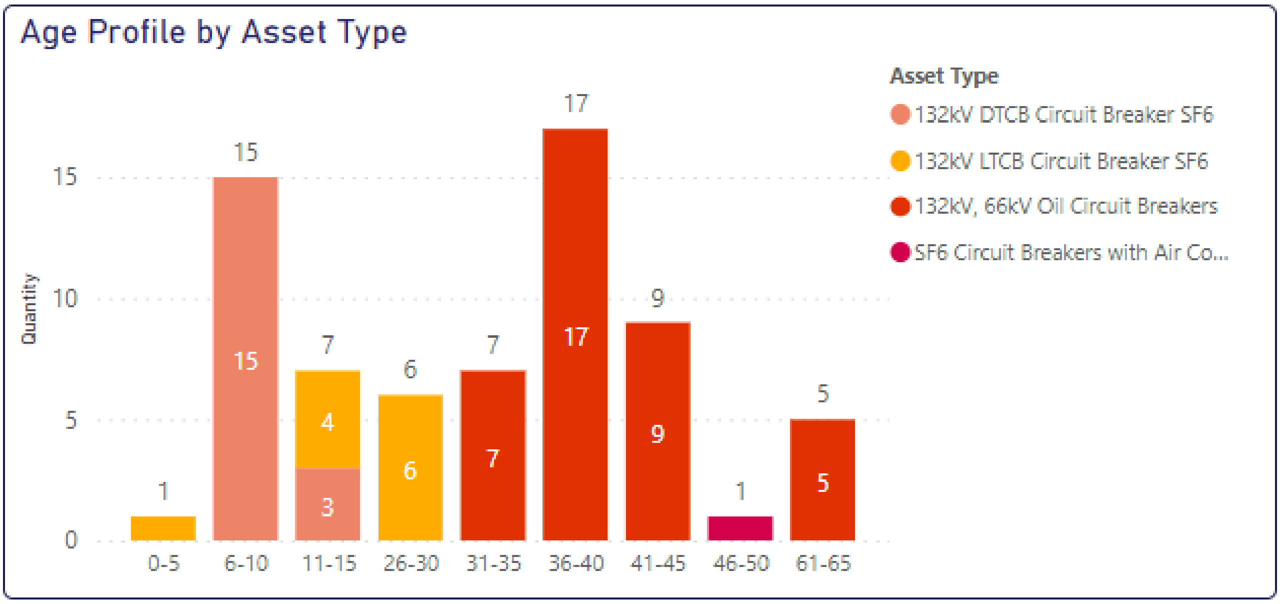
Table 4 offers a high-level count of 132kV and 66kV outdoor circuit breaker assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

TABLE 4. ASSET POPULATION, AGE, AND HEALTH PROFILES – 132KV & 66KV OUTDOOR CIRCUIT BREAKERS

Asset Type	Quantity	Unit	Design Life (yrs)	Critical Health Qty	Average Health Score	Health Category
SF6 Circuit Breakers with Air Compressor 132kV	1	each		1	25.00	Poor
HITACHI,OFPTB-120-25L	1	each		1	25.00	Poor
132kV, 66kV Oil Circuit Breakers	38	each		5	56.58	Good
ASEA,HLR145/2501E	31	each		0	64.00	Good
ASEA,HKEYC60/800	5	each		5	0.00	Very Poor
ABB,HLR145/2501E	2	each		0	83.00	Good
132kV LTCB Circuit Breaker SF6	11	each		0	96.36	Very Good
GEC,DT1-145	1	each		0	100.00	Very Good
ABB,LTB145D1	10	each		0	96.00	Very Good
132kV DTCB Circuit Breaker SF6	18	each		0	100.00	Very Good
GEC-ALSTOM,DT1-145F1FK	18	each		0	100.00	Very Good
Total	**68**	**each**		**6**	**74.04**	**Good**

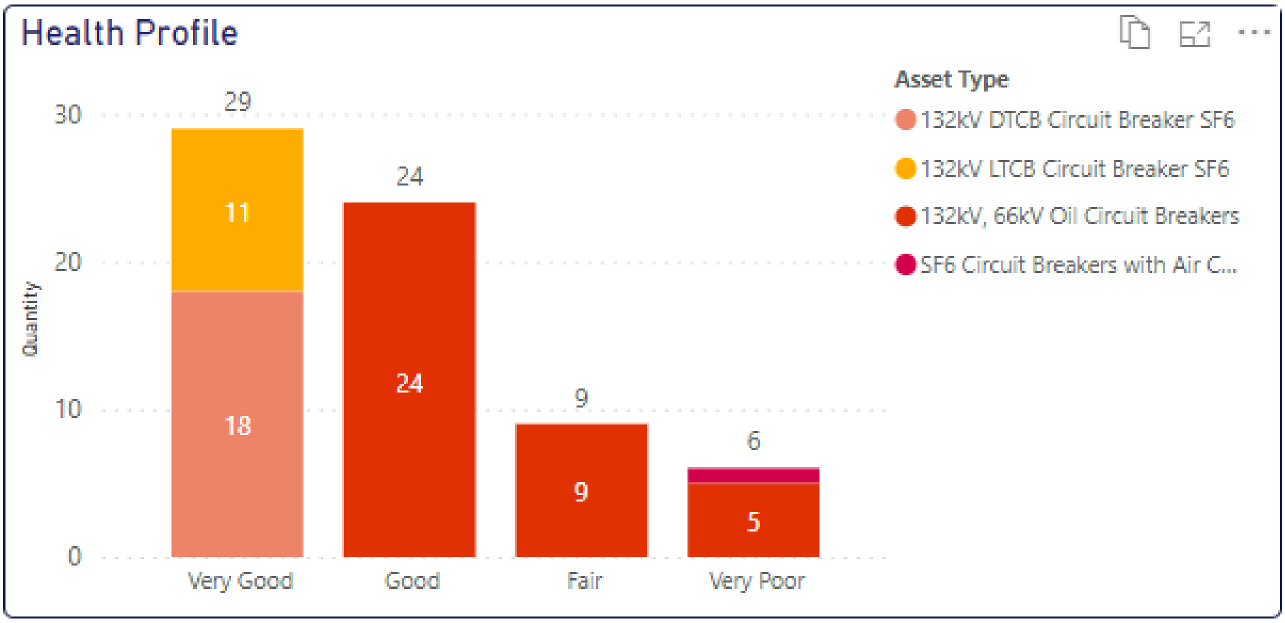
The age profile of existing assets is reflected in Figure 6.

FIGURE 6. ASSET AGE PROFILE CHART (AS AT JULY 2022) – 132KV & 66KV OUTDOOR CIRCUIT BREAKERS



The asset class health profile is summarised in Figure 7.

FIGURE 7. ASSET HEALTH PROFILE CHART (AS AT JULY 2022) – 132KV & 66KV OUTDOOR CIRCUIT BREAKERS



a) SF6 Live Tank Circuit Breakers

ABB Type LTB145D1 132kV Circuit Breakers

The population of ABB type LTB circuit breakers consists of 10 units, four of which are less than 15 years old. The balance of the population ranges between 27 and 29 years old (as of 2022). Three of the older units have exhibited SF6 leakage problems which, based on recent inspections, have been attributed to corrosion of aluminium flanges on the poles which has compromised their sealing. These have been addressed as a high priority due to the greenhouse gas impacts that SF6 has.

Early advice from the manufacturer attributes the corrosion to a likely type “issue” with the older circuit breakers. Works will be undertaken to address the existing leakage problems. Further advice is being sought from the manufacturer as to what measures must be taken to mitigate the risks presented by the remaining circuit breakers in this age group. The risk mitigation works will be undertaken as a matter of priority.

There is no evidence of similar or emerging defects with the rest of the population.

b) SF6 Dead Tank Circuit Breakers

ABB Type OFPTB-120-25L 132kV Circuit Breaker

This circuit breaker is targeted for replacement as part of a 132kV upgrade project within the Belconnen region, resulting in this asset type being removed from Evoenergy's network entirely. Although this breaker is approaching its end of service life, no major performance issues have been experienced.

Due to the modern dead tank circuit breaker design being a relatively new addition to Evoenergy's network, the assessed condition of the broader dead tank population is good with no evidence of emerging defects. Therefore, other than the planned maintenance program no other work is deemed necessary to manage their performance.

c) Oil-Filled Circuit Breakers

ABB Type HKEYC60 66kV Circuit Breakers

All five (5) ASEA (ABB) type HKEYC60 66kV minimum oil circuit breakers installed at Fyshwick zone substation are over the age of 60 years old, beyond the end of their design life, and have been assessed as being in critical condition. They are considered to present a significant risk of failure.

These circuit breakers have been proactively maintained within FY19 in order to lower the risk of failure. Even still, Fyshwick zone substation 0844 Queanbeyan line (4DB) experienced an in-service failure in May 2019, and 0845 Queanbeyan line (4FB) failed to remotely open in August 2021.

This type of aged circuit breaker is planned to be removed from Evoenergy's network as part of the Fyshwick zone substation removal project planned within the 2019-24 regulatory period.

ABB Type HLR145/2501E 132kV Circuit Breakers

On average, 2 HLRs per year experience a failure or disruption within Evoenergy's network. This ranges from degraded componentry resulting in a planned outage, to in-service failures resulting in customers off supply.

To mitigate this risk, planned CAPEX refurbishments have been undertaken per zone substation since FY21, and will continue on a 6-year rolling basis for the entirety of the remaining life span of these units. These works entail component replacements as well as in-depth condition assessments.

Further, a planned replacement program over the next two regulatory periods will see this asset type being systematically removed from the network and replaced with modern dead tank types.

4.2.3.2 132kV & 66kV Outdoor Air Insulated Switchgear

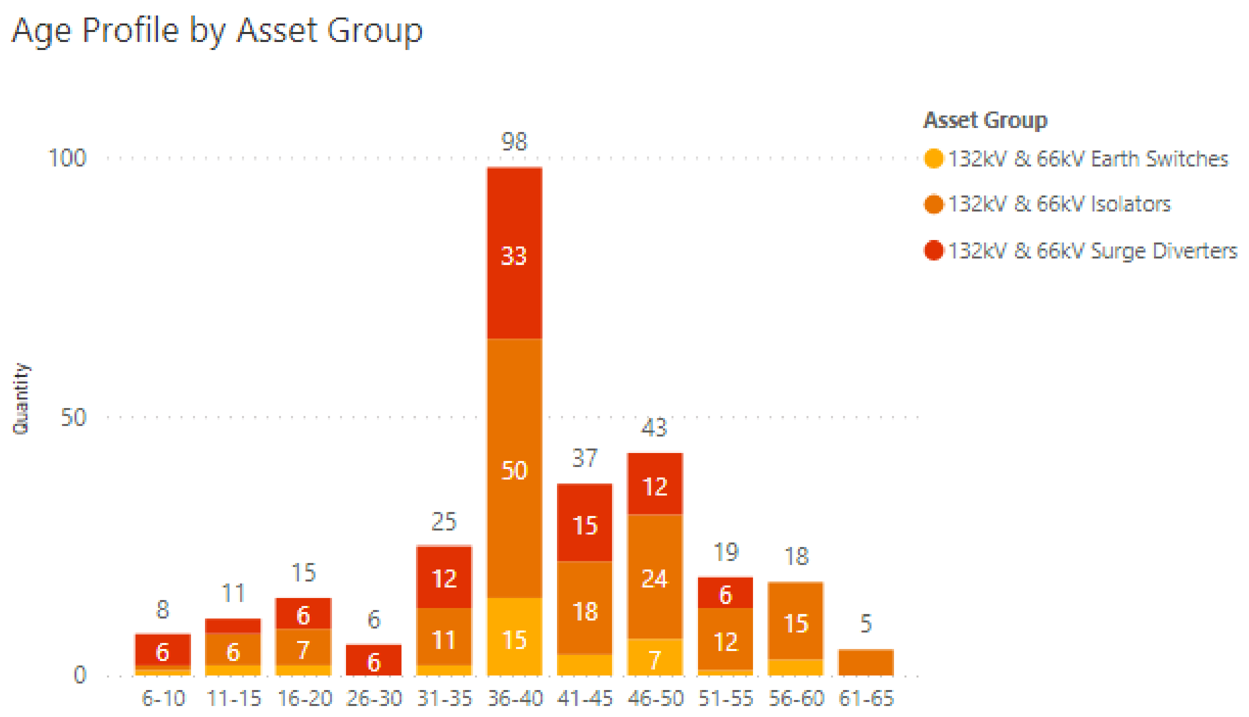
Table 5 offers a high-level count of 132kV and 66kV outdoor AIS assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

TABLE 5. ASSET POPULATION, AGE, AND HEALTH PROFILES – 132KV & 66KV AIS

Asset Group	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
132kV & 66kV Earth Switches	37	each		39.00	3	75.11	Good
N/A,N/A	37	each		39.00	3	75.11	Good
132kV & 66kV Isolators	149	each		41.00	20	69.11	Good
N/A,N/A	149	each		41.00	20	69.11	Good
132kV & 66kV Surge Diverters	99	each		39.57	0	75.12	Fair
ABB,12GC2E1	30	each		27.00	0	90.60	Very Good
ABB,HML 120	3	each		43.00	0	74.00	Good
ABB,UNKNOWN	27	each		39.00	0	75.22	Good
ABB,XAA 120	6	each		35.00	0	87.00	Good
ABB,XAR 145 A2 SP	9	each		39.00	0	81.33	Good
UNKNOWN,12GC2E1	21	each		41.00	0	75.71	Good
UNKNOWN,UNKNOWN	3	each		53.00	0	42.00	Fair
Total	**285**	**each**		**39.67**	**23**	**74.45**	**Fair**

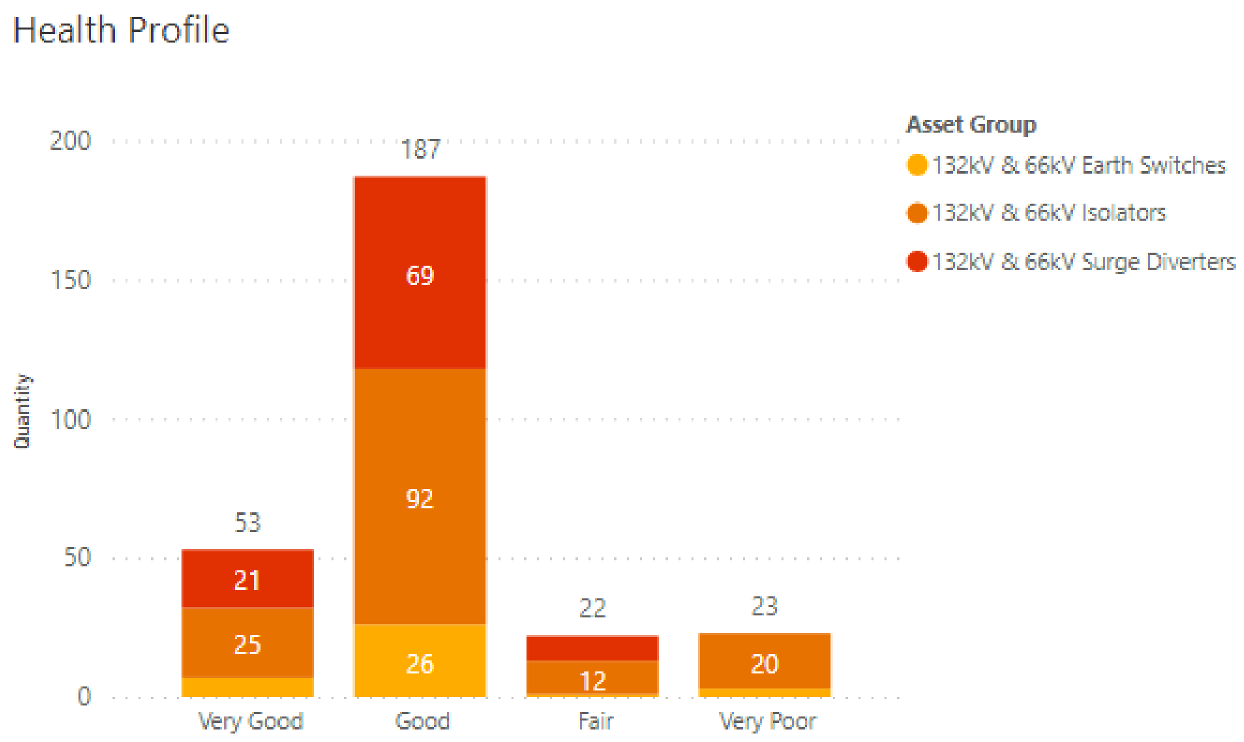
The age profile of existing assets is reflected in Figure 8.

