Asset Management Plan
Poles

Part of the Energy Queensland Group

Executive Summary

This Asset Management Plan (AMP) focuses on the management of poles.

Poles support electrical assets that deliver electricity to customers and ensure the physical separation of these electrical assets from the general public, within the electricity networks managed by Energy Queensland Limited (EQL). Poles also support additional assets including lighting and telecommunications equipment, owned by EQL or third parties such as the state government departments, local councils and telecommunications companies.

EQL manages over 1.6 million poles, comprising around 982,000 poles in the Ergon Energy region and 654,000 poles in the Energex region. The population of pole assets managed by EQL is diverse as a result of different historical construction and management practices, consisting of various species of timber, as well as metal, concrete, and composite materials.

Overall supporting structures for lines, including poles, is measured by a three-year moving average reliability standard, as defined in the Queensland Electrical Safety Code of Practice – Works and should be maintained at greater than 99.99%. Because of the safety risks involved and a legislative duty, EQL strives for higher levels of reliability than those defined by this benchmark.

This Asset Management Plan (AMP) details a range of management strategies consistent with the size, diversity, and value of these assets. Factors influencing prudent management of pole assets include public safety, the large, geographically dispersed population, assessed condition, range and variability of construction materials, various historical design standards, and diverse environmental and operational conditions.

Poles represent a significant portion total replacement value of EQL’s network asset inventory, with an estimated undepreciated replacement value of $9.36 billion. EQL employs various line refurbishment strategies to gain works efficiencies across multiple asset classes, including poles and towers, conductors, and other pole top hardware refurbishment.

EQL is actively working to align and improve data collection and record systems relating to poles across all regions. EQL continues to improve safety and the cost-effective management of these assets through use and continuous improvement of inspection and analysis techniques, optimal delivery models, and industry best practice management, through active participation in Energy Networks Australia (ENA) working groups.

Revision History

Revision date	Version number	Description of change/revision
	1	Published 21 December 2018
31/01/2020	2.01	Added V1 End Notes; Updated Action Lists to reflect those in Consolidated Action List; minor edits found during V1 review resolved. Added Document Endorsement Table back in. Updated references to ESCOP to be 2020. Updated Owners and Stakeholders. Added Asset Criticality section. Added Risk Valuation section. Added basic budgets into Section 9.4 and 9.5. Add some comments highlighting a need for Action Reviews
20/1/2021	2.03	Updated for V2 of document.
16/7/2021	2.04	Updated with various corrections and 6 months additional data
2/8/2021	2.061	Updated following peer review
08/11/2023	3.0	Split from towers. Updated data. Updated Issues sections

Document Approvals

Position title	Date
GM Asset Maintenance	Jan 2024
Chief Engineer	Jan 2024

Stakeholders / Endorsements

Title	Role
Manager Asset Strategy	Endorse
Manager Poles and Pole Top Structures	Endorse

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1 Introduction

Energy Queensland Limited (EQL) was formed 1 July 2016. It owns and manages several electrical energy related companies that operate to support energy distribution across Queensland including the Distribution Network Service Providers (DNSPs):

- Energex, covering the area defined by the Distribution Authority for Energex Corporation Limited, and
- Ergon Energy, covering the area defined by the Distribution Authority for Ergon Energy Corporation Limited.

Energy Queensland is committed to maximising value from its assets for the benefits of its customers, stakeholders and the communities in which it operates. In line with our corporate vision and purpose, EQL will look to safely deliver secure, affordable and sustainable energy solutions to its communities and customers by optimally managing its assets throughout life cycle.

There are variations between EQL's operating regions in terms of asset base and management practice, as a result of geographic influences, market operation influences, and legacy organisation management practices. This Asset Management Plan (AMP) reflects the current practices and strategies for all assets managed by EQL, recognising the differences that have arisen due to legacy organisation management. These variations are expected to diminish over time with the integration of asset management practices.

1.1 Purpose

EQL has shaped the strategic planning approach to consider what we need to do to deliver financial sustainability whilst balancing our ability to transform in an environment of significant market disruption and increased competition as we evolve towards an 'electric life' and renewable targets as described in Queensland Energy and Jobs Plan (QEJP).

The purpose of this document is to document the responsible and sustainable management of poles on the EQL network. The objectives of this plan are to:

1. Deliver customer outcomes to the required level of service.
2. Demonstrate alignment of asset management practices with EQL's Strategic Asset Management Plan and business objectives including demonstrating our progress towards alignment with ISO 55000.
3. Demonstrate compliance with regulatory requirements.
4. Manage the risks associated with operating the assets over their lifespan.
5. Optimise the value EQL derives from this asset class.

This Asset Management Plan will be updated periodically to ensure it remains current and relevant to the organisation and its strategic objectives. Full revision of the plan will be completed every five years as a minimum.

This Asset Management Plan is guided by the following legislation, regulations, rules and codes:

- *National Electricity Rules (NER)*
- *Electricity Act 1994 (Qld)*
- *Electrical Safety Act 2002 (Qld)*
- *Electrical Safety Regulation 2013 (Qld)*
- *Queensland Electrical Safety Code of Practice 2020 – Works (ESCOP)*
- *Work Health & Safety Act 2014 (Qld)*
- *Work Health & Safety Regulation 2011 (Qld)*
- Ergon Energy Corporation Limited Distribution Authority No D01/99
- Energex Limited Distribution Authority No. D07/98

This Asset Management Plan forms part of EQL's strategic asset management, and business objective documentation, as shown in Figure 1. It is part of a suite of Asset Management Plans, which collectively describe EQL's approach to the lifecycle management of the various assets which make up the network used to deliver electricity to its customers. Appendix 1 contains references to other documents relevant to the management of the asset class covered in this plan.

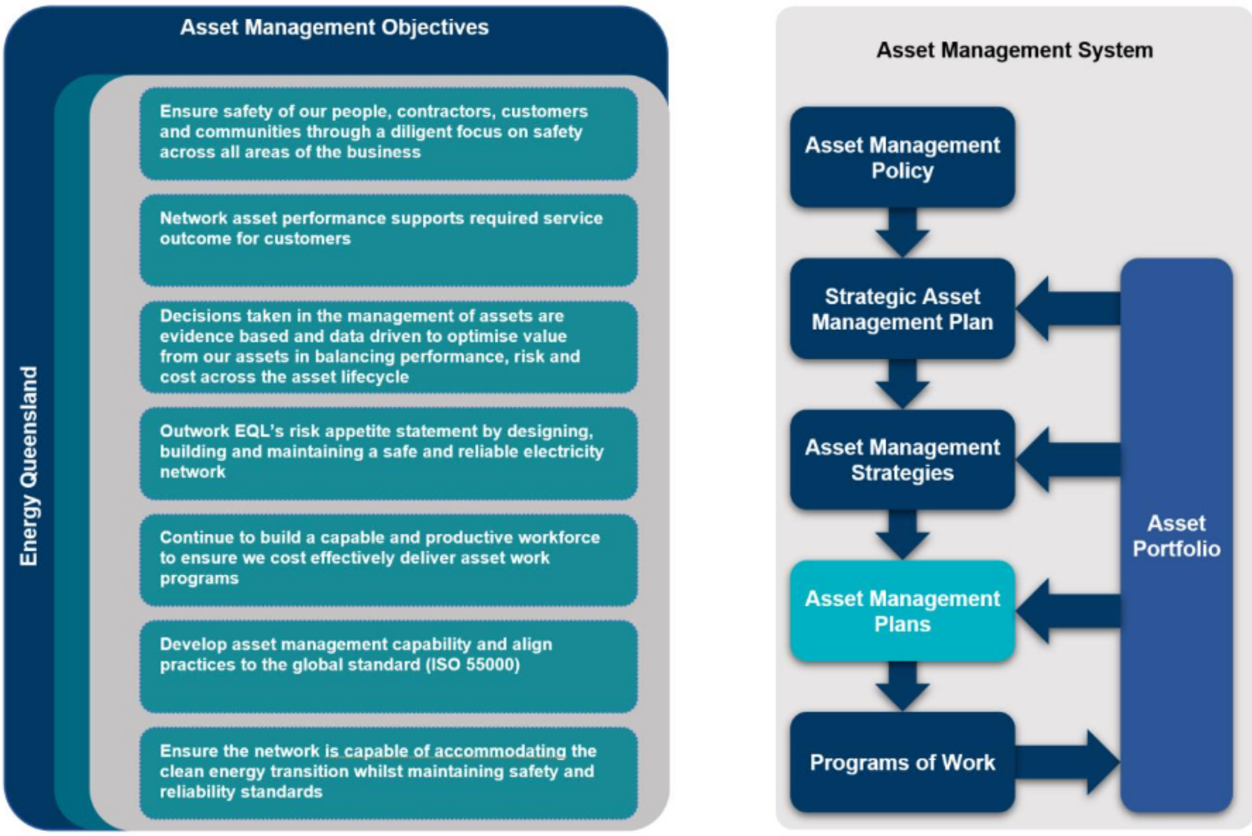

Figure 1 EQL Asset Management System

1.2 Scope

This plan covers the following assets:

- Wood poles, including reinforced and reinstated poles,
- Steel poles,
- Concrete poles,
- Composite poles,
- Stay poles or bollards; and
- Stay systems.

EQL aims to provide a co-ordinated and optimised approach to the lifecycle management of all assets within the asset base. The scope of this Asset Management Plan has a strong linkage to other overhead assets including lattice towers, overhead conductor and pole top structures. These plans should be considered together.

In Queensland, many customers, own electrical assets including private property poles and ancillary equipment. EQL inspects the asset to which the customer connects to the network (first private property or point of attachment) but does not provide maintenance services for third party assets, except as an unregulated and independent service.

In New South Wales, where EQL owns a relatively small volume of assets, EQL is required to inspect privately owned poles effectively connected to our network and advise the owner about pole condition. This does not include the remediation of any defects on the customers assets.

1.3 Total Current Replacement Cost

Poles are relatively low individual cost assets; however, the very high volume of these assets in the network makes them a significant component of the overall asset base. Based upon asset quantities and replacement costs, the poles in the EQL network have an undepreciated replacement value of approximately $9.36 billion. Figure 2 provides an indication of the relative financial value of EQL poles and towers compared to other asset classes.

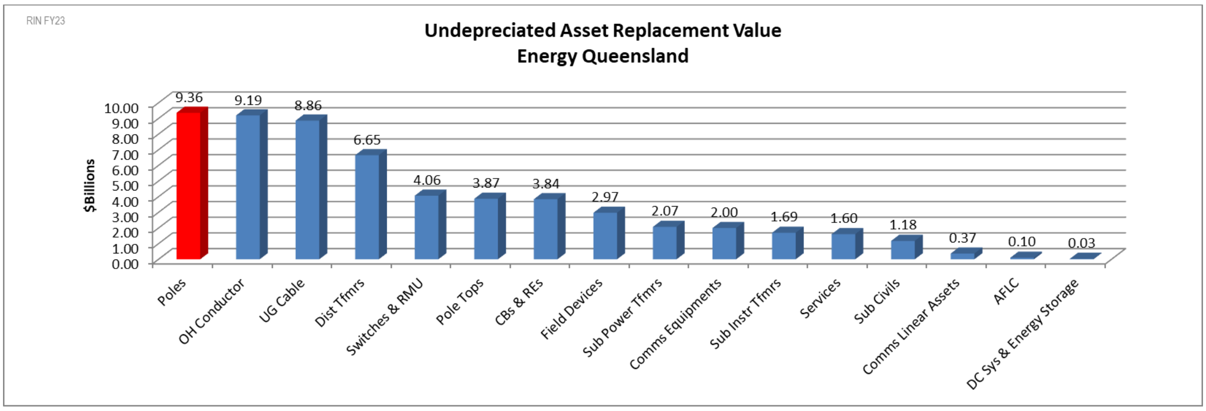

Figure 2 EQL – Total Current Asset Replacement Value

1.4 Asset Function and Strategic Alignment

Poles are important assets as they provide the support mechanism for the overhead distribution network which delivers electricity to customers across Queensland. They also support other services including streetlight and communications assets owned by EQL, as well as assets owned by third parties such as state government departments, local councils, and telecommunications companies.

The main function of a pole is to physically separate the electrical network from public access, thereby preventing electrical safety issues.

Poles are a distributed asset class, located in all terrains and environments, including frequented urban areas and remote rural areas.

Table 1 provides a summary of the relationship between EQL's asset management objectives and the pole assets covered in the scope of this Asset Management Plan.