FIGURE 8. ASSET AGE PROFILE CHART (AS AT JULY 2022) – 132KV & 66KV AIS



The asset class health profile is summarised in Figure 9.

FIGURE 9. ASSET HEALTH PROFILE CHART (AS AT JULY 2022) – 132KV & 66KV AIS



Those units identified as being in a poor or critical condition will be addressed through planned replacement. This is usually driven by mis-alignment issues inherent with older less reliable unit types. Investigations into the root cause of the observed rectifiable defects will drive the scope of preventative maintenance and this will be reviewed to include additional works as deemed necessary.

In the EN24 period, all Latham zone substation isolators and associated earth switches will be replaced due to being assessed as being in poor condition. These isolators are over 50 years of age and have been exhibiting alignment issues during close operations. Due to their benign modes of failure no wholesale replacement is warranted for earth switches specifically, however it is economical to replace when replacing isolators as these are typically ordered as one unit.

4.2.3.3 132kV Modular Switchgear

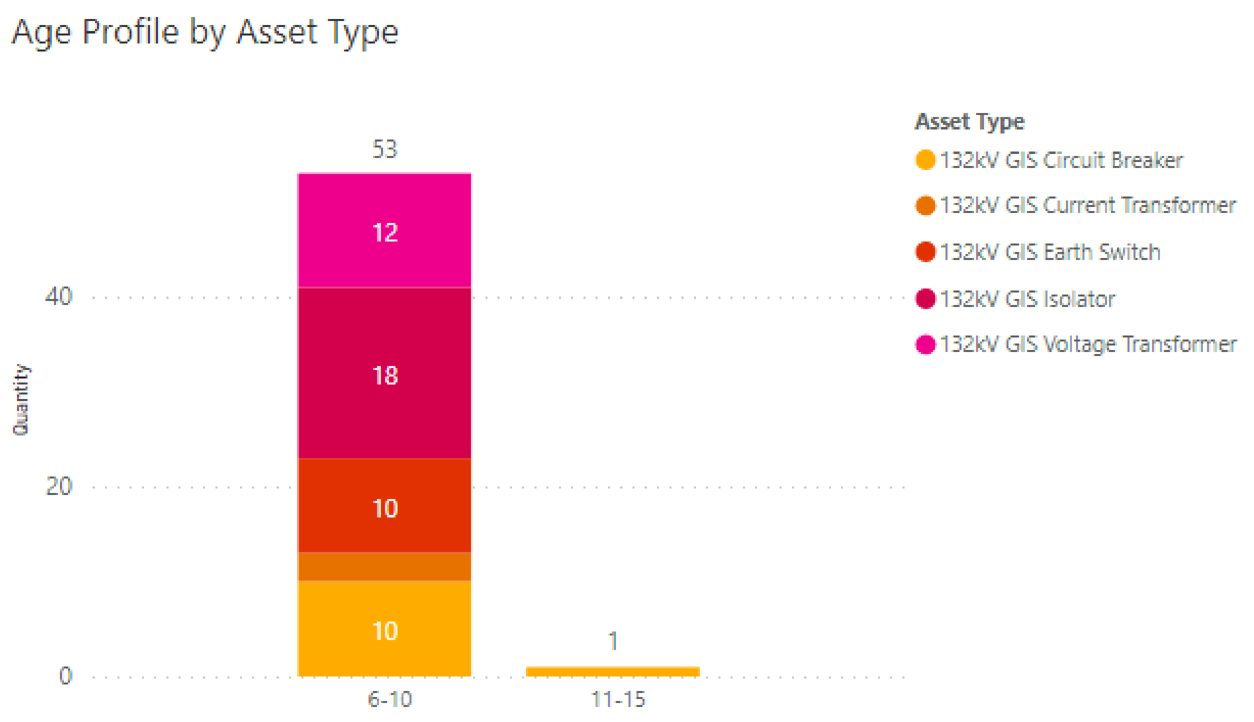
Table 6 offers a high-level count of 132kV modular switchgear assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

TABLE 6. ASSET POPULATION, AGE, AND HEALTH PROFILES – 132KV MODULAR SWITCHGEAR

Asset Type	Quantity	Unit	Design Life (yrs)	Critical Health Qty	Average Health Score	Health Category
⊟ **132kV GIS Voltage Transformer**	12	each		0	100.00	Very Good
ABB,UNKNOWN	12	each		0	100.00	Very Good
⊟ **132kV GIS Isolator**	18	each		0	100.00	Very Good
N/A,N/A	18	each		0	100.00	Very Good
⊟ **132kV GIS Earth Switch**	10	each		0	100.00	Very Good
N/A,N/A	10	each		0	100.00	Very Good
⊟ **132kV GIS Current Transformer**	3	each		0	100.00	Very Good
ABB,UNKNOWN	3	each		0	100.00	Very Good
⊟ **132kV GIS Circuit Breaker**	11	each		0	99.91	Very Good
ABB,UNKNOWN	10	each		0	100.00	Very Good
ABB,PASSM0/145	1	each		0	99.00	Very Good
Total	**54**	**each**		**0**	**99.98**	**Very Good**

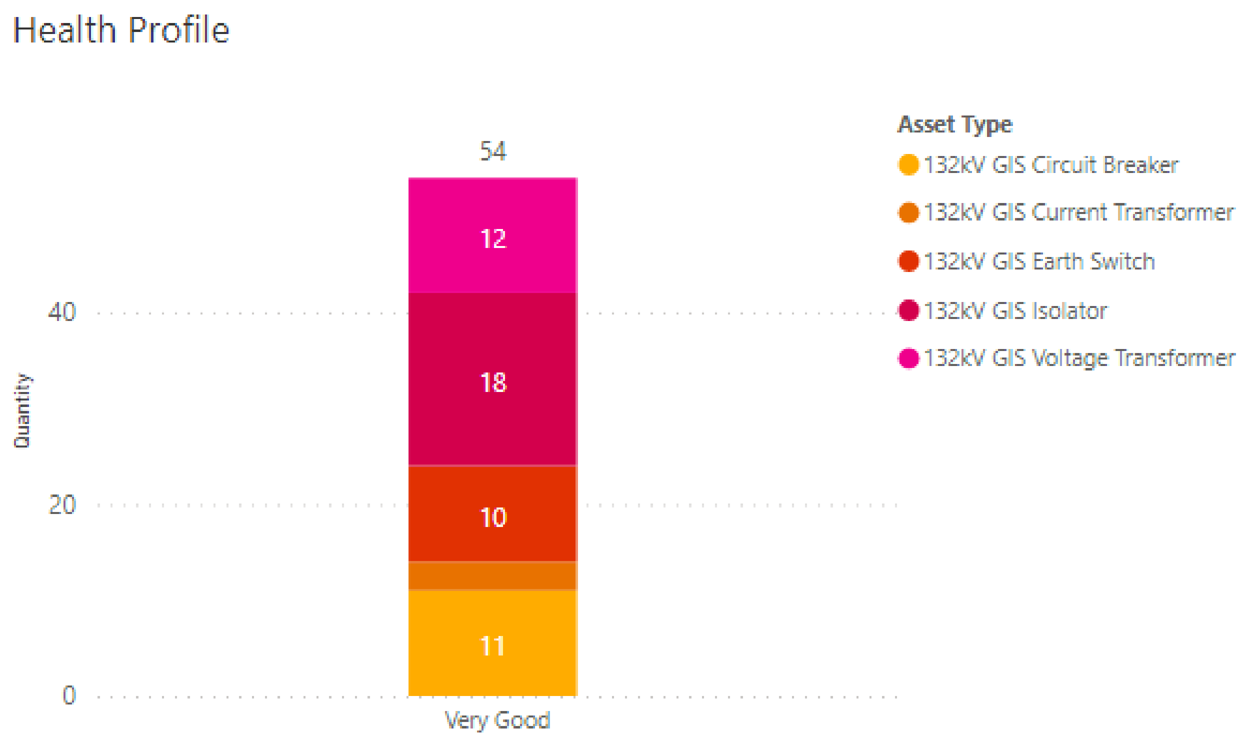
The age profile of existing assets is reflected in Figure 10.

FIGURE 10. ASSET AGE PROFILE CHART (AS AT JULY 2022) – 132KV MODULAR SWITCHGEAR



The asset class health profile is summarised in Figure 11.

FIGURE 11. ASSET HEALTH PROFILE CHART (AS AT JULY 2022) – 132KV MODULAR SWITCHGEAR



Gas insulated modular switchgear is a relatively modern introduction to Evoenergy's network, situated exclusively at Eastlake and Angle Crossing zone substations. Due to the low age of these assets as well as the inherent low maintenance requirements of this asset type, there are no notable condition or performance issues to be considered.

4.2.4 Risks and Opportunities

4.2.4.1 132kV & 66kV Outdoor Circuit Breakers

The rate of duty-cycle related deterioration, and hence the service life of the circuit breakers, is highly dependent upon the correct adjustment of key parameters such as contact speed, damping, penetration, and travel. The incorporation of contact movement analysis (time-travel analysis) into planned maintenance to ensure correct adjustment of these parameters would help these assets achieve their full design life.

HLR circuit breakers continue to present the largest risk (by volume) among this asset group, with 1-2 failures experienced annually. There are significant opportunities in this area to reduce this asset type by way of replacement works, as detailed within section 4.4.5. This would also see current transformer asset renewals as newer circuit breakers (dead tank) have these inbuilt within the bushings.

4.2.4.2 132kV & 66kV Outdoor Air Insulated Switchgear

Approximately nine 132kV isolators have been assessed as being in poor condition due to ongoing alignment issues. These will be subject to investigation and replaced as necessary.

Previous programs have been implemented to replace any silicon carbide "gapped" type surge diverters with zinc oxide, non-gapped units. This has reduced the risk of failure caused by moisture ingress; however, an in-field audit must be completed to ensure that no gapped type surge diverters remain. When found from audit, these will be programmed in for planned replacement.

Condition monitoring of surge diverters is presently limited to measurement of their insulation resistance during maintenance, following damage, or after receiving poor results from a visual assessment. Measurement of their in-service leakage current can also be undertaken if their connections to earth are suitably configured. An opportunity exists to install isolated type earth connections for surge diverters to allow online monitoring of leakage current, however this is not currently considered practical

4.2.4.3 132kV Modular Switchgear

As Evoenergy's GIS switchgear remains relatively new, few risks or opportunities are presently identified for this asset class.

4.2.5 Planned Projects, Replacements and Retirements

4.2.5.1 Augmentation Projects

Harman zone substation construction is planned for completion within financial year 2022/23. This will see the addition of the following units:

- 5 × Circuit Breaker – DTCB
- 8 × Isolators
- 8 × Earth switches
- 6 × surge diverters.

Following the Harman project, Molonglo zone substation is being designed and planned for completion within financial year 2024/25. Initially this site will be only 1 bay (1 transformer), however will likely be expanded to have up to 3 bays. The following initial assets are included:

- 2 × Circuit Breaker – DTCB
- 4 × Isolators
- 4 × Earth switches
- 3 × surge diverters.

An augmentation project is planned for Belconnen zone substation, and this includes the addition of 1 × 132kV DTCB and 1 × 132kV isolator. The planned commissioning date for these assets was originally 2019/20 however due to delays of Government land release programs, this has been postponed indefinitely.

4.2.5.2 Replacement Projects

The Fyshwick zone substation decommissioning project is a major work occurring in the 2019-24 regulatory period. This removes all 66kV circuit breakers and air insulated switchgear, as outlined below. The planned decommissioning year for these assets is 2022/23.

- 5 × Circuit Breaker – HKEYC OCB
- 7 × Isolators – Dickson Primer 9-9689-1
- 4 × Isolators – NGK HCB
- 1 × Isolator – *Unknown*
- 1 × Earth Switch – Dickson Primer 9-9689-2
- 1 × Earth Switch – NGK PB
- 9 × surge diverters.

It is also planned to begin replacing HLR circuit breakers (oil-filled) on a site-by-site basis, as outlined below. This is necessary due to the number of in-service failures experienced and unplanned maintenance that these units require.

- Woden 2 × 132kV Oil Filled HLR (FY 25-26)
- Latham 4 × 132kV Oil Filled HLR (FY 27-29).

4.2.6 Asset Management Strategy

4.2.6.1 132kV & 66kV Outdoor Circuit Breakers

The following tasks are performed for assets within this group, to align with the overall strategy of risk reduction.

- 3-monthly visual inspections (all circuit breakers)
- 6-monthly thermal inspections (all circuit breakers)
- 1-yearly air compressor check (for air compressor type circuit breaker)
- 6-yearly refurbishment (for HLR type circuit breakers)
- 6-yearly SF6 monitoring and assessment (for dead tank circuit breakers).

Further, monitoring of circuit breakers through on-line monitoring of load and fault switching duty is undertaken for post-fault situations.

4.2.6.2 132kV & 66kV Outdoor Air Insulated Switchgear

The following tasks are performed for assets within this group, to align with the overall strategy of cost reduction.

- 3-monthly visual inspections (all equipment)
- 6-monthly thermal inspections (all equipment)
- 4-yearly isolator maintenance (including contact replacements, if necessary).

4.2.6.3 132kV Modular Switchgear

Gas insulated switchgear has relatively low labour and maintenance requirements. This, coupled with the fact that the switchgear is still moderately new, results in relatively little maintenance being required. The following tasks are performed.

- 3-monthly visual inspections
- 6-monthly thermal inspections

- 4-yearly gas sampling and testing.

In addition to this, constant online SF6 gas pressure monitoring and modelling with low gas alerts (current and forecasted) are recorded in real-time. There is no planned maintenance at this time for this asset class.

GIS modules have a finite life and will eventually require refurbishing to extend the life of the asset or replacement of the asset entirely. A failure of an individual component such as a 145kV VT can be addressed as required. The decision to refurbish or replace the module following a major failure will be based on an assessment of the damage sustained during the failure and the age/condition of the asset.

4.3. ZONE SUBSTATION AUXILIARY AC AND GENERATORS STRATEGY

4.3.1 Asset Class Summary and Objectives

Auxiliary (230V) supply must be available throughout each zone substation to support various functions and building operations. AC switchboards are located at each zone substation and provide the switching and protection functionality for this supply.