Asset Management Objectives	Relationship of Asset to Asset Management Objectives
Ensure network safety for staff, contractors, and the community	Managing integrity and condition of poles is a key factor in managing safety hazards and compliance to legislative and regulatory obligations.
Meet customer and stakeholder expectations	The performance of poles supports the safe, cost-effective, secure, and reliable supply of electricity to consumers.
Manage risk, performance standards, and asset investment to deliver balanced commercial outcomes	Failure of poles can result in significant risk to public safety, disruption of the electricity network, and disruption of customer amenity. Understanding asset performance allows optimal investment to achieve intended outcomes. Prudent management of these assets assists in minimising capital and operational expenditure.
Develop asset management capability and align practices to the global ISO 55000 standard	This AMP is consistent with ISO 55000 objectives and drives asset management capability by promoting continuous improvement.
Modernise the network and facilitate access to innovative energy technologies	This AMP promotes modernisation through increased asset utilisation, industry leading condition and health assessment, and replacement of assets at end of economic life as necessary to meet current standards and future requirements.

Table 1 Asset Function and Strategic Alignment

1.5 Owners and Stakeholders

The ubiquitous nature of the electrical network means that there are many stakeholders that influence or are affected by EQL's operation and performance. Table 2 lists most of the influential stakeholders that have impacted the strategies defined by this asset management plan.

Responsible Party	Role
Queensland Government	Development of legislative framework and environment for operation of EQL in Queensland. Development of EQL Distribution Authorities.
Queensland Government as sole shareholder of EQL	Owner of company shares, holding equity in EQL and gaining benefits from EQL financial success.
EQL Board of Directors	Corporate direction, operation, and performance of EQL and its subsidiaries, in compliance with corporate and Queensland law.
Chief Financial officer	Company Asset Owner – ensuring all EQL investments are consistent with EQL corporate objectives with balanced commercial outcomes
Chief Operating Officer	Overall operational control of EQL networks including maintenance and operation, and execution of project works
Chief Engineer	Overall strategic control of EQL assets, including asset population performance, risk, and financial management,
All employees and contractors of Energy Queensland Limited	Performing all duties as required to achieve EQL corporate objectives
All unions that are party to the EQL Union Collective Agreement	Promotion of safe and fair working conditions for all EQL and subsidiary company employees
Queensland Electrical Safety Office	Regulatory overview and control of electrical safety in Queensland
Australian Energy Regulator	Regulatory overview and control of economic performance of EQL under its Distribution Authorities to promote the long-term interests of all electrical network customers connected to the National Electricity Market
Powerlink	Queensland Transmission Network Service Provider. Owner and operator of many 110kV to 330kV transmission grid assets and 74 bulk supply substations that connect and deliver energy to EQL networks
All consumers, prosumers and generators connecting to the Energy Queensland network	Operating within the electrical technical boundaries defined by legislation, regulation, and connection agreements.
All communities and businesses connected to the Energy Queensland network.	Economic prosperity of Queensland

Table 2 Stakeholders

2 Asset Class Information

The following sections provide a summary of the key functions and attributes of the assets covered in this AMP.

2.1 Asset Description

Poles in the EQL network have been installed over many decades by various legacy organisations, as the network was expanded, or maintenance and refurbishment works were completed. As a result, the population of pole assets is diverse, and construction materials consist of various species of wood as well as concrete, metal and composite fibre. Similarly, as technology has evolved, so has asset management practices.

The following sections provide a summary of the significant populations of poles, and other major factors that influence the management of the asset lifecycle of poles in the EQL network.

2.1.1 Hardwood Poles

Hardwood poles support over 90% of the EQL overhead network and consists predominately of Spotted Gum hardwood timber. All new and replacement wood poles are treated with Copper Chrome Arsenate (CCA) as a means of extending the expected life of the asset and were first installed during the 1960’s.

There are a small number (less than 1,500) of hardwood timber poles which use creosote as a pole preservative in the Ergon Energy region. Creosote was banned from further use in Queensland during the 1980’s, and creosote treated poles are progressively being phased out at end of life.

Around 9% of the EQL wood pole population are untreated poles (known also by alternative names ‘natural’ or ‘bush’ poles), which are typically iron bark timber. A shortage of these type of pole was the main driver for the use of treated timber hardwood poles in the 1960’s. Untreated poles are progressively being phased out at end of life.

2.1.2 Reinforced and Reinstated Wood Poles

Reinforced wood poles have a steel stake, referred to as a ‘pole nail’, attached to support the pole at and near the ground-line. The pole nail is designed to supplement the ground-line structural strength, and under excessive tip load force, deform in a ductile manner to reduce the potential impact of pole failure.

Reinstated poles are rebutted by enclosing the trimmed butt of the pole in a metal tube, which may also include concrete or foam filling in any resultant voids. Pole rebutting of an in-service pole is not as cost effective as pole nailing but may be used to increase line ratings and clearances of overhead lines in rural areas. Rebutted poles direct from the supplier are used in termite prone areas of western Queensland to reduce ongoing failures. Pole rebutting is no longer implemented in the Energex region.

2.1.3 Softwood Poles

Softwood poles are intended to be a direct replacement for hardwood poles of the same length and strength. Softwood poles require an increased diameter to achieve the same nominal strength as hardwood poles due to the lower strength classifications of the timbers. Softwood poles currently make up a very small proportion of the wood pole population although increasing due to supply constraints for hardwood poles.

2.1.4 Metal Poles

There are several different types of metal pole construction used across the EQL network. Metal poles are used in limited circumstances only as they are more expensive than wood poles.

Steel poles are typically of hollow tapering pipe construction with larger steel poles being segmented to support delivery logistics and fitted together on site. These poles may be used:

- For lighting support
- In termite prone areas in the network, where there is limited chance of corrosion due to salt spray or industrial pollution,
- Feeders where pole failures due to lightning strikes are a significant contributor to unplanned outages.

Approximately 80% of steel poles in the Ergon Energy region, and approximately 99% of steel poles in the Energex region, are used for lighting support. There are two basic types - base plate mounted poles, and poles that are directly buried into the ground (BIG). The Energex region also has a population of frangible or slip base mounted metal street light poles, which have been installed on major roads since before 1970. Slip based mounted poles shear at the ground level on vehicle impact and are a requirement on Queensland roads with speed limits greater than 70 km/hr. BIG installations began being phased out since the mid-1990s due to the prevalence of corrosion in the below ground portion of the pole.

A Stobie pole is a composite pole consisting of steel components with concrete fill. Current EQL standards do not support the use of Stobie poles in new constructions. There is a small population of these poles in Mount Isa and these are classified as metal poles.

2.1.5 Concrete Poles

Concrete poles are used when the network requires a high level of reliability or additional strength due to mechanical loading. Concrete poles may be either spun or cast and have steel reinforcing. Concrete typically handles compressive forces well, but does not handle tension and torsion forces, which tend to cause cracking and crumbling in concrete poles. Steel reinforcing is employed to provide additional tensional and torsional strength. They are generally more expensive than wood or steel poles, and procurement periods are considerably longer.

In the Ergon Energy region, concrete poles are only used when specific design requirements necessitate it. There are several concrete Single Wire Earth Return (SWER) lines in North Western Queensland of the Ergon Energy region. In the Energex region, concrete poles are typically used for new sub-transmission lines, for supporting larger distribution transformers or where high tip loads are required.

The concrete pole population is slowly increasing within the network as they are extremely reliable, have a significantly longer expected life than wood poles and are not subject to the same range of failure modes as wood poles.

2.1.6 Composite Fibre Poles

Composite fibre poles are lightweight, non-conductive, synthetic poles, typically made of fibreglass reinforced composite. Composite poles are not subject to many of the common failure modes of wood poles (such as termites or rot) or metal poles (such as corrosion). There is a very small number of composite fibre poles installed as a trial in regional Queensland.

2.1.7 Stay Systems

Stays are an important part of the mechanical support system for poles and structures, used to balance the forces imposed at the top of a pole or structure. Stay systems typically consist of cable that is tied to buried steel screw anchors, wooden bed logs (now obsolete) or concrete blocks. These systems may also include a dedicated stay or bollard pole. Figure 3 shows an example of a typical pole stay system.

Dependent upon the designed application, stay failure can result in the pole falling or leaning (impacting energised conductor heights). In many circumstances, a stay failure will only become evident when the pole top forces are substantial.

Poles used in a stay system are treated in the same manner as all other poles. The other components of the stay system (stay wires, insulator, anchors) are not recorded as discrete assets in any region.

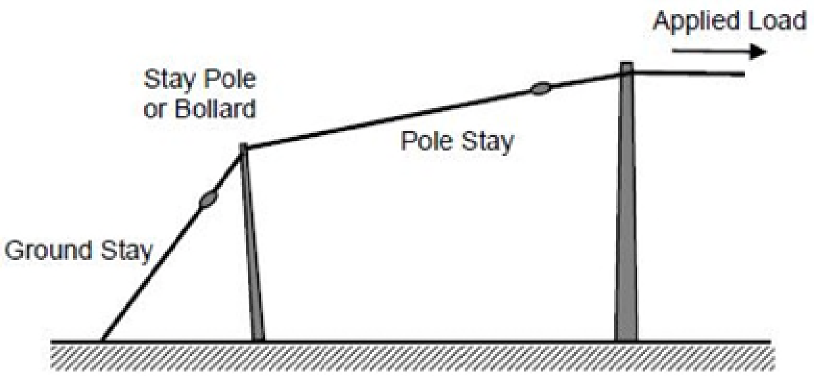

Figure 3 Example of a Pole Stay System

2.1.8 Private Property Poles

The point of attachment for the EQL network to a customer premise is commonly on a customer's private property pole. While these are not EQL owned assets, we have a duty of care to inform customers of any electrical unsafe assets that we find during the course of our inspections. In NSW, it is a legislative requirement that the DNSP inspect any customer poles directly connected to the distribution network. Ergon Energy has a small section of network that goes into NSW.

2.2 Asset Quantity and Physical Distribution

Table 3 details the total quantity of EQL's pole population by type.

Pole Type		Ergon Energy	Energex	Total
Wood	Untreated	100,846	16,279	1,328,823
	Creosote	1,364	0	
	Treated (incl. softwood and composite)	769,137	422,166	
Metal	Steel - Network	78,731	1,444	253,477
	Steel - Streetlight		177,236	
	Stobie	179	0	
Concrete	Concrete	31,412	11,308	42,233
Total		981,669	654,309	1,624,533

Table 3 EQL Pole Quantities

Table 4 details the total quantity of reinforced and reinstated wood poles by region. These quantities are included in quantities of wood poles shown in Table 3 above.

Pole Type	Ergon Energy	Energex	Total
Reinforced (nailed) wood poles	63,509	33,515	97,024
Reinstated (rebutted) wood poles	9,473	499	9,972
Total	72,982	34,014	106,996

Table 4 EQL Reinforced and Reinstated Pole Quantities

2.3 Asset Age Distribution

Prior to 1963, pole discs with stamped year of manufacture were not used and detailed installation records are not available. The actual ages of most "natural poles" are indeterminate, as they do not have pole discs. For modelling purposes, "natural poles" have had their estimated ages distributed over the known installation period between 1949 and 1963.

Around 10% of wood poles have lost their pole discs, and these have had their estimated ages distributed over the entire installation period.

Figure 4 provides an age distribution of all poles in Ergon Energy region. Pole year of manufacture (YOM) is stamped on pole discs and recorded at site asset inspection which can lead to a delay in reportable pole age. Approximately 19% of the current Ergon Energy pole population is older than 50 years old, with another 5% of the population due to reach this age in the next 5 years.

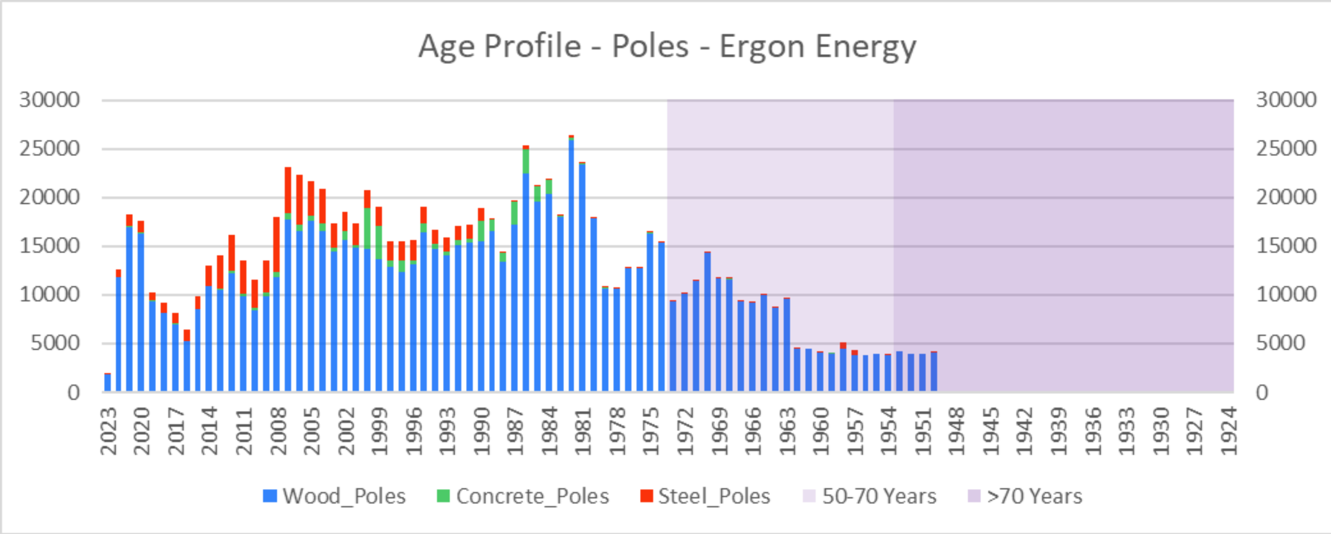

Figure 4 Pole Age Distribution – Ergon Energy

Figure 5 details the age distribution of poles in Energex region. Approximately 10% of the current Energex pole population is older than 50 years old, with another 6% of the population due to reach this age in the next 5 years.

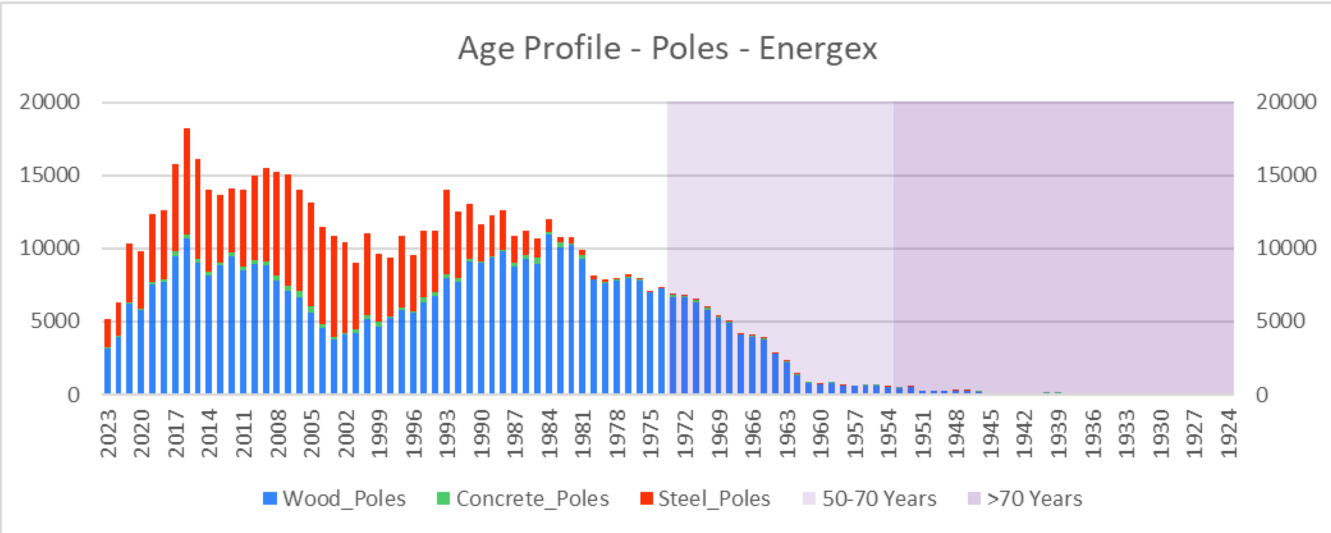

Figure 5 Pole Age Distribution – Energex

2.4 Population Trends

Most Ergon Energy poles are wood poles. The total number of wood pole installations have started to decrease slowly since the early 1990's with a recent increase starting around 2020. This increase is in response to the increasing failure rates of wood poles in Ergon Energy and the subsequent changes to the serviceability assessment criteria. There were a small number of concrete pole installations between the period of early 1980's to early 2000's.

Most Energex poles are wood poles or steel streetlights. There was a large increase in the wood pole population from the 1960's as the South East Queensland network expanded. In the wood pole population, majority of untreated wood poles were installed between 1945 and 1983 with a peak installation period around 1963-65. The steel pole population supporting streetlights increased from approximately 1985 onwards.

Across the entire Energy Queensland network, alternatives to hardwood poles (softwoods, concrete, steel and composites) are increasing due to the hardwood supply constraints of the common pole sizes.

Pole nailing typically achieves a 10-15 year pole life extension. Pole nails strengthen the pole at ground level only, allowing the pole to remain in service until end of life indicators at other sections of the pole dictate that the pole must be replaced.

Several pole types are being progressively phased out as the individual poles reach end of life, including:

- Creosote preserved poles Creosote poles are banned from further installation in Queensland.
- Untreated poles. Untreated poles are being slowly phased out.
- Buried in Ground steel streetlight poles.

2.5 Asset Life Limiting Factors

Failure of a pole typically leads to energised assets falling closer to ground level, facilitating public access to energised electrical assets and increasing the risk of public contact, shock, and electrocution. Mechanical damage due to falling objects can also occur. The potential safety issues associated with ease of access to energised assets promotes proactive pole replacement once end of life indicators become apparent.

Table 5 describes the key factors that influence the life of various poles, both above and below ground level. These factors have a significant bearing on the programs of work implemented to manage pole assets.

Factor	Influence	Impact
Third Party Damage (all poles)	Third party damage such as by car impact results in damage to the structural integrity of the pole or tower. This is a random failure mode; however, proximity to a trafficable road is an influencing factor.	Immediate failure, reduction in remaining life.
Bacterial Rot and Fungal Decay (wood poles)	Rot and decay reduces the integrity of the timber within a pole and subsequently the strength.	Reduction in remaining life, increase in defects and failures
Termites (wood poles)	Termites reduce the timber within the pole and subsequently the strength. Termite population densities and species are varied across the state, with some species being more destructive than others.	Potentially sudden and rapid reduction in remaining life, increase in defects and failures.
Lightning (all poles – more destructive in wood)	Lightning strikes result in immediate and destructive forces on the pole and pole fires. This failure mode is random; however, exposed poles in long rural feeders are particularly prone to lightning.	Immediate failure, reduction in remaining life.
Foundation Erosion / Excavation (all poles)	Loss of foundation leads to loss of stability, resulting in pole movement and subsequent failure.	Defects and failure.

Factor	Influence	Impact
Environment (varied)	High rainfall areas promote the growth of bacterial rot and fungal decay in wood poles. Long term exposure leads to: Splitting of wood poles Vibration fatigue in steel poles and towers Cracking, flaking and spalling in concrete poles. Acid soils lead to deterioration of pole material resulting in loss of strength. Corrosive and coastal environments cause corrosion of steel pole and, steel reinforcing in concrete poles resulting in loss of strength.	Reduction in remaining life, increase in defects and failures
Design (varied)	Design factors including the material of the pole determines the ability to withstand external forces from third party damage or high winds, as well as environmental influences such as bushfire.	Defects and failures

Table 5 Pole Life Limiting Factors

2.6 Asset Management Maturity

Based on the Asset Management Council's maturity models, EQL's level of asset management maturity for the pole's asset class is assessed at level 2/3 – reactive and bureaucratic. EQL's level of asset maintenance maturity is assessed at level 3 – condition based.

These maturity stages are reflected in the lifecycle strategies detailed in Section 9

3 Current and Desired Levels of Performance

The following sections define the level of performance required from the asset class, measures used to determine the effectiveness of delivering corporate objectives, and any known or likely future changes in requirements.

3.1 Desired Levels of Service

This asset class will be managed, consistent with corporate asset management policy, to achieve all legislated obligations and any specifically defined corporate key performance indicators and to support all associated key result areas as reported in the Statement of Corporate Intent (SCI).

Safety risks associated with this asset class will be eliminated so far as is reasonably practicable (SFAIRP), and if not able to be eliminated, will be mitigated SFAIRP. All other risks associated with this asset class will be managed to be as low as reasonably practicable (ALARP).

This asset class consists of a functionally alike population, differing in age, brand, technology, material, construction design, technical performance, purchase price, and maintenance requirements. The population will be managed consistently based upon generic performance outcomes, with an implicit aim to achieve the intended and optimised life cycle costs for the asset class and application.

All inspection and maintenance activities will be performed consistent with manufacturers' advice, good engineering operating practice, and historical performance, with the intent to achieve the longest practical asset life overall.

Life extension techniques will be applied where practical and cost efficient, consistent with overall legislative, risk, reliability, and financial expectations. Problematic assets such as very high maintenance or high safety risk assets in the population will be considered for early retirement.

Assets of this class will be managed by population trends, inspected regularly, and allowed to operate as close as practical to end of life before replacement. End of asset life will be determined by reference to the benchmark standards defined in the Defect Classification Manuals and or Maintenance Acceptability Criteria. Replacement work practices will be optimised to achieve bulk replacement to minimise overall replacement cost and customer impact.

While the reliability performance for poles has a regulatory standard set via the Queensland Electrical Safety Codes of Practice (ESCOP) – Works, occurrence of in-service pole failure in urban areas has much higher associated safety risk when compared to rural and remote rural areas, due to the higher likelihood of public presence. The desired level of service for poles in the Energy Queensland network is to achieve in-service pole failure numbers which deliver a safety risk outcome which is considered SFAIRP, and as a minimum, meet legislative requirements.

3.2 Legislative Requirements

Regulatory performance outcomes for this asset include compliance with all legislative and regulatory standards, including the *Electrical Safety Act 2002 (2002)*, the *Electrical Safety Regulation 2013 (Qld)* (ESR), and the ESCOP.

The *Electrical Safety Act 2002 (Qld)* s29 imposes a specific duty of care upon Ergon Energy and Energex, which are prescribed Electrical Entities:

1) An electricity entity has a duty to ensure that its works—
   a) are electrically safe; and
   b) are operated in a way that is electrically safe.

2) Without limiting subsection (1), the duty includes the requirement that the electricity entity inspect, test and maintain the works.

The ESR details some requirements for electric lines, of which poles are classed as associated equipment. These include various general obligations related to the safety of works of an electrical entity and also specific obligations, notably:

- ESR Part 5 – Overhead and underground electric lines
- ESR Part 9 – Works of an electricity entity
- ESR Division 4 – Electric Lines and control cables
- ESR s295 – Clearances for lines built before 1 January 1995
- ESR s297 – Clearances for lines built between 1 January 1995 and 1 October 2002
- ESR Schedule 2 – Exclusion zones for overhead electric lines
- ESR Schedule 4 – Clearance of overhead electric lines (other than low voltage service lines).

The ESCOP – Works detail some requirements for maintenance of supporting structures for lines. This document details expectations for supporting structure (poles) reliability, serviceability, and frequency of inspection, as well as timeframes to respond to unserviceable poles, and pole records to be kept. While many of the elements of the ESCOP – Works are advisory in nature, EQL has the intent to achieve all the key elements described in the document.

The following clauses from the ESCOP – Works are particularly relevant to the management of poles and are used to guide the EQL programs:

- ESCOP s5.1 – should achieve a minimum three-year moving average reliability of 99.99 % per annum.
- ESCOP s5.2.1 – each pole should be inspected at intervals deemed appropriate by the entity. In the absence of documented knowledge of pole performance, poles should be inspected at least every five years.
- ESCOP s5.3.4 – A suspect pole must be assessed within three months; An unserviceable pole must be replaced or reinstated within 6 months.

Dangerous Electrical Events (DEEs) are defined in legislation and required to be reported to the ESO[1]. DEEs are typically circumstances involving a high voltage asset, where a person would not have been electrically safe had they been exposed to the event. EQL classifies DEEs into the following two categories:

- Unassisted DEEs – DEEs that might have been prevented via a maintenance program (e.g. rot and decay)
- Assisted DEEs – DEEs where the root cause of failure occurs outside the control of any maintenance program (e.g. lightning strike)

3.3 Performance Requirements

EQL has a strategic objective to ensure a safe and reliable network for the community. Performance targets associated with these asset classes therefore aim to reduce unassisted failures to levels which deliver a safety risk outcome which is considered SFAIRP and as a

[1] Queensland Electrical Safety Act 2002, s12

minimum, meet legislative requirements. Current levels of performance are outlined in subsequent sections.

As specified in Section 3.2, the regulatory performance targets associated with poles is 99.99% which translate to maximum numbers of unassisted pole failures in the order of 98 per annum for the Ergon Energy region, and 63 per annum for the Energex region. All unassisted pole failures are investigated and documented with totals reported monthly.

While no performance targets exist for assisted pole failures, EQL is committed to reduce the likelihood of an assisted pole failures SFAIRP. This includes practices such as managing vegetation around overhead infrastructure and installing metal poles in areas with frequent lightning damage.

In addition to pole specific performance measures, EQL is expected to employ all reasonable measures to ensure it does not exceed minimum service standards (MSS) for reliability, assessed by feeder types as:

- System Average Interruption Duration Index (SAIDI) and
- System Average Interruption Frequency Index (SAIFI).