Zone substations must have ongoing uninterrupted power supply to ensure that critical functions can operate. The standby generators offer back up power supply for both the AC auxiliary supply and the DC battery chargers in zone substations. If AC auxiliary supply is lost, the standby generator will auto start and run to provide backup auxiliary power. Change over switches are designed to transfer loads from one power source to another.

The main interface that the backup generator power supply has is with the AC auxiliary supply. When the AC supply fails, the changeover switches will transfer the load to the standby generator. The generator will then automatically start and begin supplying power to all assets that the AC auxiliary supply was powering previously to ensure their constant operation.

FIGURE 12. STANDBY GENERATOR

FIGURE 13. TRANSFER SWITCH

4.3.2 Asset Types

4.3.2.1 Auxiliary AC Switchboards

Auxiliary (230V) supply must be available throughout each zone substation to support various functions and building operations. AC switchboards are located at each zone substation and provide the switching and protection functionality for this supply.

4.3.2.2 Standby Generators

The standby generators supply back up power for both the AC auxiliary supply and the DC battery chargers in zone substations. This ensures around-the-clock functionality, which is vital for a zone substation. If the AC auxiliary supply is lost, the standby generator will automatically start to supply backup auxiliary power. Change over switches are designed to transfer loads from one power source to another.

4.3.2.3 Automatic Transfer Switches

The main interface that the backup power supply has is with the AC auxiliary supply. When the AC supply fails the changeover switches will transfer the load to the standby generator. The generator will then automatically start and begin supplying power to all assets that the AC auxiliary supply was powering previously (e.g., the protective relays, substation lighting, fans, compressors, etc.) to ensure their constant operation.

4.3.3 Current Population, Age, and Health Profile

Table 7 offers a high-level count of auxiliary AC and generator assets within the Evoenergy network, and any notable asset health concerns are highlighted in the Health Category column

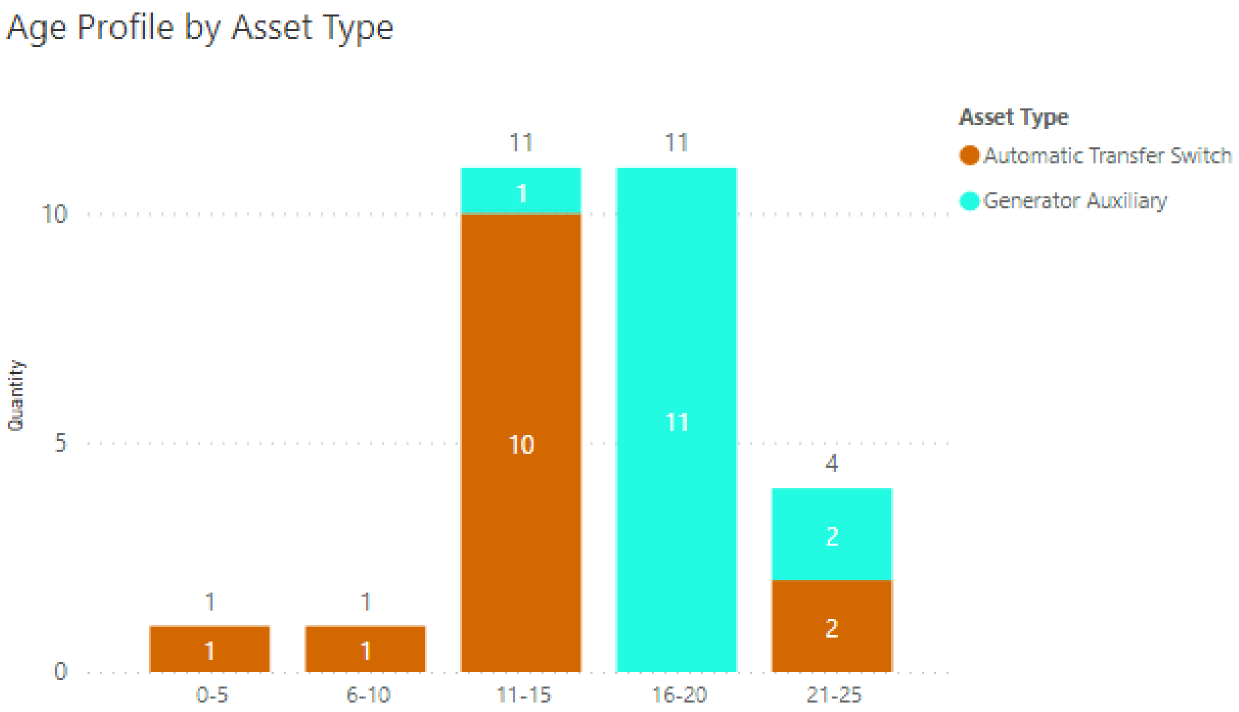
TABLE 7. ASSET POPULATION, AGE, AND HEALTH PROFILE – AUXILIARY AC AND GENERATORS

Asset Group	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
Automatic Transfer Switches	14	each		14.00	0	97.57	Very Good
OTHER,OTHER	4	each		12.00	0	98.50	Very Good
UNKNOWN,UNKNOWN	10	each		16.00	0	97.20	Very Good
Standby Generators	14	each		17.25	0	97.36	Very Good
FGWILSON,P50-2	1	each		11.00	0	99.00	Very Good
FGWILSON,P44E3	5	each		17.00	0	98.00	Very Good
FGWILSON,P55E1	6	each		17.00	0	98.00	Very Good
ONAN,32DGBC	2	each		24.00	0	93.00	Very Good
Total	**28**	**each**		**16.17**	**0**	**97.46**	**Very Good**

Auxiliary AC switchboards are a new addition to Evoenergy's digital asset hierarchy, and therefore field data capture activities have yet to be completed. Until this occurs, the average asset age is unknown.

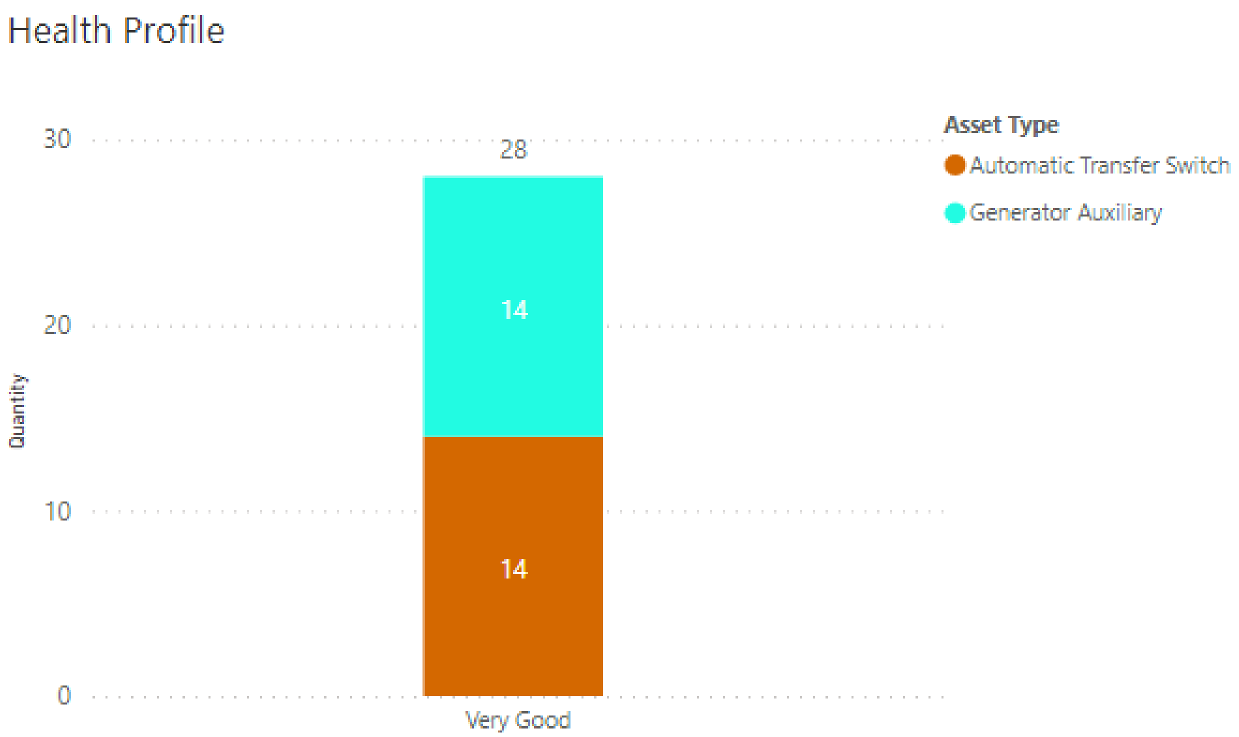
As these generator assets are relatively new, none of these assets will reach their original design life within the 2024-29 regulatory period. The age profile of this asset class reflects this and is shown in Figure 14.

FIGURE 14. ASSET AGE PROFILE CHART (AS AT JULY 2022) – AUXILIARY AC AND GENERATORS



The asset class health profile is summarised in Figure 15.

FIGURE 15. ASSET HEALTH PROFILE (AS AT JULY 2022) – AUXILIARY AC AND GENERATORS



4.3.4 Current Condition and Performance

As auxiliary standby generators are regularly tested and maintained, their condition is generally kept at a high level. However, as this asset class ages, higher levels of maintenance have been required, potentially signalling some replacement requirements within the EN24 regulatory period.

4.3.5 Risks and Opportunities

The consequence of a failed change over switch or standby generator is the loss of the auxiliary supply (that is if the power supplies the various electrical auxiliaries such as station lighting, pumps, motors, fans, compressors, and the protection relays within the zone substation). This could result in power outages as well as financial losses to the company.

A driver for rationalisation, other than the operational lifespan of the asset, is the financial performance against other options, which could be explored in a business case. The generators mostly sit idle while generating a continuous stream of operating and maintenance expenses. If the operational costs outweigh the asset capabilities compared against more efficient options, this would be an opportunity to decommission the asset. The key opportunity for this asset class is to make use of emerging technologies, such as photovoltaic (PV) generation paired with batteries, or simpler alternatives such as a single portable generator to be deployed and used as needed.

4.3.6 Planned Projects, Replacements and Retirements

4.3.6.1 Replacement Projects

End-of-life planning has begun for the oldest 5 generators and transfer switches. The drivers for these replacement works are primarily age based, and increased maintenance costs for these older units. It is proposed to replace 1 generator and related transfer switch unit per year from FY25 to FY29.

4.3.7 Asset Management Strategy

Full contractor-based maintenance is completed on generators once every 12 months. Internally conducted run tests and visual inspections are completed twice each year. Any defects are discovered and repaired as a part of these tests. Auxiliary switches are tested “by default” during the standby generator run tests. As such, they do not have an independent maintenance plan. Any defects found during these tests will initiate repair or replacement.

At the end of asset life, assets are retired and replaced. It is not feasible to refurbish units due to the complexity of the work combined with the low asset replacement cost

4.4. ZONE SUBSTATION TRANSFORMERS STRATEGY

The zone substation transformer asset class is comprised of the following asset groups:

- Auxiliary and Earthing Transformers
- Instrument Transformers (Zone)
- Power Transformer Assembly.

4.4.1 Asset Class Summary and Objectives

Zone substation transformers are located at all zone sites and have varying roles to play based on the specific type. With the one exception of current transformers, all transformers within this portfolio are ‘step down’ type, meaning the secondary voltage is less than the primary. Depending on the transformer, this is to provide distribution level voltage, auxiliary voltage, voltage for measurement purposes, or to provide a neural point. Current transformers ‘step-up’ the voltage in order to reduce the secondary current, so that this current can be accurately measured.

Power transformers operate with N-1 redundancy, whereas all other transformer types do not necessarily have this requirement or capability. The asset class objectives are to have zero in-service failures, which is achieved with condition monitoring activities and resulting proactive maintenance, refurbishment, or replacement.

4.4.2 Asset Types

4.4.2.1 Auxiliary and Earthing Transformers

Auxiliary transformers in zone substations are used to step down a three-phase 11kV supply to the 415V required to supply the substation building and associated auxiliary equipment. This includes station lighting systems, battery charger supply, pumps, motors, fans, compressor motors, and other electrical loads. As the operational requirements for auxiliary and earthing transformers are different to the power transformers in zone substations these types of transformers are smaller in size and require less insulating oil. Normally, there are two auxiliary transformers per zone substation.

Earthing transformers help to divert high earth fault current to the earth grid and hence keep all zone substation equipment at safe working levels by operating various protection devices. Earthing transformers are also known as NETs (Neutral Earthing Transformers) as this provides a neutral point to star-connected secondary windings. Three-phase earthing transformers interface between the 11kV system and earth (ground). If the neutral point is earthed, phase to ground voltages under earth fault condition do not rise to high values. Every power transformer has one earthing transformer.

4.4.2.2 Instrument Transformers (Zone)

The Instrument Transformers (Zone) asset group is comprised of the following asset types:

- 132kV & 66kV Current Transformers Oil Insulated
- 132kV & 66kV Current Transformers
- 132kV & 66kV Voltage Transformers.

CTs perform a critical function for measurement of the current in the circuits to which they are connected for both metering and protection purposes. They perform an essential function to detect fault-related conditions and initiate (via protection relays) operation of circuit breakers for fault clearance.

Voltage transformers (VTs) perform the monitoring of both steady state and transient voltages on the 132kV and 66kV circuits for input to network protection, control, synchronising and metering systems. Their function is essential for network protection schemes and maintaining network voltages within prescribed limits.

Where these are used for protection functions, they are responsible for (among other things) the detection of a network fault condition and initiation, via protection, of the tripping of the circuit breaker(s) for fault clearance. In this regard their reliability must be equivalent to that of the circuit breaker (the required degree of reliability is reduced where the fault detection is undertaken by duplicate instrument transformers). Current and voltage transformers utilised solely for metering duties do not require the same degree of reliability.

a) 132kV & 66kV Current Transformers Oil Insulated

CTs perform the monitoring of both steady state and transient currents on the 132kV and 66kV circuits for input to network protection and metering systems.

The post type CTs are of a “live tank” type construction and have an oil/paper insulation system. The typical life expectancy of and oil/paper insulation system is approximately 50 years but is dependent upon ageing factors such as thermal stress, voltage stress and moisture ingress, all of which result in accelerated ageing. By nature of their design, post type CTs operate at relatively high voltage stresses which are considerably greater than in power transformers. As such their insulation systems tend to deteriorate at a correspondingly greater rate.

Due to their design, an internal insulation failure of a post type CT would be highly likely to result in explosion and fire and would present a major risk to personnel and adjacent equipment. This mode of failure is not uncommon, with a number of instances in other utilities over recent years.

Their condition is assessed via a program of oil sampling for analysis of quality and dissolved gases.

b) 132kV & 66kV Current Transformers BCT

CTs perform the monitoring of both steady state and transient currents on the 132kV and 66kV circuits for input to network protection and metering systems.

Toroidal CTs are fitted externally to bushing turrets, typically on dead tank circuit breakers, outside the high voltage electric field. As such they have only low voltage insulation (typically epoxy or composite type material) and are of dry type (no oil) construction.

Due to their construction, there is little in the way of condition monitoring for toroidal CTs other than physical inspection which is undertaken during maintenance of the associated circuit breaker.

The toroidal CTs have exhibited no evidence of deterioration or incidence of defects and as such no works outside physical inspection are planned for the 2019-24 period.

c) 132kV & 66kV Voltage Transformers

VTs perform the monitoring of both steady state and transient voltages on the 132kV and 66kV circuits for input to network protection, control, synchronising and metering systems.