Individual pole failures typically have moderate impact upon SAIDI and SAIFI, especially when part of radial supply infrastructure.

3.4 Current Levels of Service

Figure 6 details Ergon Energy unassisted pole failure history. This graph shows the peak of unassisted poles failures was in FY2020 for the Ergon Energy region. To address the large number of poles failures, the assessment of poles serviceability was made stricter in 2020 resulting in an increased number of pole replacements. A full cycle of assessing poles with these stricter criteria is due to be completed in 2025. Until this time, the full impact of this change will not be known but early indications, as shown by the 2023 failure count, show and improvement in performance.

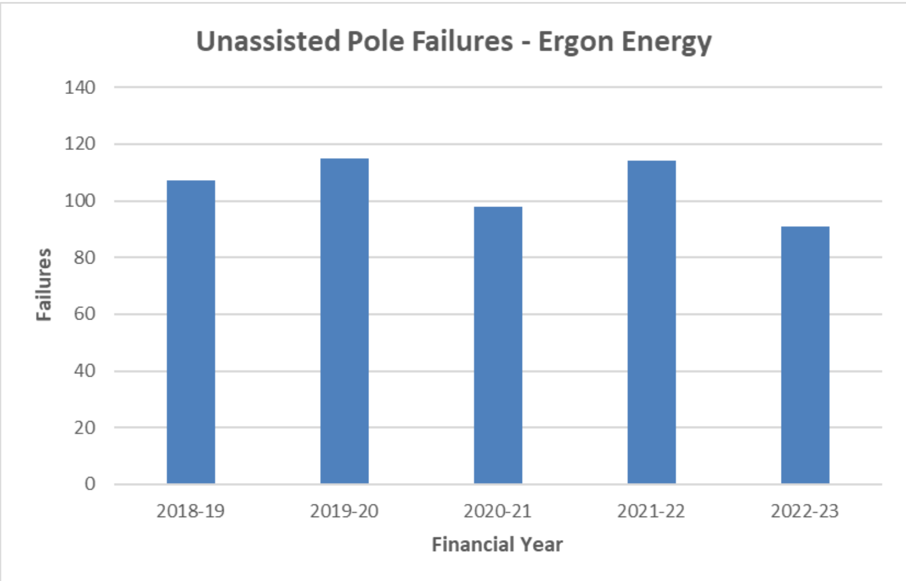

Figure 6 Unassisted Pole Failures – Ergon Energy

Figure 7 details Energex unassisted pole failure history. This graph demonstrates a steady increase in the unassisted pole failures in the Energex region. The investigations of pole failures have highlighted some areas of concern with the inspection process which are currently being addressed. It should be noted though that the overall volume of failures is still low, and as the following graph shows, is still well withing the legislative limits for unassisted poles failures.

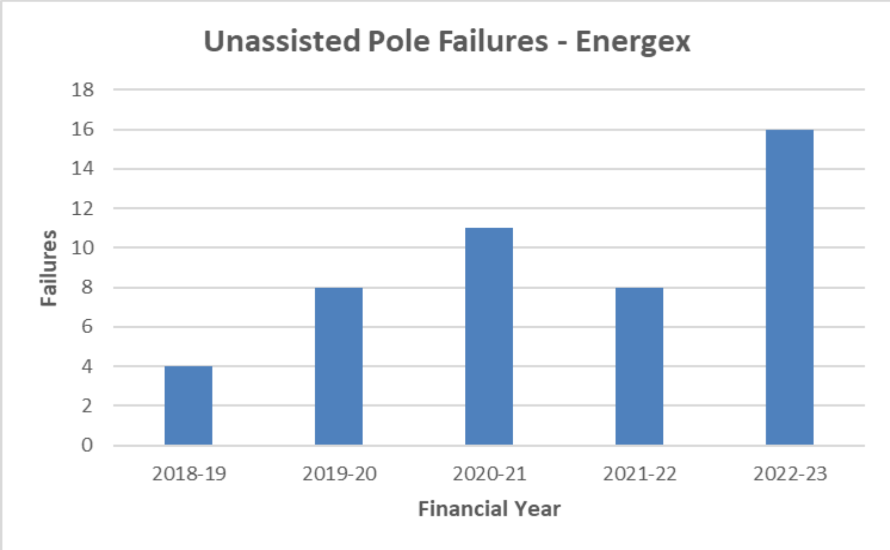

Figure 7 Unassisted Pole Failures - Energex

To date, all poles at end of life, are removed or replaced due to causes other than pole nail or pole rebutt failure (e.g. failure just above the nail or pole top due to soft rot, or termite infestation). No evidence of severe pole nail corrosion has been recorded at any pole replacement.

Figure 8 highlights that Ergon Energy's three year moving average pole reliability is below the legislated performance level defined under Clause 5.1 of the Electrical Safety Code of Practice Works 2020. Energex's three year moving average pole reliability is above the legislated performance level defined under Clause 5.1 of the Electrical Safety Code of Practice Works 2020

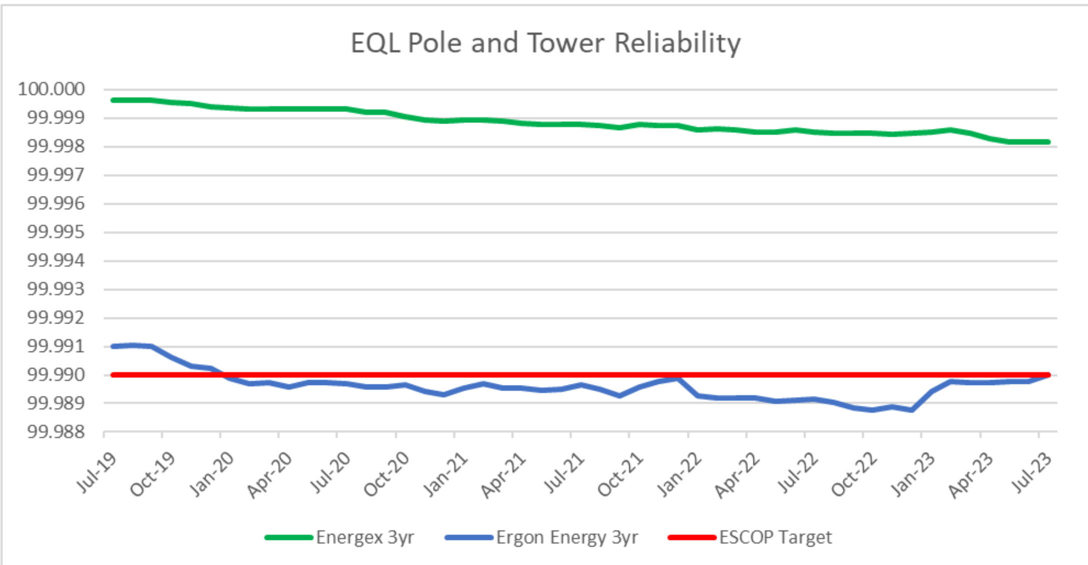

Figure 8 Pole Reliability Performance – EQL[2]

The overall historical replacement volume records of poles and nails is detailed in Figure 9. This highlights the significant increase in unserviceable poles identified with the change to the pole serviceability criteria in Ergon Energy during the 2020 financial year.

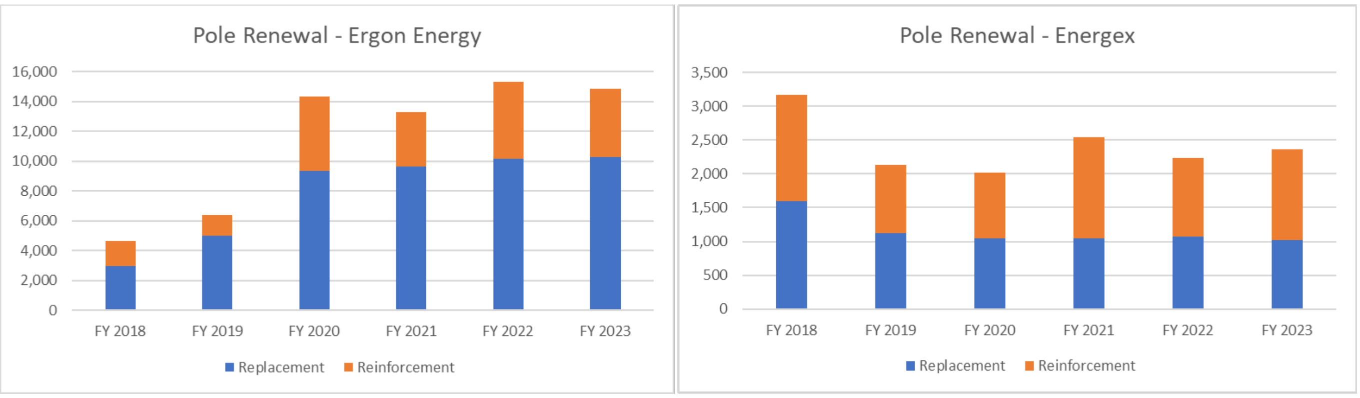

Figure 9 Annual Renewal Volumes

Figure 10 and Figure 11 demonstrates the number of defects identified on EQL poles. Identified defects are scheduled for repair according to a risk-based priority scheme. The P0, P1 and P2 defect categories relate to priority of repair from P0 requiring immediate rectification through to P2 where the normal planning processes are employed for rectification.

In line with the changes to the pole serviceability assessment changes, the number of pole defects increased in the Ergon Energy regions during the 2020 financial year. Some of the defect increases will likely reduce again after 2024 financial year once the entire pole population has been inspected under the new pole serviceability criteria has been completed. A more recent spike in defects relates to the new inspection process for stay systems.

[2] Pole Reliability is calculated monthly, as an average of the previous 36 monthly reliability calculations, being

(P-F)/P

Where:

P= total number of in-service poles

F = total numbers of pole failures in the month

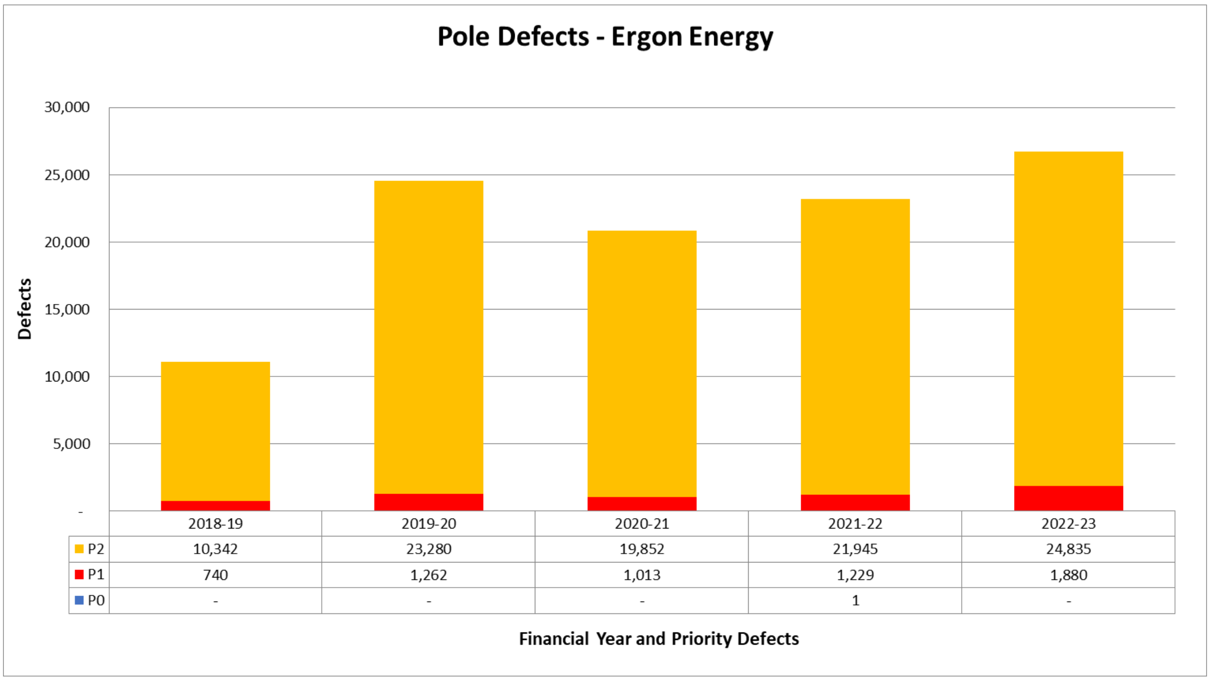

Figure 10 Pole Defect Totals – Ergon Energy

Pole defect rates within the Energex region has remained relatively stable. A more recent spike in defects relates to the new inspection process for stay systems.