VTs have an oil/paper insulation system and, as with the post type CTs, operate at relatively high voltage stresses which are considerably greater than in power transformers. As such their insulation systems tend to deteriorate at a correspondingly greater rate than the nominal 50-year life expectancy for power transformers.

An internal insulation failure of a VT would be likely to result in explosion and fire and would present a major risk to personnel and adjacent equipment.

Their condition is assessed via a program of oil sampling for analysis of quality and dissolved gases.

4.4.2.3 Power Transformer Assembly

The Power Transformer Assembly asset group is comprised of the following asset types:

- Power Transformers
- Bushings
- Online Tap Changers.

The power transformer assembly asset class is one of Evoenergy’s most valuable and critical groups. This critical interface links transmission and distribution systems, serving power to customers.

a) Power Transformers

Power transformers convert electric power from transmission level voltages (132kV, 66kV) to distribution voltages (22kV, 11kV). They are the critical interface within a zone substation between the transmission network and the distribution network. All of the equipment in a zone substation, with the exception of the outgoing feeder circuit breakers, is there to serve the requirements of the transformers (isolation, protection, power transfer and telemetry).

b) Bushings

Bushings provide a method for conductors to enter the main tank of the transformer in an electrically sound manner. These exist on both the high and low voltage sides of the transformer.

Traditionally these bushings are all oil-impregnated type (OIP) within our network, whereas bushing replacements performed from 2017 have been newer resin-impregnated types (RIP). RIP offer longer life expectancy and are easier to store, however they are not as cost efficient as OIP type.

c) Online Tap Changers

Online Tap Changers (OLTC) change the output voltage in response to alternating load conditions, by essentially changing the turns ratio of the transformer. This increases or reduces the output voltage to maintain system voltages within acceptable levels.

4.4.3 Current Population, Age, and Health Profile

4.4.3.1 Auxiliary and Earthing Transformers

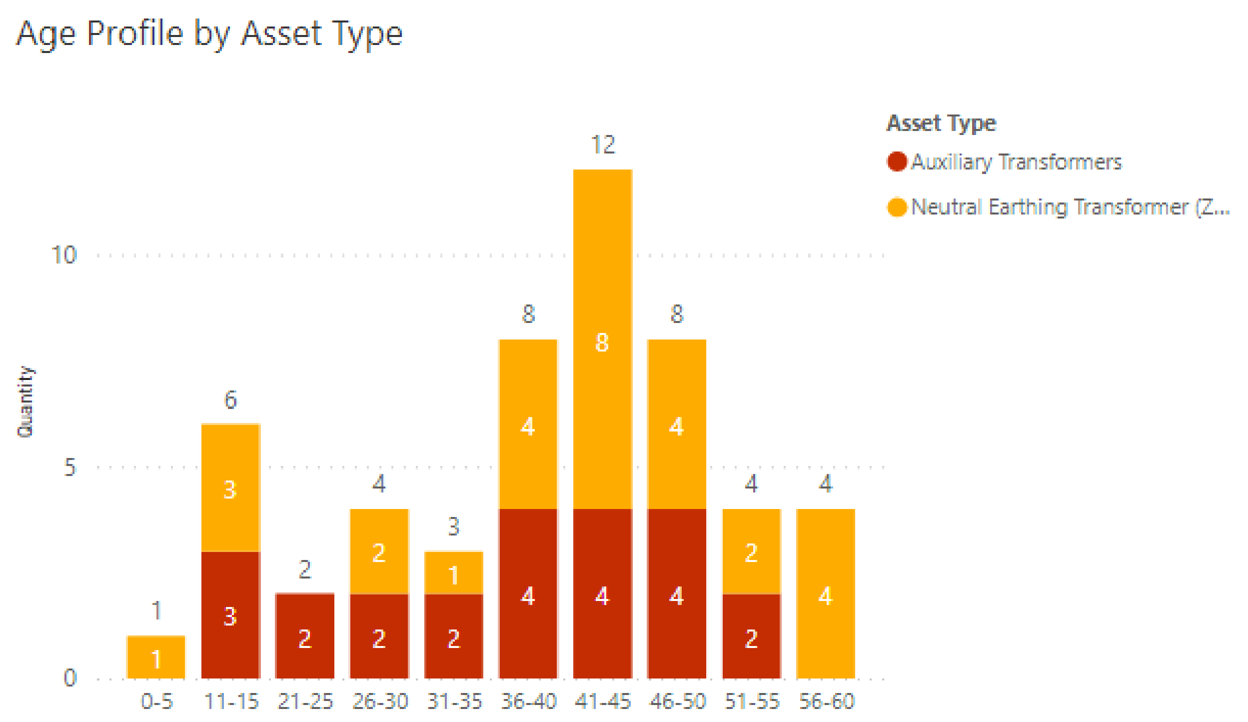
Table 8 offers a high-level count of auxiliary and earthing transformer assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

TABLE 8. ASSET POPULATION, AGE, AND HEALTH PROFILES – AUXILIARY AND EARTHING TRANSFORMERS

Asset Group	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
⊟ **Auxiliary Transformers**	23	each		30.00	0	87.48	Good
ABB,UNKNOWN	3	each		12.00	0	100.00	Very Good
WILSON,UNKNOWN	2	each		30.00	0	95.00	Very Good
GECHED,UNKNOWN	4	each		36.00	0	91.00	Very Good
TYREE,UNKNOWN	14	each		42.00	0	82.71	Good
⊟ **Earthing Transformers**	29	each		28.17	0	82.45	Good
ABB,UNKNOWN	3	each		9.00	0	100.00	Very Good
UNKNOWN,UNKNOWN	1	each		11.00	0	100.00	Very Good
GEC-ALSTOM,UNKNOWN	1	each		31.00	0	95.00	Very Good
WILSON,UNKNOWN	2	each		30.00	0	95.00	Very Good
GECHED,UNKNOWN	4	each		40.00	0	88.50	Good
TYREE,UNKNOWN	18	each		48.00	0	75.11	Good
Total	**52**	**each**		**28.90**	**0**	**84.67**	**Good**

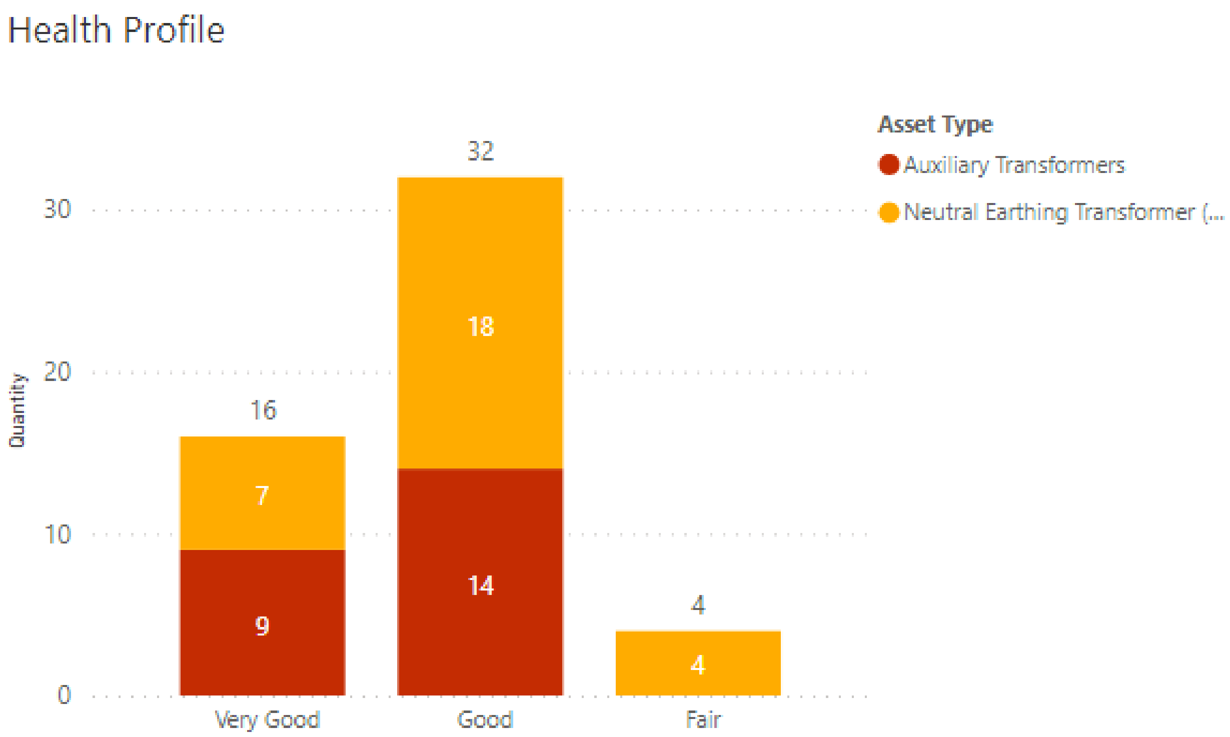
The age profile of existing assets is reflected in Figure 16.

FIGURE 16. ASSET AGE PROFILE CHART (AS AT JULY 2022) – AUXILIARY AND EARTHING TRANSFORMERS



The asset class health profile is summarised in Figure 17.

FIGURE 17. ASSET HEALTH PROFILE (AS AT JULY 2022) – AUXILIARY AND EARTHING TRANSFORMERS



Despite the ageing population, there have been no systemic, recurring, or unusual issues with the auxiliary or earthing transformer populations.

4.4.3.2 Instrument Transformers (Zone)

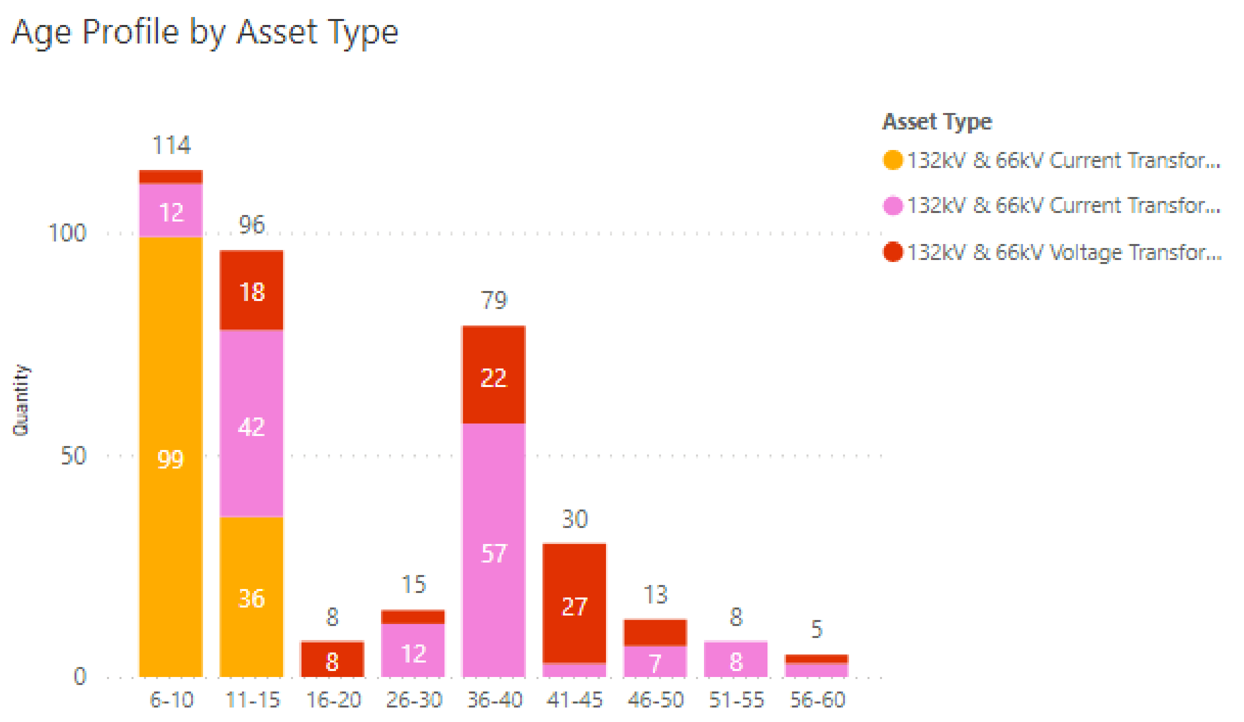
Table 9 offers a high-level count of zone substation instrument transformer assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

TABLE 9. ASSET POPULATION, AGE, AND HEALTH PROFILES – INSTRUMENT TRANSFORMERS (ZONE)

Asset Type	Quantity	Unit	Design Life (yrs)	Critical Health Qty	Average Health Score	Health Category
132kV & 66kV Voltage Transformer Oil Insulated	89	each		8	65.72	Fair
UNKNOWN,UNKNOWN	2	each		2	0.00	Very Poor
TYREE,M0514511	21	each		0	67.00	Good
TYREE,M051327	21	each		0	38.00	Poor
TYREE,M051326	6	each		6	25.00	Poor
TYREE,M0513210	6	each		0	48.00	Fair
KONCAR,VPU145	20	each		0	99.00	Very Good
EMILPFIFFNER,EOF145	1	each		0	74.00	Good
ARTECHE,UTE145	3	each		0	100.00	Very Good
ALSTOM,UXT145	6	each		0	99.00	Very Good
ABB,M0514529	3	each		0	86.00	Good
132kV & 66kV Current Transformer Oil Insulated	144	each		18	72.65	Good
TYREE,06/145/60	9	each		0	74.00	Good
TYREE,06/145/59	6	each		0	74.00	Good
TYREE,06/145/45	6	each		0	68.00	Good
TYREE,06/145/44	6	each		0	68.00	Good
TYREE,06/145/43	12	each		0	70.00	Good
TYREE,06/145/39	6	each		0	65.00	Good
TYREE,06/145/38	5	each		0	79.00	Good
TYREE,06/145/37	9	each		0	65.00	Good
PLESSEYDUCON,DKS132/25/3	2	each		2	0.00	Very Poor
KONCAR,AGU-145	34	each		0	98.00	Very Good
ENDURANCE,UNKNOWN	3	each		3	0.00	Very Poor
CROMPTONGREAVES,CT72.5	9	each		0	100.00	Very Good
ASEA,IMBE145A5	1	each		1	9.00	Poor
ASEA,IMBD145A5	9	each		6	18.00	Poor
ASEA,IMBA70A3	6	each		6	0.00	Very Poor
ALSTOM,OSKF-145	9	each		0	99.00	Very Good
ABB,UNKNOWN	3	each		0	86.00	Good
ABB,840355	6	each		0	86.00	Good
ABB,840223	3	each		0	86.00	Good
132kV & 66kV Current Transformer	135	each		0	99.56	Very Good
UNKNOWN,UNKNOWN	30	each		0	98.00	Very Good
N/A,N/A	15	each		0	100.00	Very Good
ALSTOM,UNKNOWN	84	each		0	100.00	Very Good
ALSTOM,DT1-145F1FK	6	each		0	100.00	Very Good
Total	**368**	**each**		**26**	**80.85**	**Fair**

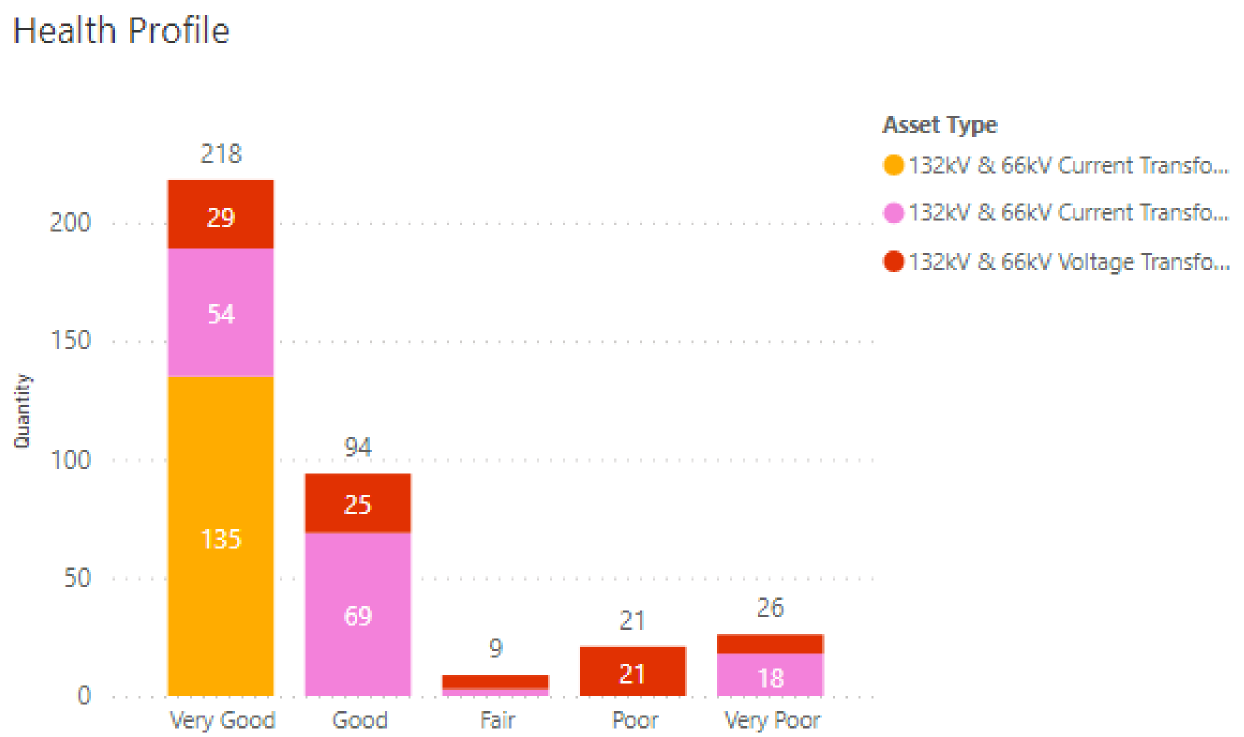
The age profile of existing assets is reflected in Figure 18.

FIGURE 18. ASSET AGE PROFILE CHART (AS AT JULY 2022) – INSTRUMENT TRANSFORMERS (ZONE)



The asset class health profile is summarised in Figure 19.

FIGURE 19. ASSET HEALTH PROFILE (AS AT JULY 2022) – INSTRUMENT TRANSFORMERS (ZONE)



a) 132kV & 66kV Current Transformers Oil Insulated

Due to the age, and difficulty with taking oil samples of these units, there are two 3-phase units that are budgeted for replacement within the EN24 regulatory period. In general, these units are replaced either when they fail, or proactively to reduce those types that cannot be oil-sampled.

b) 132kV & 66kV Current Transformers BCT

Bushing CTs (BCTs) are situated within dead tank circuit breakers, which are a recent addition to the network. There are no condition or performance concerns.

c) 132kV & 66kV Voltage Transformers

All VTs of the capacitive type have been removed and replaced with modern alternatives. There are no more units with known performance issues. In general, these units are replaced either when they fail, or proactively to reduce those types that cannot be oil-sampled.

4.4.3.3 Power Transformer Assembly

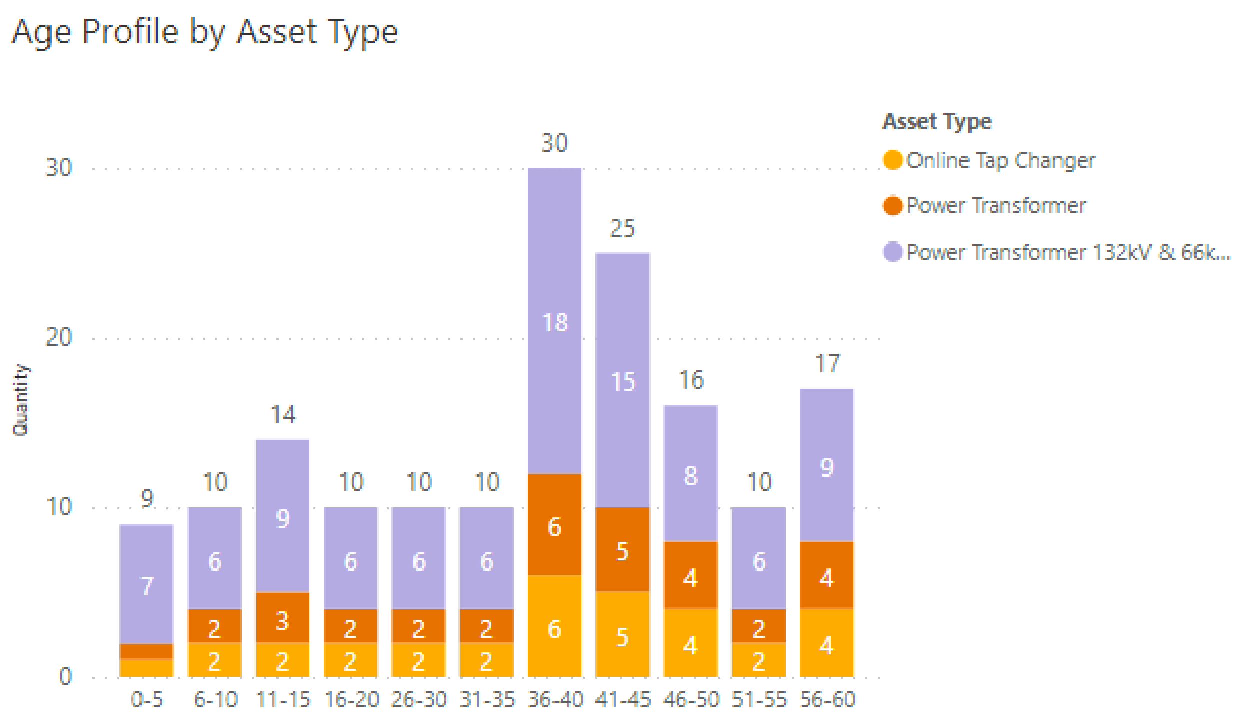
Table 10 offers a high-level count of power transformer assembly assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column.

TABLE 10. ASSET POPULATION, AGE, AND HEALTH PROFILES – POWER TRANSFORMER ASSEMBLY

Asset Type	Quantity	Unit	Design Life (yrs)	Critical Health Qty	Average Health Score	Health Category
Power Transformer 132kV & 66kV Bushing	96	each	30	9	61.64	Fair
MICAFIL,CTF145/630	44	each	30	9	46.00	Fair
ASEA,GOB650/1250	21	each	30	0	59.00	Fair
ABB,UNKNOWN	6	each	30	0	94.00	Very Good
ABB,RTZF145-650/800	3	each	30	0	92.00	Very Good
ABB,GOB650/1250	13	each	30	0	80.00	Good
ABB,GOB3258000.3O	3	each	30	0	90.00	Good
ABB,GOB325/800	6	each	30	0	84.00	Good
Power Transformer	33	each	50	0	82.42	Good
WILSON,UNKNOWN	1	each	50	0	100.00	Very Good
WILSON,P1606	1	each	50	0	100.00	Very Good
TYREE,UNKNOWN	1	each	50	0	68.00	Good
REINHAUSEN,UNKNOWN	1	each	50	0	95.00	Very Good
GEC,UNKNOWN	6	each	50	0	87.00	Good
EMILPFIFFNER,UNKNOWN	17	each	50	0	73.00	Good
ABB,UNKNOWN	6	each	50	0	99.00	Very Good
Online Tap Changer	32	each		4	57.41	Fair
REINHAUSEN,VVIII250D761223	1	each		0	91.00	Very Good
REINHAUSEN,MIIIY500/60C	8	each		0	51.00	Fair
REINHAUSEN,DIIIY400-60/110	4	each		0	38.00	Poor
REINHAUSEN,DIIIY400-150/60	4	each		4	27.00	Poor
ASEA,UZEDN380/500	7	each		0	58.00	Fair
ABB,UZFRT380/300	2	each		0	84.00	Good
ABB,UZFDN380/500	2	each		0	70.00	Good
ABB,UZEDN380/600	1	each		0	89.00	Good
ABB,UBBRN350/150	1	each		0	87.00	Good
ABB,N/A	2	each		0	94.00	Very Good
Total	**161**	**each**	**35**	**13**	**65.06**	**Fair**

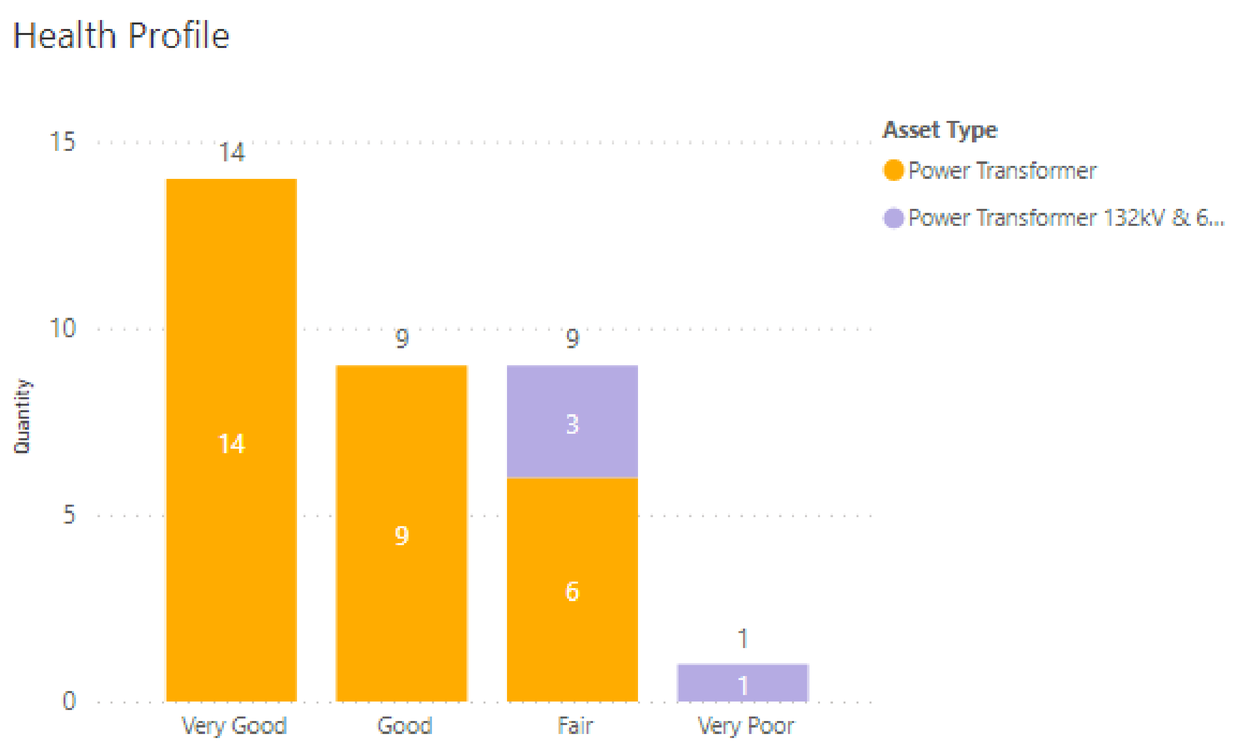
The age profile of existing assets is reflected in Figure 20. Several assets are approaching end of life and will require close monitoring to ensure that they can continue to maintain a reliable power supply.

FIGURE 20. ASSET AGE PROFILE CHART (AS AT JULY 2022) – POWER TRANSFORMER ASSEMBLY



The asset class health profile is summarised in Figure 21.

FIGURE 21. ASSET HEALTH PROFILE (AS AT JULY 2022) – POWER TRANSFORMER ASSEMBLY



a) Power Transformers

There are no recurring issues within the power transformer population, however the general insulation level (as measured) is decreasing as expected with age. To expand on this, power transformers have a stated ‘design life’ of 40 years, and an ‘expected life’ of 50 years. Currently 6 of the 33 total units are over the age of 50, with 4 units to reach age 60 within the EN24 regulatory period.

b) Bushings

Over the lifespan of a typical power transformer, the HV bushings will generally require replacing once. This is generally due to moisture ingress, capacitive layer breakdown, or physical damage. Due to Canberra’s favourable climate however, these issues have proven to be less common as compared to other utilities situated within more humid environments. Dielectric Loss Angle (DLA) testing of bushings have uncovered no condition or performance concerns for power transformer bushings.

c) Online Tap Changers

There are no outstanding or recurring issues withing the OLTC population. As issues arise they are dealt with, almost always with replacement parts such as contacts, resistors, or switches. This almost exclusively happens proactively during tap changer refurbishment works.

4.4.4 Risks and Opportunities

4.4.4.1 Auxiliary and Earthing Transformers

Earthing and auxiliary transformers are critical interfaces between the transmission and distribution network systems. The only way to reduce the criticality of a single unit is to have power directed through an alternate auxiliary transformer in the same zone substation, by using the zone substation standby diesel generator (for a short duration of a few hours), or by transferring distribution load to another zone substation and taking the power transformer out of service.

4.4.4.2 Instrument Transformers (Zone)

Refurbishment of post type CTs is neither technically nor economically viable, therefore they require replacement at assessed end of life. However, many of the post type CTs are installed in conjunction with the older minimum oil circuit breakers. These CTs will be replaced on an opportunity basis when the related circuit breaker is replaced.

Refurbishment of VTs is neither technically nor economically viable, therefore they require replacement at assessed end of life. The use of voltage taps on bushings of adjacent plant will be investigated as an alternative to VTs.

4.4.4.3 Power Transformer Assembly

Power transformers traditionally have a 12-month lead time, with a ‘design life’ stated to be 40 years. Currently over 40% of Evoenergy’s fleet is over this age, and approximately 18% are over 50 years. Insulation integrity readings (as measured) have indicated that 6 transformers are nearing end of life conditions.

The consequences of a failed transformer range in severity from inconvenient with no outage to major, including loss of life or severe injury, damage to transformer blast walls, environment destruction and extended outages. Special duty of care applies to minimise these impacts by maintaining these transformers in a good and safe working manner.

Opportunities to minimise these risks that have been explored include installing online dissolved gas analysers, and steps to introduce a power transformer as a network spare (as detailed in section 4.4.5). Further, transformer moisture assessment testing equipment has recently been purchased that will aid in reducing the transformers degradation curve.

4.4.5 Planned Projects, Replacements and Retirements

4.4.5.1 Augmentation Projects

Harman zone substation construction is planned for completion within financial year 2022/23. This will add the following assets within the Zone Substation Transformer asset group:

- 2 × Auxiliary transformers
- 2 × Earthing transformers
- 2 × Power transformers
- 10 × Bushing current transformers (3ph) (incorporated within 132kV circuit breakers).

Following the Harman project, Molonglo zone substation is being designed and planned for completion within financial year 2024/25. Initially this site will be only 1 bay (1 power transformer), however will likely be expanded to have up to 3 bays. The following initial assets are included:

- 1 × Auxiliary transformers
- 1 × Earthing transformers
- 1 × Power transformers
- 4 × Bushing current transformers (3ph) (incorporated within 132kV circuit breakers).