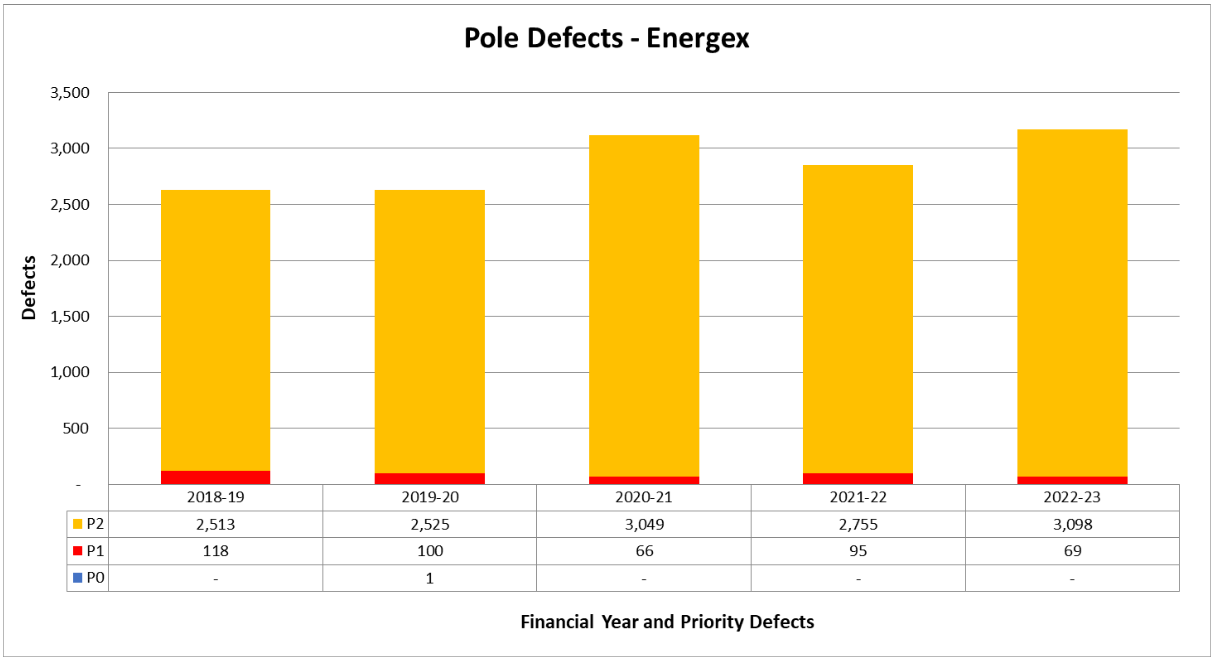

Figure 11 Pole Defect Totals - Energex

Figure 12 shows that the recent focus on stays is having a larger impact on the total defect volumes in the Ergon Energy region than in the Energex region. In addition to this, the Ergon Energy region has a lot more defects above ground, although typially these are not defects that result in assessing the pole as unservicable (e.g. cable gaurds, pole caps).

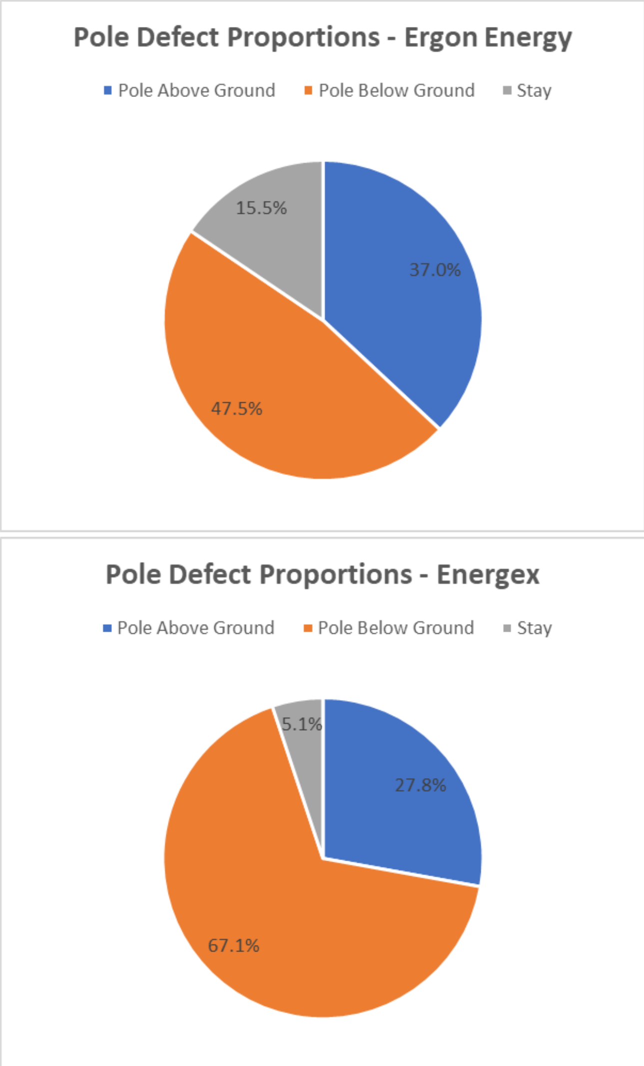

Figure 12 Pole Defect Proportions – EQL

3.5 Risk Valuation

Ergon Energy is committed to adopting an economic, customer value-based approach when it comes to ensuring the safety and reliability of the network. To substantiate the advantages of this approach for the community and businesses over the modelling period, they have employed Net Present Value (NPV) modelling. This commitment is in line with their efforts to minimize the impact on customer prices.

A cost benefit analysis has been conducted to confirm that the pole replacements are prudent capital investments.

4 Asset Related Corporate Risk

As detailed in Section 3.2, Queensland legislation details that EQL has a duty to ensure its works are electrically safe. This safety duty requires that EQL acts so far as is reasonably practicable (SFAIRP) to eliminate safety related risks, and where it is not possible to eliminate these risks, to mitigate them SFAIRP[3]. Risks in all other categories are managed as low as reasonably practicable (ALARP).

Figure 13, Figure 14, and Figure 15 provide threat-barrier diagrams for the different pole materials. Many threats are unable to be controlled (e.g. lightning), although EQL undertakes a number of actions to mitigate their safety components SFAIRP. Failure of a pole risks public and staff safety in several ways, most notably:

- Bringing energised electrical conductors to easily accessible heights, risking public contact, shock, and electrocution
- Heavy objects physically falling, risking physical harm to anyone in the vicinity or extensive material damage.

EQL's safety duty results in most inspection, maintenance, refurbishment, replacement, and expenditure related to poles being entirely focused upon preventing and mitigating pole failure.

The asset performance standards described in Section 3.3 detail EQL's achievements to date in respect of this safety duty. The following sections detail the ongoing asset management journey necessary to continue to achieve to high performance standards into the future.

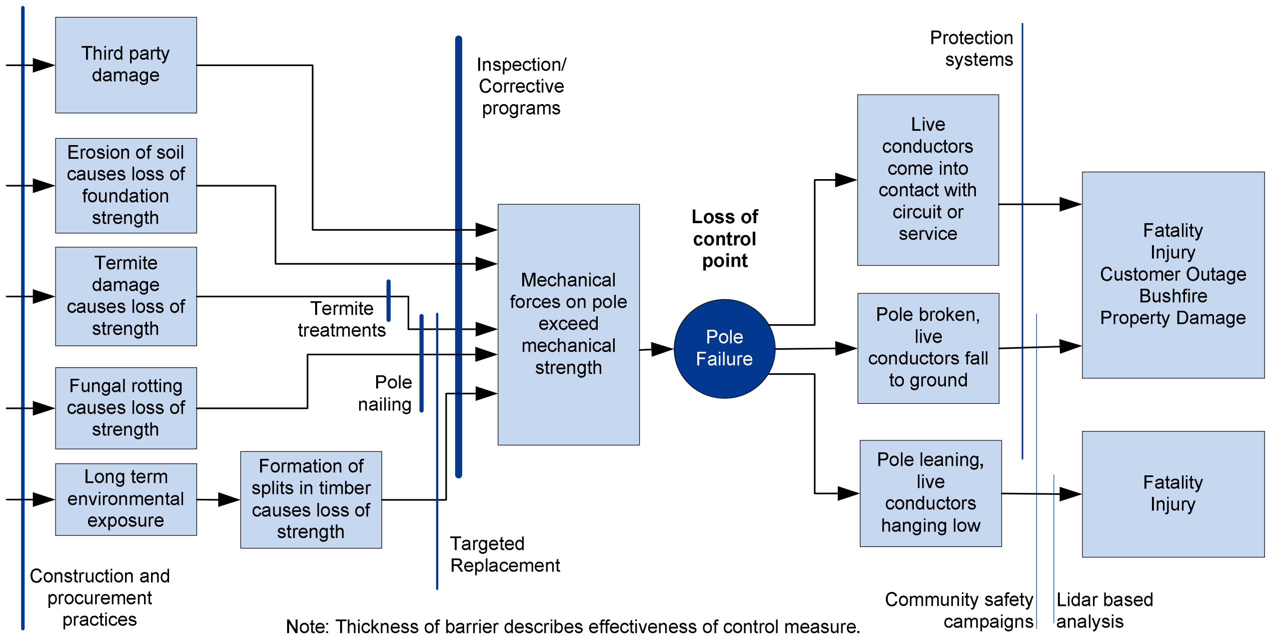

Figure 13 Threat-Barrier Diagram for Wood Poles

[3] QLD Electrical Safety Act 2002 s10 and s29

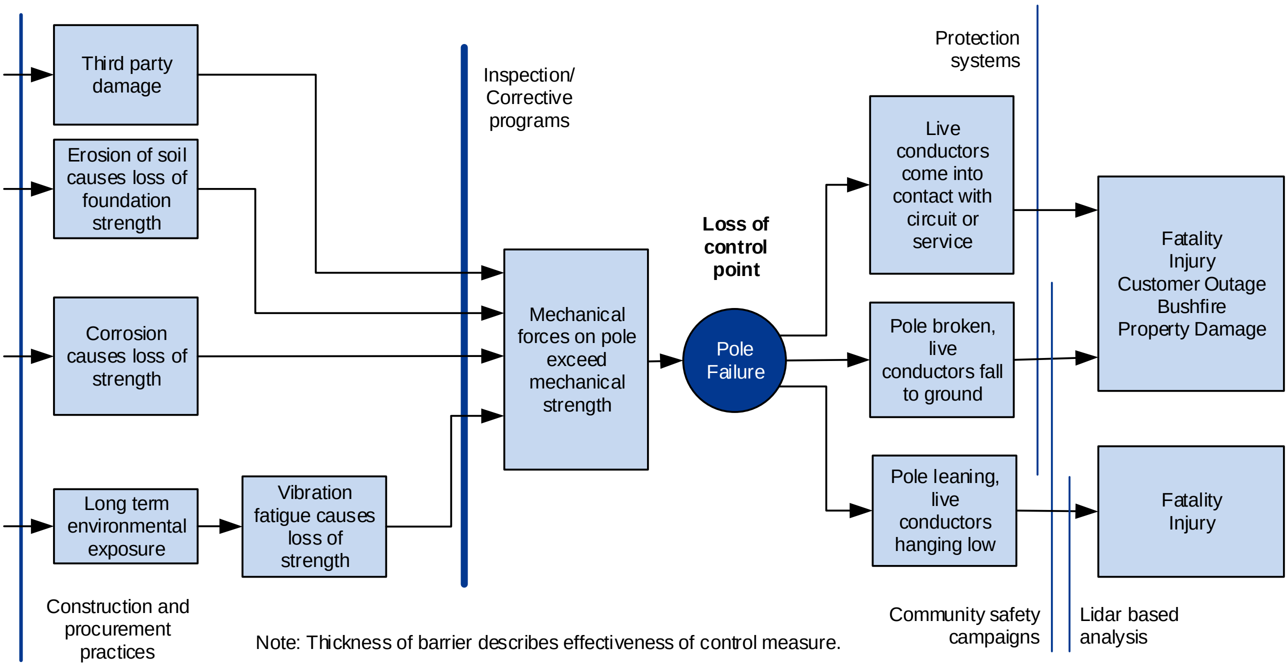

Figure 14 Threat-Barrier Diagram for Steel Poles

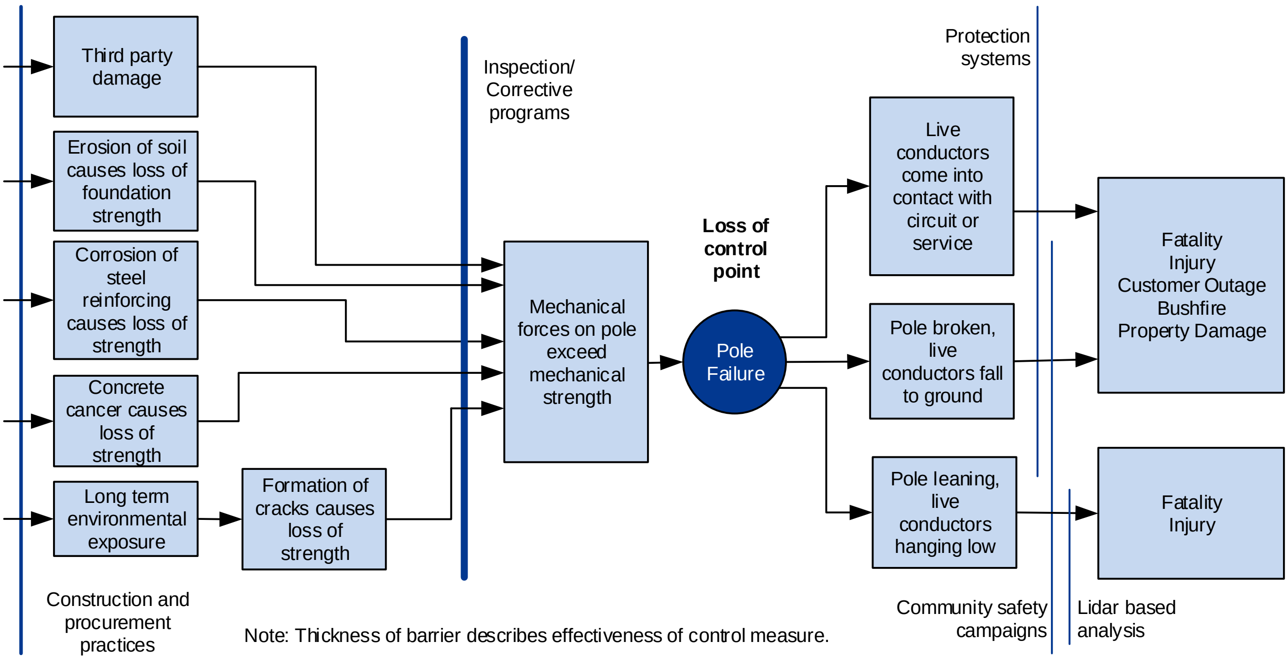

Figure 15 Threat-Barrier Diagram for Concrete Poles

5 Health, Safety & Environment

In the Ergon Energy region, the below-ground section of timber poles installed before 2019 is wrapped with a boron pellet blanket, as it was believed that boron acted to reduce soft rot. In Energex region, the below-ground section of timber poles installed before 2014 is wrapped with a boron pellet blanket, for similar reasons. These have been progressively removed when inspected from these dates as they have been found to be ineffective.

Energy Queensland has 3 approved treatments for termite activity in wood poles:

- Biflex is to be used in grazing areas only. Biflex dissolves in water and becomes diluted over time with rain or changes in the underground water table.
- Termidor is to be used in non-grazing areas only as it bioaccumulates in animals that graze near the treated area.
- Altriset is a newly approved termite treatment which can be used in all areas as it does not bioaccumulate in animals that graze near the treated area.

All of these chemicals are injected into pole as well as the ground around the wood poles.

Burnt CCA poles present inspectors and field crews with air borne hazards if the pole char and ash are disturbed, as arsenic is retained after burning within the friable ash and cinders. Operational Updates describe the precautions to be taken when inspecting such poles. Poles in some bushfire prone areas have had a fire protection material installed, commonly referred to as “Fire Mesh”, to reduce damage from grass fires.

Wood CCA poles used to be treated as regulated waste and be disposed appropriately in regulated waste management facilities. Due to recent regulation changes, wood CCA poles are no longer treated as regulated waste.

6 Current Issues

The following sections outline current issues that have been identified as having the potential to impact EQL's ability to meet corporate objectives.

6.1 Low Strength Pole Resilience

The presence of relatively low strength (nominal strength less than or equal to 5kN) Limit State Strength (LSS) poles within the EQL asset base has been identified as a risk. Analysis of data from defect and asset failure investigations to date indicate that pole failures in aged, low strength poles, generally occur above the inspection zone; at heights above 2m from ground. These failures are very difficult to detect using current ground based visual inspections, and thus these poles may present increased risk over time.

Installation of most of these lower strength poles occurred over a 50-year period between 1957 and 2017. Corporate system data indicates that many of these lower strength poles are now greater than 40 years old and will start to approach end of life in the coming decade. No region is currently installing poles rated at or below 5kN in the network.

EQL is undertaking a risk-based approach to address the issues identified with lower strength poles. Some of these poles are now being double-nailed as a means of increasing below ground-line strength.

Several other initiatives have been actioned to reduce the risk of low strength poles:

- Review inspection and replacement practices in relation to low strength poles, including consideration of pole inspector training, pole strength calculation, risk-based inspection, and suitable replacement alternatives.
- Incorporate the management of the low strength pole population into the priority of targeted line replacement programs across all regions, including consideration of geographical location to ensure appropriate management of safety risk.
- Establish appropriate reporting to monitor the performance of the low strength pole population and the effectiveness of the control measures implemented to mitigate the risk.

6.2 Reliability Performance of Ergon Energy Poles

Section 3.4 highlights that Ergon Energy pole reliability performance is slightly below the recommended and nominal benchmark standard defined by the ESCOP as detailed in Figure 8. Ergon Energy has increased pole replacements substantially since 2020 as detailed in Figure 9. Unassisted failures have been in decline since the peak in 2020 with the full effect of the new serviceability assessments to be known at the completion of a full cycle using these methods in 2024.

Many unassisted pole failures are caused by termites and rot. Termites can completely eat a hardwood pole within 6 months, which is problematic given inspection cycles of 4-5 years. Failures due to rot are typically occurring deeper than 350mm below the groundline, which is considered the safe level to dig down around the pole without compromising the pole structural strength.

6.3 Pole Availability

There were concerns of a developing shortage in hardwood poles, predominantly in the 12.5 to 14 m range which accounts for approximately 64% of the pole usage. Ongoing high demand for 11m

8-14kN hardwood poles has meant that stocks were very low, and there was the potential for supply shortages to occur.

Steel and concrete poles offered immediate alternate solutions, though typically at higher cost. A major supplier of steel poles had recently withdrawn from the steel pole market. There was a risk associated with this withdrawal in terms of steel pole supply, availability and cost. A watching brief is being maintained.

The Australian bushfire crisis of 2019-2020 resulted in further major shortages of hardwood poles. In response, EQL developed and published a series of design standards that allow use of softwood poles to replace hardwood poles. The larger diameter of the softwood poles presented issues with pole replacement in built up areas and required consideration in the overall solution.

The use of composite poles is also being trialled as an option to diversify supply. These products are specifically targeting the standard pole sizes which are in low supply. Composite poles come with a set of complications such as higher costs, different tooling and training requirements.

6.4 Stay Condition

Multiple issues have been identified with stay systems which support the Energy Queensland pole population. These Include:

- Stay Foundations (Bed Logs)
- Stay Rod Failures
- Stay Cables.

Stay design currently employs buried steel screw anchors and concrete blocks to provide the foundation support and strength required to manage the stay cable tension. Earlier (pre) Ergon Energy designs (of the 1950-1970's era) often employed sawn off sections of hard wood poles buried in the ground to provide the foundational support. Over time, the hardwood bed logs have deteriorated and rotted, reducing their foundational strength. It is suspected that some stay foundations may have deteriorated to the point of providing little or no foundational strength, reducing the ability of the pole structure to withstand even moderate level wind loading. Despite this aging issue, reliability performance is not yet measurably influenced by stay failures.

Across Ergon, rod failures account for approximately 58% of all unassisted stay failures in 2022/23. Rod failures tend to be seen more frequently in western areas demonstrated by the South-West area where rod failures account for 84% of the unassisted stay failures in this region.

Investigations into stay rod failures has highlighted several challenges with identifying the below-ground condition of stays to prevent unassisted failures:

- Analysis has shown that the condition of the rod at and above groundline is not always a reliable indicator of below-ground condition.
- Asset Inspectors do not have access to previous inspection cycle photos to identify evidence of rods pulling out of the ground over time.
- The viability of non-destructive testing methods to detect underground corrosion on stay rods during inspections is not yet established.
- Additional inspection practices were needed to physically move the stay guard to inspect the stay cables underneath. This has now been implemented.

Investigations into stay cable failures highlighted issues with inspection practices which previously only looked at the permanently visible portions of the cable. Multiple failures highlighted corrosion to the cables under the stay guards which were inspected under the previous inspection practices but has now been included.

While there are now records of stay locations and photos of the assets, there are no records of foundation type including bed log locations, stay rod types or details about the stay cables (termination types, insulators etc). An attempt was made to train an AI program to identify some of these details from the stay photos, however the desired level of accuracy was not achieved using this program.

7 Emerging Issues

The following sections outline emerging issues which have been identified as having the potential to impact on EQL's ability to meet corporate objectives in the future.

7.1 Economic Limitations for Ergon Energy

In 2019, changes to failure reporting and analysis resulted in recognition of an emerging risk that Ergon Energy's pole performance would likely reduce below the ESCOP reliability standard. Figure 8

demonstrates this risk has subsequently been realised.

In early 2019, prior to recognising this risk, EQL submitted Ergon Energy's draft regulatory submission for funding for the 2020-2025 period. In early 2020, after the emerging risk had been identified, Ergon Energy's revised regulatory submission included a proposal for significant increase (41%) in pole replacements and pole nailing, prompted by a general concern about the forecasts predicted by the updated calculation, and the emerging risk of falling below the ESCOP reliability standard.

The AER disagreed with Ergon Energy's proposed pole replacement justifications and considered that Ergon Energy's replacement volumes were excessive. The AER settled upon alternative (reduced) REPEX budget allowances, generally consistent with their REPEX models, Ergon Energy's draft submission and generally consistent with historical REPEX levels.

Concurrent with, but independent of the economic justification process, pole replacement and pole nailing volumes were lifted to address the identified emerging ESCOP reliability risk.

As at the time of development of AMP review from the original submitted version, there was no formal economic justification or documented strategy that supports the increase in pole renewal works that is already evident from FY1920. This is causing an ever-widening gap between TOTEX funding (as established by the AER) and replacement expenditure. This absence risks future and significant external scrutiny and challenge that might reflect poorly upon corporate asset administration.

8 Improvements and Innovation

The following sections outline any improvements or innovations to asset management strategies relevant to this asset class, being investigated by EQL.

8.1 Pole Serviceability Assessment

EQL's legacy organisations had slightly different methods for determining the ongoing serviceability of a pole (a legislated obligation). The methods were embedded in field technology employed by Pole Inspectors.

The Field Mobile Computing (FMC) upgrade project for Ergon Energy was completed and implemented in late 2019. This software change included rectifying some deficiencies in the serviceability calculation of residual pole strength. This resulted in that some poles at or past the end of their serviceable life were not being identified for remediation, leading to increased unassisted failures. To meet Australian standard AS/NZS7000:2016, improved serviceability calculations and minimum strength criteria were developed and implemented to improve the identification of unserviceable poles.

These assessment calculations will be further aligned when EQL introduce a single EAM/ERP solution which will move the asset inspection program onto a single IT system.

8.2 Composite Fibre Poles

Composite fibre poles present a lightweight alternative to traditional wood, concrete, or steel poles used in the EQL network. Technologies used in the construction of composite poles are continuing to advance, with manufacturers advertising comparable strength and longevity to other pole types, making them progressively more viable for use. The lightweight nature of the composite fibre poles also provides numerous logistical and manual handling benefits.

Given the issues discussed in Section 6.3 regarding the procurement of wood poles to meet forward demand, and the cost of alternative concrete and steel poles, EQL is continuing to trial the use of composite fibre poles as an alternative to wood poles.

8.3 Health Index and Risk Monetisation

To support / justify the increased replacement volumes and resolve the economic limitation of Ergon Energy and Energex, EQL has:

- Engaged an independent expert reviewer was commissioned to evaluate the effectiveness of Ergon Energy's pole serviceability calculation methodology. The review focused on data collection through to pole serviceability rating calculations with the goal of identifying ways in which the process can help reduce unassisted pole failures by accurately assessing a pole's ability to withstand its design loadings. The review confirms the following:
    - Pole assessment serviceability calculation used is consistent with world best practice.
    - The pole assessment methodology and active pole replacement to reduce the unassisted pole failure rate are a necessary response for Ergon Energy to fulfil its obligation set out in the Electrical Safety Act (Qld).
- Developed a condition-based risk quantification modelling tool to establish optimum replacement volumes.
- Committed to adopt an economic, customer value-based approach when it comes to ensuring the safety and reliability of the network. To substantiate the advantages of this

approach for the community and businesses over the modelling period, we have employed Net Present Value (NPV) modelling. This commitment is in line with their efforts to minimize the impact on customer prices.

- A cost benefit analysis has been conducted to confirm that the pole replacements are prudent capital investments.

8.4 Future Technologies to Deliver Inspection Capability

The cost of pole inspection remains a significant portion of the overall operating expenditure for EQL, due to the ongoing need to visit each site and undertake manual inspection activities, such as excavating around the base of the pole or drilling.