The Fyshwick zone substation augmentation project includes decommissioning Fyshwick zone substation in the EN24 regulatory period. This removes all 66kV operating voltage assets from Evoenergy's network, specifically:

- 2 × Voltage transformers
- 5 × Current transformers
- 2 × Auxiliary transformers
- 3 × Earthing transformers
- 3 × Power transformers.

4.4.5.2 Replacement Projects

It is proposed to replace transformer No.2 at Telopea zone in order to address security of supply issues from one of Evoenergy's most critical sites. This transformer has been identified as being the lowest health unit within the network, based on estimated insulation levels from paper sampling. This project will result in this transformer becoming a network spare, ready for deployment when needed. This will address significant lead times (up to 12 months) and network redundancy issues experienced following a power transformer failure.

Due to age, one auxiliary transformer is budgeted to be replaced during FY27. This is currently earmarked to be Wanniassa Auxiliary #1. Due to the very low demand, and therefore low wear, no NETs are planned for replacement at this stage.

4.4.6 Asset Management Strategy

4.4.6.1 Auxiliary and Earthing Transformers

Earthing and auxiliary transformers are fitted with several protection and monitoring devices to ensure long life and optimal operation. Transformer core and winding temperatures and other critical conditions such as Buchholz operations are monitored remotely.

Aside from these measurements, transformers are regularly inspected for oil leaks at gaskets, valves, as well as tank, bushings, cable connections and rust.

The following condition monitoring activities are undertaken:

- 3-monthly visual inspection
- 6-monthly thermographic inspection
- 2-yearly oil sample for auxiliary transformers
- 2-yearly oil sample for earthing transformers.

There is no planned or defined unplanned maintenance at this time for this asset class. Maintenance is completed as issues are identified.

Earthing and auxiliary transformers have a finite service life, most often quoted as 50 years, and are generally run-to-fail. It is always in the benefit of the zone substations to have available spare units to maintain zone substation reliability without disturbing the distribution network.

In the event of failure of any of the auxiliary transformers, a zone substation standby diesel generator can be used temporarily for a few hours.

In the event of failure of any of the earthing transformers, the associated power transformer in a zone substation will be out of service. Remediation time varies from a few hours to a few months depending upon the availability of a system spare unit or the lead time required to procure a replacement unit. Evoenergy Stores maintains one spare Neutral Earthing Transformer (NET), however the condition must be assessed prior to deployment.

4.4.6.2 Instrument Transformers (Zone)

Transformers are regularly inspected for oil leaks at gaskets, valves, as well as tank, bushings, cable connections and rust.

The following condition monitoring activities are undertaken:

- 3-monthly visual inspection
- 6-monthly thermographic inspections
- 4-yearly oil sample
- 5-yearly testing (Main current path resistance, and primary circuit insulation resistance).

There is no planned or defined unplanned maintenance at this time for this asset class. Maintenance is completed as issues are identified.

Instrument transformers have a finite service life of 50 years and are generally run-to-fail. It is in the benefit of the zone substations to have available spare units to maintain zone substation reliability without disturbing the distribution network.

4.4.6.3 Power Transformer Assembly

Power transformers are fitted with several protection and monitoring devices to ensure long life and optimal operation. Transformer core and winding temperatures and other critical conditions such as Buchholz operations are monitored remotely.

The following maintenance activities are undertaken for this asset class:

- 3-monthly visual inspection
- 6-monthly thermographic inspections
- 1-yearly oil sample (power transformers)
- 1-yearly exercising (ABB online tap changers)
- 2-yearly bushing DLA testing (40 years old and over)
- 5-yearly bushing DLA testing (under 40 years old)
- 6-yearly refurbishment (ABB online tap changers)
- 7-yearly refurbishment (Reinhausen online tap changers)
- As needed – Intrusive paper sample (power transformers).

At end of life, power transformer refurbishment can be a viable option, however this is rarely a risk-free solution that has considerable costs and logistical impediments.

4.5. ZONE SUBSTATION 11KV SWITCHBOARD ASSEMBLY STRATEGY

4.5.1 Asset Class Summary and Objectives

The zone substation 11kV switchboard assembly asset class includes all the 11kV switchgear located in zone substations. On average, these supply 6,113 customers per switchboard. This equipment is required to switch, protect, isolate, and earth electrical plant and networks. Their reliable operation is fundamental to the safe and reliable operation of the network.

All switchgear is indoor 11kV metal partitioned with single and double busbar configurations and rackable circuit breakers of both minimum oil and vacuum types. The zone substation 11kV switchboard assembly asset class includes:

- Zone 11kV Switchboards
- Zone 11kV Instrument Transformers (CTs and VTs)
- Zone 11kV Oil Circuit Breakers
- Zone 11kV Vacuum Circuit Breakers
- Zone 11kV Earth/Test Trucks.

A typical zone substation has between 2-3 switchboards which comprise of 2 power transformer connections, 1 bus coupler, and 10 feeder circuit breakers per switchboard.

Notably, protection and control equipment are also housed in zone substation 11kV switchboards, however these assets are not managed under this strategy. For information concerning protection and control equipment refer to the Secondary Systems Assets Portfolio Strategy.

4.5.2 Asset Types

4.5.2.1 Zone 11kV Switchboards

Zone 11kV switchboards are metal-partitioned switchgear comprising of a series of 11kV switchboard panels. Each panel contains busbars, one circuit breaker, and instrument transformers to provide one circuit. The switchboard is the enclosure for busbars, instrument transformers, and circuit breakers.

4.5.2.2 Zone 11kV Instrument Transformers

Instrument transformers include CTs and VTs. They measure current and voltage on the electrical network which is used by protection, control, and metering devices to operate the network.

4.5.2.3 Zone 11kV Circuit Breakers

Circuit breaker performance is vital for the safe and reliable operation of the distribution network by clearing network faults, providing safe access to the network, load management and restoring supply to customers.

Oil circuit breakers use oil as the insulating and arc suppression medium in the breaking chamber. New 11kV oil circuit breakers have not been installed since 1985 and instead have been superseded by newer generation vacuum circuit breakers. Asset replacement programs will continue to phase out oil circuit breakers.

Vacuum circuit breakers utilise a vacuum as the insulating and arc suppression medium in the breaking chamber.

4.5.2.4 Zone 11kV Earth/Test Truck

Earth/test trucks provide safe access and test connection points to the electrical network through 11kV switchboards. This is essential for maintenance of the network.

4.5.3 Current Population, Age, and Health Profile

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

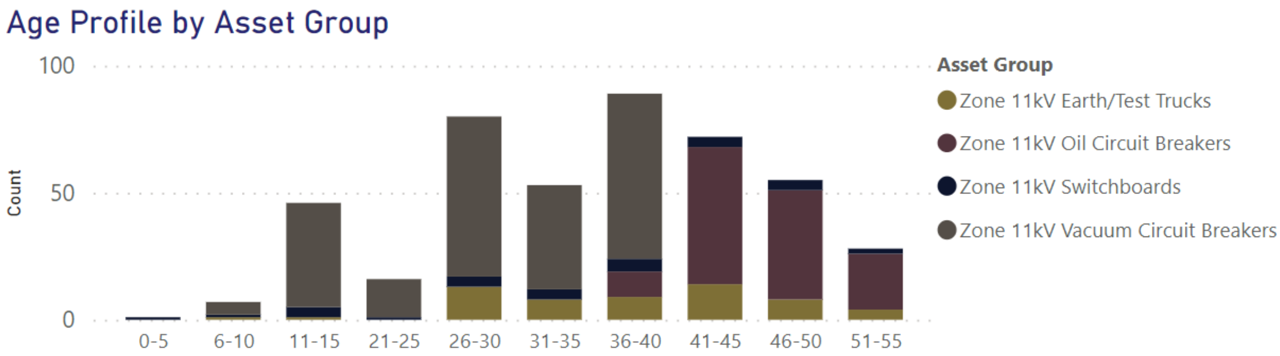
TABLE 11. ASSET POPULATION, AGE, AND HEALTH PROFILE – 11KV SWITCHBOARD ASSEMBLY

Asset Group	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
Zone 11kV Switchboards	30	each	40.00	34.00	4	54.10	Fair
ABB,ZS1	6	each	40.00	11.00	0	88.50	Good
HAWKERSIDDELEY,UNKNOWN	2	each	40.00	32.00	0	58.00	Fair
GEC,UNKNOWN	8	each	40.00	33.00	0	57.00	Fair
GECHED,UNKNOWN	4	each	40.00	36.00	0	51.50	Fair
BRUSHSWITCHGEAR,UNKNOWN	5	each	40.00	45.00	0	34.20	Poor
EMAIL,UNKNOWN	5	each	40.00	47.00	4	28.60	Poor
Zone 11kV Circuit Breakers	359	each	40.00	37.00	44	52.24	Fair
ABB,VD4	46	each	40.00	12.00	0	87.57	Good
HAWKERSIDDELEY,VMH	15	each	40.00	23.00	0	73.00	Good
GEC-ALSTOM,SBV3/DB	79	each	40.00	30.00	0	61.96	Good
GECHED,SBV1	90	each	40.00	37.00	0	50.66	Fair
BRUSHSWITCHGEAR,Q20/2MK3	1	each	40.00	41.00	0	43.00	Fair
BRUSHSWITCHGEAR,Q20/2MK2	20	each	40.00	43.00	0	38.85	Poor
BRUSHSWITCHGEAR,R8/2MK4	64	each	40.00	43.00	0	38.36	Poor
EMAIL,J18X-A24	32	each	40.00	52.00	32	20.50	Poor
EMAIL,J22X-A30	12	each	40.00	52.00	12	20.50	Poor
Zone 11kV Earth/Test Trucks	58	each	40.00	34.60	8	46.84	Fair
UNKNOWN,UNKNOWN	2	each	40.00	10.00	0	89.50	Good
GEC-ALSTOM,UNKNOWN	16	each	40.00	30.00	0	61.81	Good
GECHED,UNKNOWN	14	each	40.00	37.00	0	50.79	Fair
BRUSHSWITCHGEAR,UNKNOWN	18	each	40.00	44.00	0	37.44	Poor
EMAIL,UNKNOWN	8	each	40.00	52.00	8	20.50	Poor
Total	**447**	**each**	**40.00**	**35.50**	**56**	**51.66**	**Fair**

Within this asset class, zone 11kV oil circuit breakers are the oldest assets in service and have not been installed since 1985. All new and replacement circuit breakers are vacuum circuit breaker type which have a lower consequence of failure (environmental and safety impact) and have lower OPEX costs.

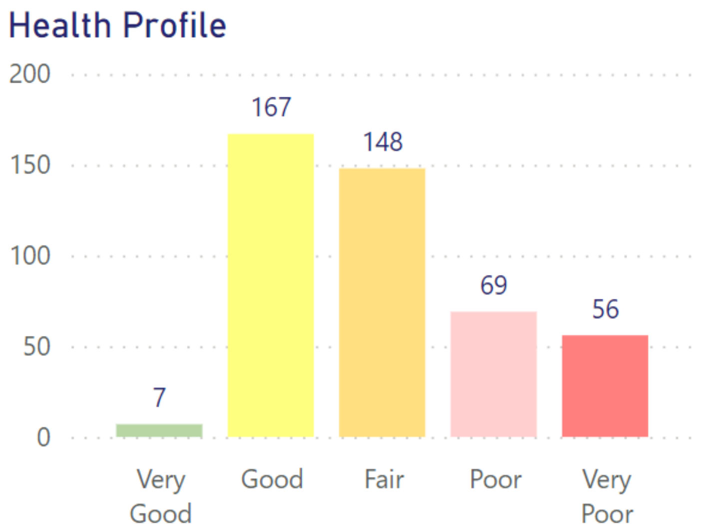
The age profile of this asset class reflects this and is shown in Figure 22.

FIGURE 22. ASSET AGE PROFILE CHART (AS AT JULY 2022) – 11KV SWITCHBOARD ASSEMBLY



The asset class health profile, as of 2022, is summarised in Figure 23.

FIGURE 23. ASSET HEALTH PROFILE (AS AT JULY 2022) – 11KV SWITCHBOARD ASSEMBLY



The following assets are identified in poor condition approaching end of life with increasing risk. The asset class objective is zero catastrophic failures and therefore the strategy must implement condition monitoring and/or planned replacement of these assets when they reach end of life. All of these assets are located at Wanniassa and Latham zone substations (both boards AG and BG, for both sites).

- Zone 11kV switchboard – Email
- Zone 11kV oil circuit breaker – Email J18X-A24
- Zone 11kV oil circuit breaker – Email J22X-A30
- Zone 11kV earth/test truck – Email.

4.5.3.1 Zone 11kV Switchboards

Recurring 'jamming' issues have been experienced with shutters during rack-in procedures with EMAIL boards.

4.5.3.2 Zone 11kV Circuit Breakers

No recurring or systemic issues have been experienced with 11kV circuit breakers. The largest risk is however obtaining spare parts as needed for older units, due to factories having closed down.

4.5.3.3 Zone 11kV Instrument Transformers

No outstanding or recurring issues exist for the 11kV instrument transformer population.

4.5.3.4 Zone 11kV Earth/Test Trucks

No outstanding or recurring issues exist for the 11kV earth/test truck population.

4.5.4 Risks and Opportunities

Zone 11kV switchboard assembly assets have a very high cost of failure and must be replaced before catastrophic failure to manage the environmental, safety and network reliability risks. Failures in this asset class often have large impacts on System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI) performance.

The combined financial, operations, reputation, safety, and environmental risk cost of a catastrophic failure of an 11kV switchboard is over $10.5M (as determined by PowerPlan). This is a significant cost and is more than triple the planned replacement cost. The successful operation of zone 11kV switchboard assembly assets is crucial in ensuring network reliability, community safety, the safety of our personnel and equipment.

There are currently four zone 11kV switchboards and 44 zone 11kV circuit breakers which will exceed their design life by the end of the EN24 regulatory period, and thus need to be effectively managed. Replacement of assets at end of life with modern day equipment provides additional benefits including reduced OPEX costs and increased safety to operational and maintenance staff.

Assets in the zone 11kV switchboard assembly asset class are manufactured from 1970 on with older generation equipment using oil circuit breaker technology and limited safety features when compared to modern equipment installed today. Opportunities arising from the replacement of older generation equipment with modern switchgear include:

- Safety – improved safety from arc flash, improved operational interlocks and earthing, no oil explosion and fire
- Environmental – no oil, reducing risk to the environment through fire or oil spillage
- Lifecycle cost – maintenance of vacuum circuit breakers is less expensive compared to oil
- Reliability – modern design with less moving parts and less energy required in operations.

There is an opportunity to economically extend the life of 11kV switchboards through refurbishment. This is the replacement of 11kV circuit breaker trucks at end of life while preserving the existing 11kV switchboard panels including panels, busbars, and instrument transformers. This is most suitable to switchboards that are approximately mid-life and utilise outdated technology such as oil insulating medium.

4.5.5 Planned Projects, Replacements and Retirements

4.5.5.1 Augmentation Projects

Harman zone substation construction is planned for completion within financial year 2022/23. This will see the addition of the following units:

- 2 × 11kV switchboards
- 14 × 11kV vacuum circuit breakers
- 4 × Earth/Test trucks.

Following the Harman project, Molonglo zone substation is being designed and planned for completion within financial year 2024/25. Initially this site will be only 1 bay (1 transformer), however will likely be expanded to have up to 3 bays. The following initial assets are included:

- 1 × 11kV switchboards
- 8 × 11kV vacuum circuit breakers
- 2 × Earth/Test trucks.

4.5.5.2 Replacement Projects

The following 11kV switchboards have been earmarked for proactive replacement over the period FY25-26. These will be replaced utilising new stand-alone demountable buildings housing the new switchboards.

- Wanniassa 11kV switchboard BG (1970; Email J-Type)
- Latham 11kV switchboard BG (1970; Email J-Type).

After these replacement projects have been completed, the following switchboards are to be replaced within EN29. These will be replaced with units installed directly within the existing 11kV switchrooms.

- Wanniassa 11kV switchboard BG (1970; Email J-Type)
- Latham 11kV switchboard BG (1970; Email J-Type).

These four switchboards are the oldest within the network and have presented with operational and safety related risks. Further, due to pitch filled incoming cables, proper condition monitoring activities cannot be feasibly undertaken.

4.5.6 Asset Management Strategy

Several options were evaluated with a risk-condition based approach in accordance with our strategic direction to determine the optimal strategy. That is, the preferred strategy meets the asset class objectives, is technically feasible, controls risk at an acceptable level and has the least Net Present Cost (NPC) for customers and the community over the long term. The evaluation also considers alignment of maintenance and renewal activities with associated asset classes for delivery efficiency.

The preferred option from this evaluation is to maintain the existing strategy and risk profile.

The design life of zone substation 11kV switchboard assembly assets is 50 years. The useful life may be less than or greater than the design life which can depend on quality of manufacturing, installation, maintenance, and operational conditions.

Over the past decade, 2 zone substation 11kV switchboards were replaced at Civic zone substation to manage risks to supply security, safety of staff and collateral damage to adjacent assets in the event of catastrophic failure. These assets were assessed at the end of their useful life from electrical and mechanical condition assessments and increasing operational malfunctions. These assets were aged 47 years at retirement

4.6. ZONE SUBSTATION SITE AND STRUCTURES STRATEGY

4.6.1 Asset Class Summary and Objectives

This class includes assets that are needed to meet the general requirements of a zone substation, as well as the zone substation "asset". This includes:

- Non-Network Items Transmission Sites:
  - Air conditioning
  - Fire system
  - Plumbing and drainage
  - Onsite facilities (bathroom/lunch room)
  - Grounds and depot
  - Water and sewerage charges
  - Electrical and lighting
  - Electronic security systems
  - Security fence and patrols
  - Building
  - Land rates
- General Items Transmission Sites:
  - Zone Substations/Switching Stations
  - Landing Towers
- Earthing.

4.6.2 Asset Types

4.6.2.1 Non-Network Items Transmission Sites

The function of the zone property asset class for transmission sites is to provide safe, reliable support to the primary assets used to distribute network supply to the customers. The support mainly consists of zone substation building and yard facilities.

The general zone property items pertain to Evoenergy's 14 zone substations, and 2 switching stations. These are largely managed by Property and Security who engage contractors on fixed terms to undertake works.

4.6.2.2 General Items Transmission Sites

This grouping is to capture general items that are directly related to the support of energy transmission. The following assets fall within this grouping:

- Zone Substations/Switching Stations
- Landing Towers.

The towers are used in zone substations and 132kV switching stations to support the 132kV aerial conductors. They are referred to as H-type towers, landing towers, or gantries.

The landing towers support the 132kV aerial conductors entering the zone or switching station from the 132kV sub-transmission network. The aerial conductors are then connected from the landing tower to other primary assets such as 132kV circuit breakers and 132kV/11kV power transformers.

4.6.2.3 Earthing

Earthing at zone substations has the following functions:

- To provide an earth for connecting neutral points, equipment bodies and support structures to earth
- For safety of personnel and for enabling earth fault protection
- To provide the path for discharging the earth current from neutrals, faults, surge arresters, overhead shielding wires, etc., with safe step and touch potentials
- To protect the transmission line overhead conductors from direct lightning strikes by connecting overhead earth wire to local earthing.

4.6.3 Current Population, Age, and Health Profile

The design life of the earthing equipment as well as landing tower assets is 50 years. This is however affected by a range of ageing factors as follows:

- Rust/acidity of soil
- Electrical loading
- Thermal conditions
- Moisture/contamination ingress into the insulation
- Exposure to overvoltage conditions.

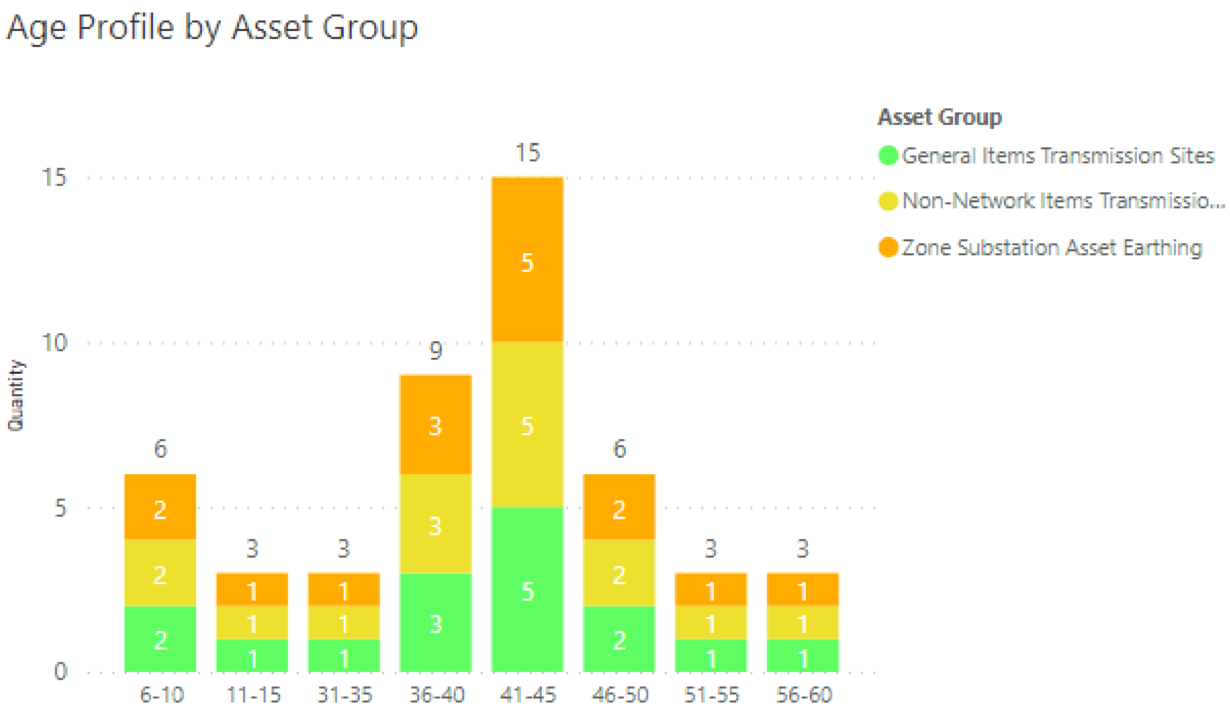
Table 12 offers a high-level count of zone substation site and structures assets within the Evoenergy network, and any notable population performance or potential failure concerns are highlighted in the Health Category column. Note that zone substation property has been omitted throughout this section due to irrelevance.

TABLE 12. ASSET POPULATION, AGE, AND HEALTH PROFILE – SITE AND STRUCTURES

Asset Specific Plan	Quantity	Unit	Design Life (yrs)	Average Age	Critical Health Qty	Average Health Score	Health Category
Zone Substation Sites and Structures	48	each	50	37	22	36.46	Fair
Zone Substation Earth	16	each		37	16	0.00	Very Poor
Electric Supply Site Non-Network Assets	16	each	50	37	3	54.69	Fair
Electric Supply Site Network Assests	16	each	50	37	3	54.69	Fair

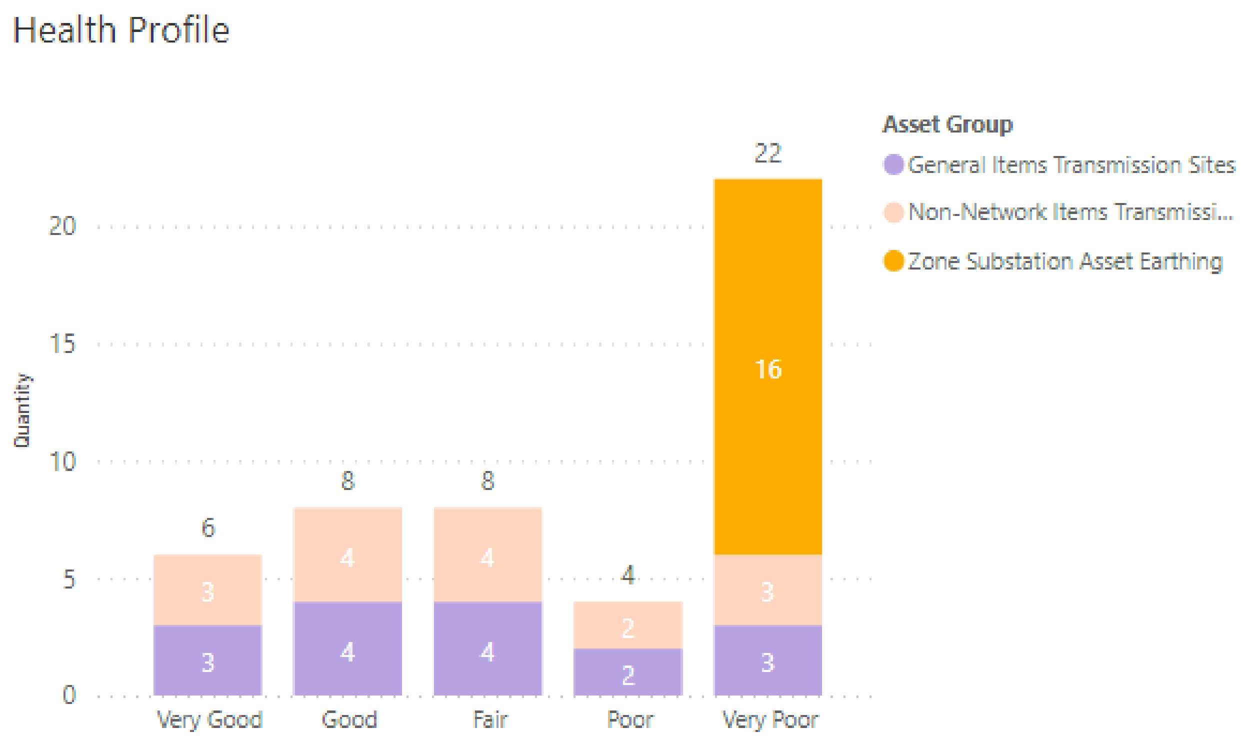
The age profile of this asset class reflects this and is shown in Figure 24.

FIGURE 24. ASSET AGE PROFILE CHART (AS AT JULY 2022) – SITE AND STRUCTURES



Evoenergy calculates asset condition using an age-based degradation model with modifiers for known asset condition, environment, and usage, where known. The asset class health profile, as of 2022, is summarised in Figure 25.

FIGURE 25. ASSET HEALTH PROFILE (AS AT JULY 2022) – SITE AND STRUCTURES



No outstanding or recurring issues are present throughout the sites, structures, or earthing asset population.

4.6.4 Risks and Opportunities

After finding several non-conformities with asset earthing, a network-wide dedicated inspection and re-bonding program was conducted within 20/21. A specialist earthing contractor is now employed on a 10-yearly basis to perform an earthing analysis of all zone substation sites. Further, annual earth resistance checks are planned to be undertaken internally from FY23.

During a FY23 power transformer replacement project, it was found that the roof of the Telopea zone 11kV switching room requires a fire-rating upgrade. This was found to be necessary due to the inadequate clearances between the roofline and the power transformers. This work is currently being planned and will likely commence FY24.

Recently the ACT government expanded its requirements for building construction within Bushfire Prone Areas (BPA). Previously, these regulations applied only to greenfield and 'rural' development areas. The changes came into effect in 2019, and now cover all new builds and substantial construction within BPAs. These sites will now be subject to formal evaluation to identify bushfire mitigation steps that can be incorporated, such as heat resistant materials or screening vents. This will be a consideration as a number of Evoenergy zone substations are located within BPAs.

Although it is not a legal requirement, Evoenergy has identified City East zone substation would benefit from a bushfire-risk assessment. This is due to the ZSS location and proximity to scrubland and trees at the base of Mount Ainslie (within a BPA). Possible remediation works include the installation of roof sprinklers, replacing the roofing material to a substance more fire resistant, and/or the introduction of screening vents. This assessment is expected to be undertaken within FY23.

4.6.5 Planned Projects, Replacements and Retirements

4.6.5.1 Augmentation Projects

Harman zone substation construction is planned for completion within financial year 2022/23. This will see the addition of the following units:

- 1 × Substation
- 4 × Landing Structures
- 1 × Earth Mat.

Following the Harman project, Molonglo zone substation is being designed and planned for completion within financial year 2024/25. Initially this site will be only one transformer bay, however will likely be expanded to have up to 3 transformer bays. The following initial assets are included:

- 1 × Substation
- 2 × Landing Structures
- 1 × Earth Mat.

4.6.6 Asset Management Strategy

The recommended maintenance strategies for these assets are as follows:

- 3-monthly visual inspection (all assets)
- 6-monthly thermal inspection (landing towers, earthing)
- 1-yearly resistance checks (earthing)
- 10-yearly specialist testing (earthing)
- As needed – general repair works on non-network assets undertaken by contractors.

4.7. ZONE SUBSTATION REACTIVE PLANT STRATEGY

4.7.1 Asset Class Summary and Objectives

Evoenergy does not presently have any reactive plant in use within its network. As the penetration of variable renewable energy sources increases, the addition of reactive plant is likely to become necessary.

This heading acts as a placeholder until this asset class is expounded.