Emerging technologies in the field of non-destructive testing techniques will present a viable alternative to traditional inspections, as the technologies are proven, and costs come down. Similarly, sensors which may be used to detect pole failures and defects may become an alternative to traditional inspection in the future. Ongoing monitoring and consideration of these technologies is recommended.

8.5 Future Technologies as an Alternative to Replacement

Technology advancement in areas which present an alternative to traditional network is currently increasing at an unprecedented rate. Technologies such as distributed generation, batteries and isolated grids sometimes present a viable alternative to like-for-like replacement in order to mitigate risk, particularly in rural areas.

EQL continues to investigate and install technology-based techniques, looking to provide an alternative to like-for-like replacement to deliver greater risk reductions at lower cost.

8.6 Wood Pole Durability Research Co-operative

EQL is currently participating in a research co-operative headed by the University of the Sunshine Coast, along with other DNSPs, to investigate many aspects of managing wood poles. This includes, but is not limited to, inspection techniques, pole preservative treatments, softwood pole use in the utility industry, termite hazard mapping and rot analysis.

9 Lifecycle Strategies

The following sections outline the approach of EQL to the lifecycle asset management of this asset class.

9.1 Philosophy of Approach

Poles are very high volume, relatively moderate individual cost assets, and are typically managed on a population basis through periodic inspection for condition and serviceability. Poles may be proactively replaced based on risk, where criteria indicating assets are either at or near end of life can be identified. Proactive replacement is typically undertaken with other work such as feeder refurbishment programs or bundled into logical groups for efficiency of delivery and cost.

While both legacy organisations employed a common set of standard processes and inspection defect benchmarks, the practical implementation of the work has been different. This has developed as a result of variations in approach to use of contractors for tasks, contractual obligations, asset environments (e.g., CBD vs long rural), routine travel distances and diversity of environments promoting a range of work practices, and corporate direction and policy.

With the establishment of EQL, there was intent to merge these practices, policies, and procedures where prudent, such as when contracts fall due and are renewed, and to actively pursue opportunities for common approach and service delivery where performance improvement opportunities arise.

Engineering processes and standards are now completely aligned. Inspection processes have been homogenised and common Inspection Contracts now employ the same technical obligations and performance benchmarks.

9.2 Supporting Data Requirements

There is a disparity between asset records being kept in the Ergon Energy region and the Energex region. Historical data capture practices restrict the ability to analyse the large volumes of data associated with this asset class without substantial manual effort and offers significant potential for improved asset management.

In the Ergon Energy region, the recent introduction of wide-spread online field staff computing facilities has begun to address this issue of delay data collection on commission. There is still a significant backlog in this data being entered into our asset register, typically around 1 year.

Energex records this information at time of installation through the commissioning process and paper forms and have a smaller backlog, however there may still be up to six months delay between commissioning and data records being updated.

Legacy organisation Ergon Energy developed and implemented a recording system for all failures, incorporating a requirement to record the asset component (object) that failed, the damage found, and the cause of the failure using the Maintenance Strategy Support System (MSSS) in Ellipse; the current Enterprise Asset Management (EAM) System.

Energex previously maintained detailed records of pole failures in a separate database outside of corporate systems.

EQL has now adopted aligned to the MSSS approach and is building this system of record over time, providing the information necessary to support improvements in inspection and maintenance practices. The historical failure data has been reviewed back to 2017. While this is too short to establish long term trends, it has been sufficient to recognise that the unassisted failure root causes across the years appear to be consistent with more recent validated data. Alignment of data, capture and recording is now considered complete, with common systems being implemented into the EAM system.

EQL has initiated implementation of a new Enterprise Asset Management system. While not yet complete, it is intended to embody a new asset and works management system covering both Ergon Energy and Energex assets and works.

9.3 Acquisition and Procurement

Assets are created when new lines are developed, existing lines are upgraded or extended, and when poles are replaced due to condition. A very small volume of poles are “gifted” assets, but the annual number of gifted poles is insignificant. Poles are procured via period contracts based on forecast requirement. Normal procurement time of wood poles and steel poles is typically 1-2 weeks. Procurement time of concrete poles is typically of the order of several months.

The overall growth rate of the population of pole assets is less than 1% across all regions due to the prevalence of undergrounding new developments.

As detailed in Section 6.3, there is a developing shortage in hardwood poles, predominantly in the 12.5 to 14m range which accounts for approximately 64% of the wood pole usage. Ongoing high demand for 11m 8-14kN hardwood poles has meant that stocks are very low, and there a supply shortage.

9.4 Operation and Maintenance

Operation and maintenance work includes both planned and corrective maintenance. Operation and maintenance procedures are supported by a suite of documentation which describes in detail the levels of maintenance applicable, the activities to be undertaken, the frequency of each activity, and the defect and assessment criteria to which the condition and testing are compared to determine required actions. The relevant documents are included in Appendix 1 for reference.

9.4.1 Preventive Maintenance

EQL actively manages poles using a combination of condition based visual assessment and preventive maintenance tasks, which includes:

- Periodic in-service condition assessment of physical condition and immediate environment.
- Routine non-intrusive maintenance activities to ensure correct functionality.

Ground based visual inspections are used to identify defects on other asset classes as well as poles in order to deliver an efficient overhead network inspection program. Ground based visual inspections are detailed in the documents referenced in Appendix 1.

Audit systems are in place to ensure efficacy of the overall inspection process. These are embedded in pole inspection contracts and the governing procedures and standards detailed in Appendix 1

Under the inspection process, poles are assessed according to a set of pass/fail benchmark criteria documented in the Lines Defect Classification Manual (LDCM). Individual benchmark failure records are labelled “Defects”. The benchmark criteria are reviewed periodically based upon overall pole population failure and refurbishment statistics, as well as reported situational circumstances that have been encountered.

Defects are scheduled for repair according to a documented risk-based priority scheme). Actual individual repair periods are recorded and monitored, with performance criteria established for the population repair period statistics.

Where pole serviceability calculations suggest the base strength is marginal or inadequate, the pole will be reinstated using pole nails, rebutted, or replaced.

The frequency of pole inspections in Ergon Energy is nominal 4 and 5 years with the intent to ensure all poles are inspected within 5 years. The frequency of pole inspection for Energex is consistent across the population at 4 years and 9 months with intent to ensure all poles are inspected on a 5-year cycle.

9.4.2 Corrective Maintenance

Corrective maintenance is generated from preventive maintenance programs, ad-hoc inspections, public reports and in-service pole failures. Non-urgent actions to address asset issues identified through customer notification or ad-hoc inspections may be rectified at the time of inspection or scheduled for a later time through corrective maintenance.

For corrective maintenance, poles and other assets are repaired if cost effective (corrective OPEX) or replaced with like-for-like to the current standard (REPEX).

9.5 Refurbishment and Replacement

The following sections outline the practices used to either extend the life of the asset through refurbishment or to replace the asset at the end of its serviceable life.

9.5.1 Refurbishment

Where pole serviceability calculations suggest the base strength is marginal or inadequate, the pole may be reinstated using pole nails or rebutting techniques.

Pole nailing is performed as part of the Defect Refurbishment Program, primarily to achieve the intended service life of the pole. This is achieved by fitting a steel stake (pole nail) to support the deteriorated section of the pole at ground-line.

Rebutting of a pole in-situ to raise conductor clearances to ground and increase rating may be performed as part of a refurbishment program. Rebutting to reinstate an unserviceable wood pole in-situ is not normally cost-effective; however, purchasing pre-butted poles direct from the suppliers has proven to be cost effective.

9.5.2 Replacement

Poles are predominately replaced based upon condition. Poles are usually proactively replaced, where criteria can be identified indicating that assets have either reached or are approaching end of life. These criteria are based on a combination of pole type, age, location, previous strength assessment, and/or the period that the pole has been nailed for. Proactive replacement is typically undertaken with other work such as feeder refurbishment programs or bundled into logical work packages for efficiency of delivery and cost.

The average life extension of poles due to reinforcing or reinstatement techniques was expected to be approximately 15 years when the technique was introduced. Data collected to date indicates that life extension has generally exceed this expectation across all regions. Performance data has also shown that the cause of nailed poles reaching end of life has been due to the wood pole failing other inspection criteria and not the nail-enhanced structural strength criteria. The average life extension of a pole due to nailing is being monitored, as there are a growing number of poles remaining in service that have been nailed for over 15 years.

Replacement poles are determined based on design criteria and current standards. Use of steel butts in termite areas is encouraged. Poles are purchased already rebutted to support installation efficiency. Concrete or steel poles may also be considered however are unlikely to be cost effective in most cases.

Ergon Energy also utilised EA Technology’s Condition Based Risk Management (CBRM) and Common Network Asset Indices Methodology (CNAIM) principles to determine the condition of our pole population. These models utilise condition data such as observed ground level deterioration and pole rot condition and measured condition data such as strength ratio and sound wood measurement to determine the Health Index (HI) of a pole asset. The condition data is collected through our inspection program.

Each pole in our population has an individual HI score, which means that the type of pole, location and condition is factored into the HI calculations.

- 0 indicating best condition or a new pole.
- indicating the worst condition.

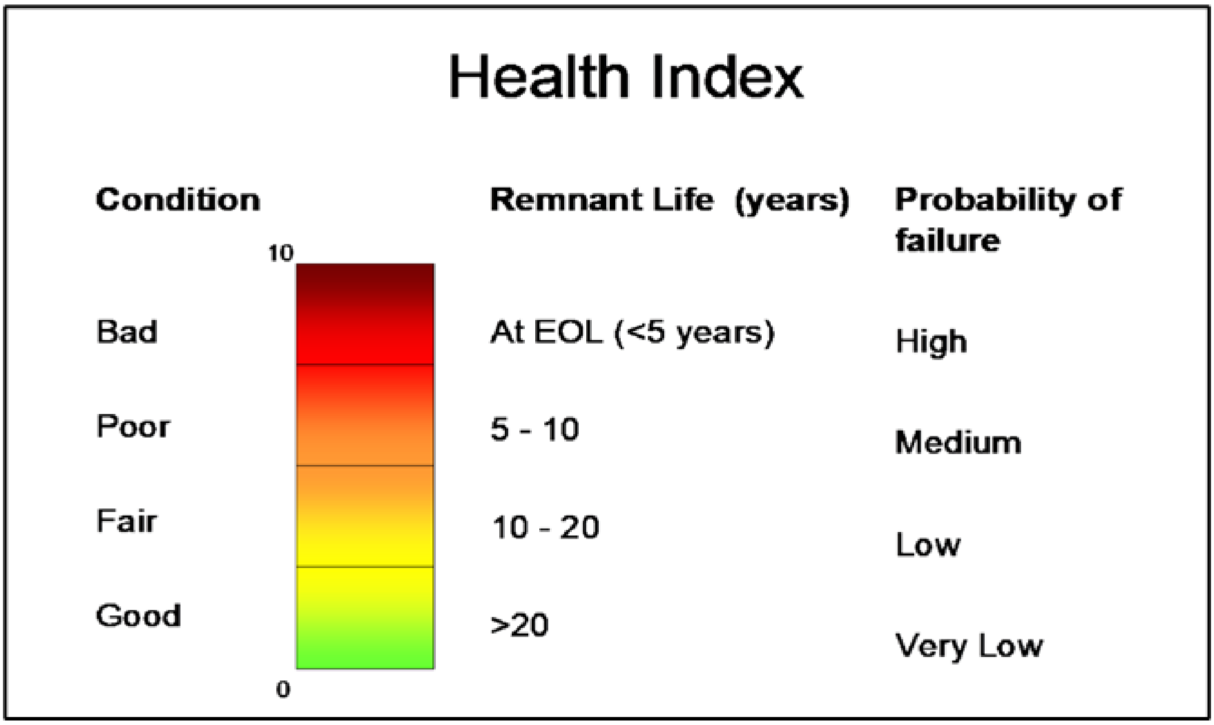

Figure 16 CBRM Health Index

In next 20 years CBRM predictive analysis estimate around 270,000 poles for Ergon Energy and 180,000 pole for Energex will be exceeding HI of 7.5 indicates poor condition of the pole with intervention required in a specified time frame.

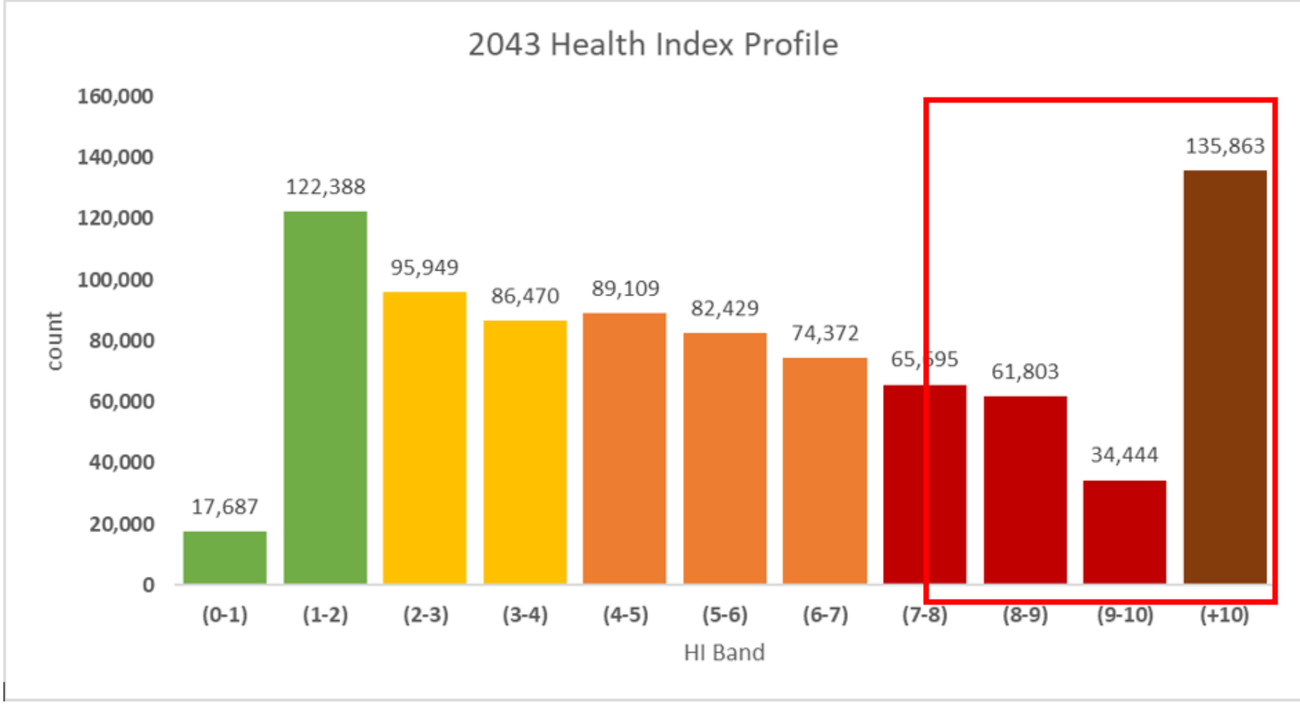

Figure 17 Ergon Energy HI Prediction

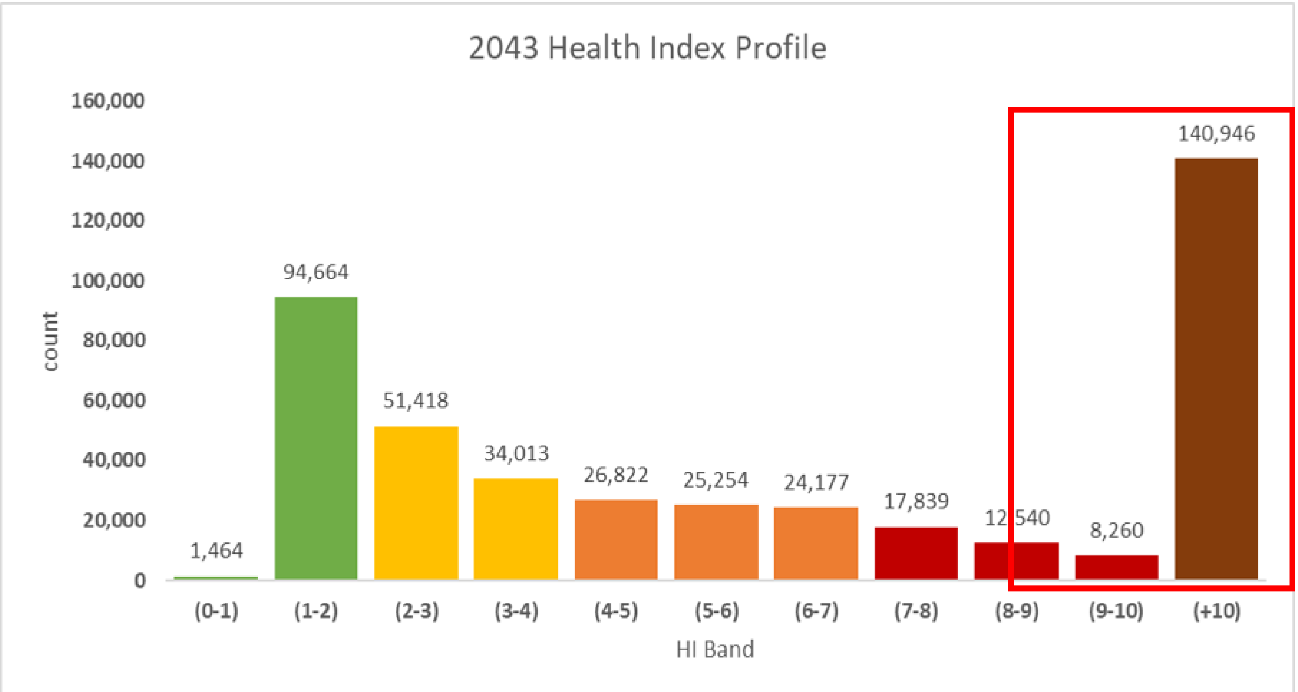

Figure 18 Energex HI Prediction

9.5.3 Spares

Energy Queensland does not currently require a documented spares strategy for poles.

Wood poles and steel streetlight poles are managed as stock items within the corporate procurement and inventory systems. Holdings are managed to minimum levels based on historical usage and forecast programs of work, with typical procurement time of 1-2 weeks. Wood and steel poles are stored at most depots to ensure a reasonable supply is available locally for all normal contingencies. Volumes held reflect local seasonal usage requirements considering logistic issues related to efficient site delivery.

Concrete and steel poles are typically ordered on an on-demand basis per design requirements due to their larger size and longer lead times, which can be in the order of months. Concrete and steel poles used for distribution applications are managed with minimum stock holdings in the stores system, though at much smaller quantities.

Concrete poles are relatively expensive (compared to wood and steel poles) and often used in locations where very high reliability is required, very tall poles are required, or future maintenance access is likely to be problematic (such as in natural parks and rain forests, with very long spans in rugged country). While failures of concrete and steel poles are rare, replacement of failed poles is problematic due to the lack of spares. Lead time for procurement is typically measured in months.

9.6 Disposal

The disposal of poles varies depending upon the type of pole that is being disposed of. Typical methods of disposal are as follows:

- Any pole butts that have received termiticide or fungicide treatments are disposed of in accordance with health and safety and environmental legislation.
- Untreated pole sections are shredded or mulched or sent to companies that reuse and recycle timber.
- CCA treated pole sections are sent to regulated waste dump sites.
- Disposal of poles treated with now-banned chemicals such as creosote and organochlorines, is in accordance with current legislation.
- Steel poles are salvaged for scrap material where possible or else sent to regulated waste dump sites.
- Concrete poles are sent to regulated waste dump sites.

10 Program Requirements and Delivery

The programs of maintenance, refurbishment, and replacement required to outwork the strategies of this AMP are documented in Grid Investment Plan and reflected in corporate management systems. Programs are typically coordinated to address the requirements of multiple asset classes at a higher level, such as a substation site or feeder, to provide delivery efficiency and reduce travel costs and overheads. The Grid Investment Plan provide a description of works included in the respective programs as well as the forecast units.

Program budgets are approved in accordance with Corporate Financial Policy. The physical and financial performance of programs is monitored and reported on a monthly basis to manage variations in delivery and resulting network risk.

Appendix 1. References

It takes several years to integrate all standards and documents after a merger between two large corporations. This table details documents authorised/approved for use in either legacy organisation (and therefore authorised/approved for use by EQL), that supports this Asset Management Plan.

Organisation	Document Number	Title	Type
EQL	Net Policy - 001	Asset Management Policy	Policy
EQL	P043	Risk Management Policy	Policy
Ergon Energy Energex	STNW0330 03918	Standard for Network Assets Defect/Condition Prioritisation	Standard
Ergon Energy Energex	STNW1160 STD00299	Maintenance Acceptance Criteria	Manual
EQL	2021-Q3-4	Lines Defect Classification Manual	Manual
Energex	00302	Overhead Design Manual	Manual
Ergon Energy Energex	04920	Overhead Construction Manual	Manual
EQL	PGCDM002	QLD Electricity and Metering Manual	Manual
EQL	S032	Standard for Inspecting Poles	Standard
EQL	S033	Standard for Treating Poles	Standard
Ergon Energy Energex	NA000403W114 00707	Standard for Network Assets Defect/Condition Prioritisation	Standard
Ergon Energy Energex	NA000403W114 02048	Managing Pole Failure Investigations Work Instruction	Standard
Ergon Energy Energex	STNW0340 01821	Standard for Managing Line Asset Defects	Standard
Energex	00357	Wood Pole Management	Standard
Energex	00369	Pole Inspection Guidelines	Standard
Energex	00629	Asset Inspection Tablet for Pole Inspection Use	Standard
Energex	00958	Wood Pole Structural Analysis	Standard
Ergon Energy	NA000403R127	Asset Inspection and Earthing Data Capture	Standard
Ergon Energy	NA000403R166	FMC Mobile Application Manual	Standard
Ergon Energy	NA000403R217	FMC Desktop Manual	Standard
Ergon Energy	NA000403R166	Pole Structure Guidelines	Standard
Ergon Energy	STNW0033	Standard for Wood Pole Serviceability	Standard
EQL	WCS5.1	Poles, Inspect and Treat	Specification

Organisation	Document Number	Title	Type
EQL	WCS5.1A	Poles, Inspect and Treat - Assessment	Specification
EQL	WCS5.4	WCS5.4 Wood Poles Reinstatement and Reinforcement	Specification
EQL	WCS5.4A	WCS5.4 Wood Poles Reinstatement and Reinforcement - Assessment	Specification
EQL	WCS5.6	WCS5.6 Poles, Ground Based Overhead Assessment	Specification
EQL	WCS5.6A	WCS5.6 Poles, Ground Based Overhead Assessment - Assessment	Specification

Appendix 2. Definitions

Term	Definition
Condition Based Risk Management	A formal methodology used to define current condition of assets in terms of health indices and to model future condition of assets, network performance, and risk based on different maintenance, asset refurbishment, or asset replacement strategies.
Corrective maintenance	This type of maintenance involves planned repair, replacement, or restoration work that is carried out to repair an identified asset defect or failure occurrence, in order to bring the network to at least its minimum acceptable and safe operating condition. An annual estimate is provided for the PoW against the appropriate category and resource type.
Digital Twin	A virtual representation (model) that serves as the real-time digital counterpart of a physical object or process
Distribution	LV and up to 22kV networks, all SWER networks
Forced maintenance	This type of maintenance involves urgent, unplanned repair, replacement, or restoration work that is carried out as quickly as possible after the occurrence of an unexpected event or failure; in order to bring the network to at least its minimum acceptable and safe operating condition. Although unplanned, an annual estimate is provided for the PoW against the appropriate category and resource type.
Preventative maintenance	This type of maintenance involves routine planned/scheduled work, including systematic inspections, detection and correction of incipient failures, testing of condition and routine parts replacement designed to keep the asset in an ongoing continued serviceable condition, capable of delivering its intended service.
Reinforced pole	Pole has had mechanical reinforcement using a steel stake, referred to as a ‘pole nail’, attached to the pole. The pole nail is designed to supplement the ground-line structural strength
Reinstated pole	Pole has been rebutted by enclosing the trimmed butt of the pole in a metal tube, which may also include concrete or foam filling in any resultant voids.
Sub transmission	33kV and 66kV networks
Transmission	Above 66kV networks
Unserviceable	Asset is deemed no longer able to perform the function it was intended to perform under the conditions it was designed for.

Appendix 3. Acronyms and Abbreviations

Abbreviation or acronym	Definition
ALARP	As low as reasonably practicable
AMP	Asset Management Plan
AUGEX	Augmentation Expenditure
C&I SUBSTATION	Commercial and/or Industrial Substation
CBRM	Condition Based Risk Management
DEE	Dangerous Electrical Event
ENA	Energy Networks Australia
EQL	Energy Queensland Limited
ESCOP	Queensland Electricity Safety Code of Practice
ESR	Queensland Electrical Safety Regulation (2013)
FMC	Field Mobile Computing
HV	High voltage
ISCA	In-Service Condition Assessment
LiDAR	Light Detection and Ranging
LDCM	Lines Defect Classification Manual
LV	Low Voltage
MSS	Minimum Service Standard
MSSS	Maintenance Strategy Support System
POEL	Privately Owned Electric Line
QEJP	Queensland Jobs and Energy Plan
QLD	Queensland
REPEX	Renewal Expenditure
RIN	Regulatory Information Notice
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SFAIRP	So far as is reasonably practicable
SWER	Single Wire Earth Return