5. PROGRAM OF WORK

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

5.1. REPLACEMENT PROGRAM

TABLE 13. 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 Zone Substation	**67**	**6,349,407**	**59**	**4,628,316**	**52**	**5,792,800**	**59**	**1,197,474**	**56**	**2,049,595**
Zone Substation 11kV Switchboard Assembly	**1**	**4,307,925**			**1**	**4,307,925**				
Replacement	**1**	**4,307,925**			**1**	**4,307,925**				
EP-00827 - EN24 - Latham Zone - 11kV Switchboard Replacement (AG)	1	4,307,925								
Replace zone sub 11kV switchboard	1	4,307,925								
EP-00829 - EN24 - Wanniassa Zone - 11kV Switchboard Replacement (AG)					1	4,307,925				
Replace zone sub 11kV switchboard					1	4,307,925				
EP-01139 - EN29 - Zone Substation 11kV Switchboard Assembly										
Zone Substation 132kv & 66kv Switchgear	**35**	**610,566**	**18**	**635,049**	**21**	**476,092**	**21**	**439,766**	**19**	**916,473**
Refurbishment	**17**	**108,362**			**17**	**144,688**	**17**	**108,362**	**17**	**253,665**
EP-00990 - EN24 - Multiple Sites - Refurbish 132kV Oil Circuit Breakers	17	108,362			17	144,688	17	108,362	17	253,665
Refurb	17	108,362			17	144,688	17	108,362	17	253,665
Replacement	**18**	**502,205**	**18**	**635,049**	**4**	**331,404**	**4**	**331,404**	**2**	**662,808**
EP-00946 - EN24 - Latham 132kV HLR CB Replacement (2EB, 2HB, 2CB, 2BB)	4	331,404	4	331,404	4	331,404	4	331,404		
Replace 132kV circuit breaker	4	331,404	4	331,404	4	331,404	4	331,404		
EP-00947 - EN24 - Woden 132kV HLR CB Replacement (2CB, 2DB)									2	662,808
Replace 132kV circuit breaker									2	662,808

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-00991 - EN24 - Latham Zone - 132kV Isolator Replacement x11	14	170,801	14	303,645						
Replace 132kV/66kV earth switch	2	24,400	2	43,378						
Replace 132kV/66kV isolator switch	12	146,400	12	260,268						
EP-01140 - EN29 - Zone Substation 132kv & 66kv Switchgear										
Zone Substation Auxiliary AC and Generators	**6**	**445,277**	**6**	**276,326**	**6**	**276,326**	**6**	**276,326**	**6**	**276,326**
Replacement	**6**	**445,277**	**6**	**276,326**	**6**	**276,326**	**6**	**276,326**	**6**	**276,326**
EP-00988 - EN24 - Multiple Sites - Replace Zone Generators	5	106,356	5	106,356	5	106,356	5	106,356	5	106,356
Replace standby generator	5	106,356	5	106,356	5	106,356	5	106,356	5	106,356
EP-00989 - EN24 - Multiple Sites - Replace Zone AC board	1	338,921	1	169,970	1	169,970	1	169,970	1	169,970
EP-01135 - EN29 - Auxiliary AC Supply Systems										
Zone Substation Sites and Structures	**1**	**308,630**	**1**	**112,161**	**2**	**354,665**	**2**	**294,358**	**1**	**112,161**
Refurbishment	**1**	**308,630**			**1**	**242,504**	**1**	**182,196**		
EP-00992 - EN24 - Telopea Park Building Upgrade	1	308,630								
EP-00993 - EN24 - City East zone - Building fire Uprating					1	242,504	1	182,196		
Replacement			**1**	**112,161**	**1**	**112,161**	**1**	**112,161**	**1**	**112,161**
EP-00994 - EN24 - Multiple Sites - Security System Upgrades			1	112,161	1	112,161	1	112,161	1	112,161
EP-01141 - EN29 - Zone Substation Sites and Structures										
Zone Substation Transformers	**24**	**677,008**	**34**	**3,604,780**	**22**	**377,793**	**30**	**187,025**	**30**	**744,634**
Refurbishment	**21**	**597,289**	**21**	**10,442**	**21**	**39,680**	**21**	**39,680**	**21**	**597,289**
EP-00995 - EN24 - Multiple Sites - Refurbish OLTC	21	597,289	21	10,442	21	39,680	21	39,680	21	597,289
Refurbish power transformer online tap changer	21	597,289	21	10,442	21	39,680	21	39,680	21	597,289
Replacement	**3**	**79,719**	**13**	**3,594,338**	**1**	**338,113**	**9**	**147,345**	**9**	**147,345**
EP-00823 - EN24 - Telopea Zone - Replace Power Transformer 2 (BT)			1	3,367,274						

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 ($)
Replace power transformer			1	3,367,274						
EP-00996 - EN24 - City East zone - Replace 132kV CT	3	79,719								
Replace 132kV/66kV CT	3	79,719								
EP-00997 - EN24 - Woden zone - Replace 132kV CT			3	79,719						
Replace 132kV/66kV CT			3	79,719						
EP-00998 - EN24 - Wanniassa zone - Replace Auxiliary Transformer					1	338,113				
Replace auxiliary transformer					1	338,113				
EP-00999 - EN24 - Multiple Sites - 132kV Bushing Replace			9	147,345			9	147,345	9	147,345
Replace power transformer 132kV bushing			9	147,345			9	147,345	9	147,345
EP-01142 - EN29 - Zone Substation Transformers										

5.2. MAINTENANCE PROGRAM

TABLE 14. 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	TASK COST ($)	QTY	TASK COST ($)	QTY	TASK COST ($)
Maintenance Zone Substation	**641**	**1,743,288**	**678**	**1,174,473**	**626**	**1,864,977**	**548**	**1,737,720**	**620**	**1,316,997**
Zone Substation 11kV Switchboard Assembly	**67**	**425,306**	**155**	**333,138**	**53**	**113,038**	**105**	**455,321**	**38**	**92,408**
Condition Monitoring	**5**	**290,950**					**4**	**232,760**		
-	**5**	**290,950**					**4**	**232,760**		
Test zone sub 11kV switchboard	5	290,950					4	232,760		
Planned Maintenance	**43**	**84,852**	**136**	**283,634**	**34**	**63,534**	**82**	**173,057**	**19**	**42,904**
-	**43**	**84,852**	**136**	**283,634**	**34**	**63,534**	**82**	**173,057**	**19**	**42,904**

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	TASK COST ($)
Maintain zone sub 11kV Earth/Test Truck	2	3,536	14	24,752						
Maintain zone sub 11kV oil circuit breaker	14	34,174	66	161,106	6	14,646	43	104,963	14	34,174
Maintain zone sub 11kV vacuum circuit breaker	27	47,142	56	97,776	28	48,888	39	68,094	5	8,730
Unplanned Maintenance	**19**	**49,504**	**19**	**49,504**	**19**	**49,504**	**19**	**49,504**	**19**	**49,504**
-	**19**	**49,504**	**19**	**49,504**	**19**	**49,504**	**19**	**49,504**	**19**	**49,504**
Maintain zone sub 11kV oil circuit breaker - fault based	3	9,264	3	9,264	3	9,264	3	9,264	3	9,264
Maintain zone sub 11kV vacuum circuit breaker - fault based	16	40,240	16	40,240	16	40,240	16	40,240	16	40,240
Zone Substation 132kv & 66kv Switchgear	**51**	**38,659**	**52**	**37,674**	**46**	**31,395**	**12**	**11,749**	**77**	**56,511**
Condition Monitoring	**1**	**3,676**					**1**	**3,676**		
-	**1**	**3,676**					**1**	**3,676**		
Inspect pressure vessel	1	3,676					1	3,676		
Planned Maintenance	**50**	**34,983**	**52**	**37,674**	**46**	**31,395**	**11**	**8,073**	**77**	**56,511**
-	**50**	**34,983**	**52**	**37,674**	**46**	**31,395**	**11**	**8,073**	**77**	**56,511**
Maintain 132kV/66kV earth switch	11	0	10	0	11	0	2	0	14	0
Maintain 132kV/66kV isolator switch	39	34,983	42	37,674	35	31,395	9	8,073	63	56,511
Zone Substation Auxiliary AC and Generators	**43**	**37,495**	**43**	**37,495**	**43**	**37,495**	**43**	**37,495**	**43**	**37,495**
Condition Monitoring	**28**	**14,756**	**28**	**14,756**	**28**	**14,756**	**28**	**14,756**	**28**	**14,756**
-	**28**	**14,756**	**28**	**14,756**	**28**	**14,756**	**28**	**14,756**	**28**	**14,756**
Test Standby Generator	28	14,756	28	14,756	28	14,756	28	14,756	28	14,756
Planned Maintenance	**14**	**21,644**	**14**	**21,644**	**14**	**21,644**	**14**	**21,644**	**14**	**21,644**
-	**14**	**21,644**	**14**	**21,644**	**14**	**21,644**	**14**	**21,644**	**14**	**21,644**
Maintain Standby Generator	14	21,644	14	21,644	14	21,644	14	21,644	14	21,644
Unplanned Maintenance	**1**	**1,095**	**1**	**1,095**	**1**	**1,095**	**1**	**1,095**	**1**	**1,095**
-	1	1,095	1	1,095	1	1,095	1	1,095	1	1,095
Replace standby generator battery	1	1,095	1	1,095	1	1,095	1	1,095	1	1,095
Zone Substation Sites and Structures	**279**	**655,003**	**279**	**655,003**	**295**	**1,200,891**	**279**	**655,003**	**279**	**655,003**

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	TASK COST ($)
Condition Monitoring	**144**	**151,536**	**144**	**151,536**	**160**	**697,424**	**144**	**151,536**	**144**	**151,536**
-	**144**	**151,536**	**144**	**151,536**	**160**	**697,424**	**144**	**151,536**	**144**	**151,536**
Earth Continuity Testing	16	10,672	16	10,672	16	10,672	16	10,672	16	10,672
Inspect zone substation	64	35,264	64	35,264	64	35,264	64	35,264	64	35,264
Inspect zone substation - thermovision	32	43,072	32	43,072	32	43,072	32	43,072	32	43,072
Repair zone sub earth					16	545,888				
Test zone sub fire system	32	62,528	32	62,528	32	62,528	32	62,528	32	62,528
Planned Maintenance	**110**	**484,080**	**110**	**484,080**	**110**	**484,080**	**110**	**484,080**	**110**	**484,080**
-	**110**	**484,080**	**110**	**484,080**	**110**	**484,080**	**110**	**484,080**	**110**	**484,080**
Earth Continuity Testing	16	10,672	16	10,672	16	10,672	16	10,672	16	10,672
Inspect zone sub - security patrol	16	93,760	16	93,760	16	93,760	16	93,760	16	93,760
Land Rates - Average Cost of All Sites	16	321,072	16	321,072	16	321,072	16	321,072	16	321,072
Maintain zone sub building - cleaning and sanitary	16	10,912	16	10,912	16	10,912	16	10,912	16	10,912
Maintain zone sub grounds	16	12,352	16	12,352	16	12,352	16	12,352	16	12,352
Maintain zone sub security system	16	35,312	16	35,312	16	35,312	16	35,312	16	35,312
Water & sewerage	14	0	14	0	14	0	14	0	14	0
Unplanned Maintenance	**25**	**19,387**	**25**	**19,387**	**25**	**19,387**	**25**	**19,387**	**25**	**19,387**
-	**25**	**19,387**	**25**	**19,387**	**25**	**19,387**	**25**	**19,387**	**25**	**19,387**
Repair zone sub air conditioning	2	2,172	2	2,172	2	2,172	2	2,172	2	2,172
Repair zone sub building	16	8,976	16	8,976	16	8,976	16	8,976	16	8,976
Repair zone sub electrical and lighting	5	2,805	5	2,805	5	2,805	5	2,805	5	2,805
Repair zone sub plumbing and drainage	2	5,434	2	5,434	2	5,434	2	5,434	2	5,434
Zone Substation Transformers	**201**	**586,825**	**149**	**111,163**	**189**	**482,158**	**109**	**578,152**	**183**	**475,580**
Condition Monitoring	**187**	**581,589**	**134**	**105,553**	**175**	**476,922**	**95**	**572,916**	**168**	**469,970**
-	**187**	**581,589**	**134**	**105,553**	**175**	**476,922**	**95**	**572,916**	**168**	**469,970**
Inspect power transformer oil	33	23,562	33	23,562	31	22,134	32	22,848	33	23,562

EXPENDITURE CATEGORY	FY 24-25		FY 25-26		FY 26-27		FY 27-28		FY 28-29	
	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	TASK COST ($)	QTY	TASK COST ($)
Test 132kV/66kV CT oil analysis	39	35,646	45	41,130	42	38,388			54	49,356
Test 132kV/66kV VT oil analysis	21	17,934	18	15,372	37	31,598	11	9,394	17	14,518
Test oil - auxiliary transformer	11	3,058	12	3,336	11	3,058	11	3,058	12	3,336
Test oil - earthing transformer	18	5,004	11	3,058	18	5,004	11	3,058	18	5,004
Test power transformer - DP insulating paper test	5	420,005			4	336,004	6	504,006	4	336,004
Test power transformer 132kV bushing	60	76,380	15	19,095	32	40,736	24	30,552	30	38,190
Planned Maintenance	**14**	**5,236**	**15**	**5,610**	**14**	**5,236**	**14**	**5,236**	**15**	**5,610**
-	**14**	**5,236**	**15**	**5,610**	**14**	**5,236**	**14**	**5,236**	**15**	**5,610**
Maintain power transformer online tap changer - exercise	14	5,236	15	5,610	14	5,236	14	5,236	15	5,610

5.3. LONG-TERM FORECAST

Table 15 presents the higher level 10-year long term forecast from FY24/25 to FY33/34.

TABLE 15. 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 Zone Substation	**6,349,407**	**4,628,316**	**5,792,800**	**1,197,474**	**2,049,595**	**4,302,250**	**4,386,678**	**4,490,599**	**4,365,033**	**4,385,905**
Zone Substation 11kV Switchboard Assembly	4,307,925	0	4,307,925	0	0	1,862,720	1,862,720	1,862,720	1,862,720	1,862,720
Zone Substation 132kv & 66kv Switchgear	610,566	635,049	476,092	439,766	916,473	334,356	649,044	334,356	334,356	334,356
Zone Substation Auxiliary AC and Generators	445,277	276,326	276,326	276,326	276,326	179,439	179,439	179,439	179,439	179,439
Zone Substation Sites and Structures	308,630	112,161	354,665	294,358	112,161	732,858	628,164	732,858	732,858	628,164
Zone Substation Transformers	677,008	3,604,780	377,793	187,025	744,634	1,192,877	1,067,311	1,381,226	1,255,660	1,381,226
Maintenance Zone Substation	**1,743,288**	**1,174,473**	**1,864,977**	**1,737,720**	**1,316,997**	**1,461,606**	**1,097,238**	**1,260,601**	**2,543,407**	**1,211,562**
Zone Substation 11kV Switchboard Assembly	425,306	333,138	113,038	455,321	92,408	588,860	153,812	293,787	481,728	333,138
Zone Substation 132kv & 66kv Switchgear	38,659	37,674	31,395	11,749	56,511	41,350	31,395	11,749	56,511	40,453
Zone Substation Auxiliary AC and Generators	37,495	37,495	37,495	37,495	37,495	37,495	37,495	37,495	37,495	37,495

Zone Substation Sites and Structures	655,003	655,003	1,200,891	655,003	655,003	655,003	655,003	655,003	655,003	655,003
Zone Substation Transformers	586,825	111,163	482,158	578,152	475,580	138,898	219,533	262,567	1,312,670	145,473

GLOSSARY

TERM	DEFINITION
AC	Alternating Current
ACT	Australian Capital Territory
AEMO	Australian Energy Market Operator
AIS	Air Insulated Switchgear
ALARP	As Low As Reasonably Practical
AMS	Asset Management System
AS	Australian Standards
BCT	Bushing Current Transformer
BPA	Bushfire Prone Area
CAPEX	Capital Expenditure
CT	Current Transformer
DC	Direct Current
DLA	Dielectric Loss Angle
DP	Degree of Polymerization
ENSMS	Electricity Networks Safety Management System
EOL	End Of Life
FSA	Formal Safety Assessment
GIS	Gas Insulated Switchgear
HV	High Voltage
LV	Low Voltage
NEM	National Electricity Market
NER	National Electricity Rules
NET	Neutral Earthing Transformer
NPC	Net Present Cost
OCB	Oil Circuit Breaker
OLTC	Online Tap Changer
OPEX	Operational Expenditure
PV	Photovoltaic
QoS	Quality of Supply
RCM	Reliability Centered Maintenance
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAMP	Strategic Asset Management Plan
SCADA	Supervisory Control And Data Acquisition

TERM	DEFINITION
SF6	Sulfur hexafluoride, used as an electrical insulator and arc suppressant in Gas Insulated Switchgear.
VT	Voltage Transformer
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