Jemena Electricity Networks (Vic) Ltd

2026-31 Electricity Distribution Price Review - Revised Regulatory Proposal

Supporting justification document

Pole Top Stuctures Replacement Program - Business Case
ELE-999-PA-EL-009

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Abbreviations

BMP	Bushfire Mitigation Plan
CBRM	Condition Based Risk Management
ELCMP	Electric Line Clearance Management Plan
HV	High Voltage
HVI	High Voltage Injection
JEN	Jemena Electricity Networks (Vic) Ltd.
LV	Low Voltage
PTFM	Pole Top Fire Mitigation
ST	Sub Transmission

1. Executive Summary

A substantial volume of crossarms in the Jemena Electricity Network have exceeded their nominal useful life and are now exhibiting deteriorated condition as they approach end of life. Crossarms and pole top structures require replacement once their condition has deteriorated to an unacceptable level as determined through regular inspection. Timely replacement of deteriorated assets is necessary to maintain network reliability and public and employee safety risk to acceptable levels in accordance with the As Far As Practicable (AFAP) principle.

The degrading condition of the population is driving increased failure rates and crossarm replacements due to condition issues. While failure rates remain relatively low, they are trending upward. Replacement rates are lower than as determined through Weibull modelling due to efficient asset management enabling extraction of all residual life from this asset class. Risk associated with aging crossarms is being successfully mitigated through an effective asset management program however replacement volumes are expected to increase as more aging crossarms develop condition issues.

The proposed replacement volumes are necessary to maintain network reliability within community expectations and safety in accordance with AFAP.

2. Introduction

Jemena Electricity Networks (JEN) has a population of approximately 126,000 crossarms of which around half are wooden. 35% of wooden crossarms have exceeded the nominal useful life of 45 years and are exhibiting advanced stages of deterioration. When compared with the current regulatory period, a substantially increased volume of crossarms will require replacement in the next period.

3. Purpose Statement

The purpose of this paper is to explain the expected increase in crossarm replacement volumes over the next regulatory period compared with the current regulatory period.

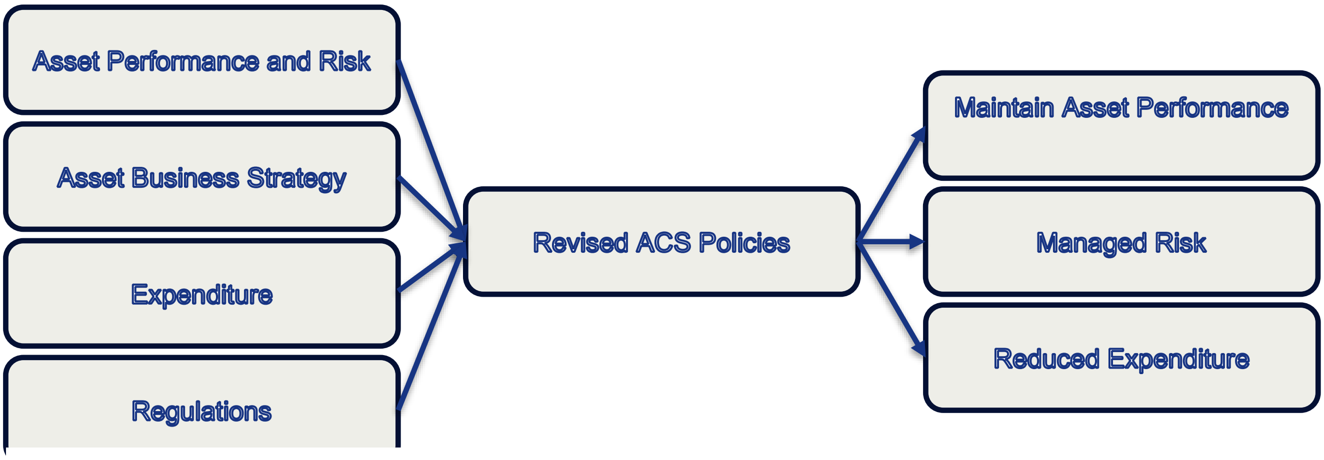


Figure 1 JEN ACS Inputs and Outputs

4. Strategic Objectives

Replacement strategy for JEN wooden crossarms is to regularly inspect and replace upon determination of unsatisfactory condition while maintaining network reliability and safety in accordance with AFAP. This enables replacements to be deferred and maximum extraction of residual life from these assets. This has enabled reduced expenditure on this asset class.

A substantial proportion of wooden crossarms in JEN have exceeded their nominal life and are exhibiting advanced stages of deterioration. A trend of increased failures has become apparent as this asset class continues to age. Replacement volumes are projected to increase as the population continues to degrade due to age and more crossarms exceed their nominal lifespan.

During the previous regulatory period replacement volumes were also high due to aging assets. The expected increase in expenditure for regulatory period 26-31 will assist in management of the increased reliability and risk issues posed by this aging asset class and enable an efficient asset management program.

4.1 Jemena Networks Strategy

In 2022, Jemena developed a 10-year strategy to respond to changes in the Electricity Distribution market, driven by the energy transition which is shaping the future state of the energy industry. The Jemena Networks Strategy has three key principles.

- Continue to build a safe and inclusive workplace.
- Deliver safe, reliable, affordable energy and sustainable performance for all.
- Transition our assets and business to enable a resilient energy future.

5. Pole Top Structures Asset Class Strategy

The Asset Class Strategy for Pole Top Structures is informed by the Jemena Business plan in conjunction with the Jemena Networks Strategy to provide context for the four key business objectives.

Operational Excellence

Manage assets throughout their lifecycle in a safe and environmentally responsible manner, in accordance with Reliability Centred Maintenance (RCM) principles. Maintain asset information/knowledge to enable efficient and effective decision making. Embed continuous improvement throughout asset lifecycle.

Customer

Maintain our current service level, incorporate customer feedback in our decision-making process.

Growth

Acquire/install/maintain assets to meet future demand requirements.

People

Maintain a safe work environment, engage team leaders in assessment of new assets and training.

5.1 Statutory

Obligations under National Electricity Rules, National Electricity Law and the Electricity Safety Act include mandates for responsible management of expenditure, health, safety and environment, reliability and service availability. These statutory obligations include mandates to achieve expected customer service standards, meet increasingly stringent safety concerns given the increasing fire hazard associated with a changing climate, and ensure sufficient network access despite increasing demand and embedded DER while ensuring that investment is efficient. Statutory obligations are further explained in the Section 6.

6. Background

6.1 Current State

The crossarm population comprises of both wooden and steel types. Initially, only wooden crossarms were installed across the network region. From around 1980, steel crossarms were introduced, and their installation steadily increased until they became the predominant type being installed.

As at writing, quantities of crossarm volumes on JEN according to type are:

- 54,000 wooden crossarms;
- 72,000 steel crossarms; and
- 126,000 crossarms in total.

6.2 Crossarm Population Age Profile

The JEN crossarm population age profile is shown in Figure 2. Any wooden crossarm installed prior to 1980 is now over 45 years of age, the nominal lifespan of wooden crossarms. There is a substantial quantity of crossarms that are 45 years or older due to a period of rapid network expansion that occurred between 1960 and 1990.

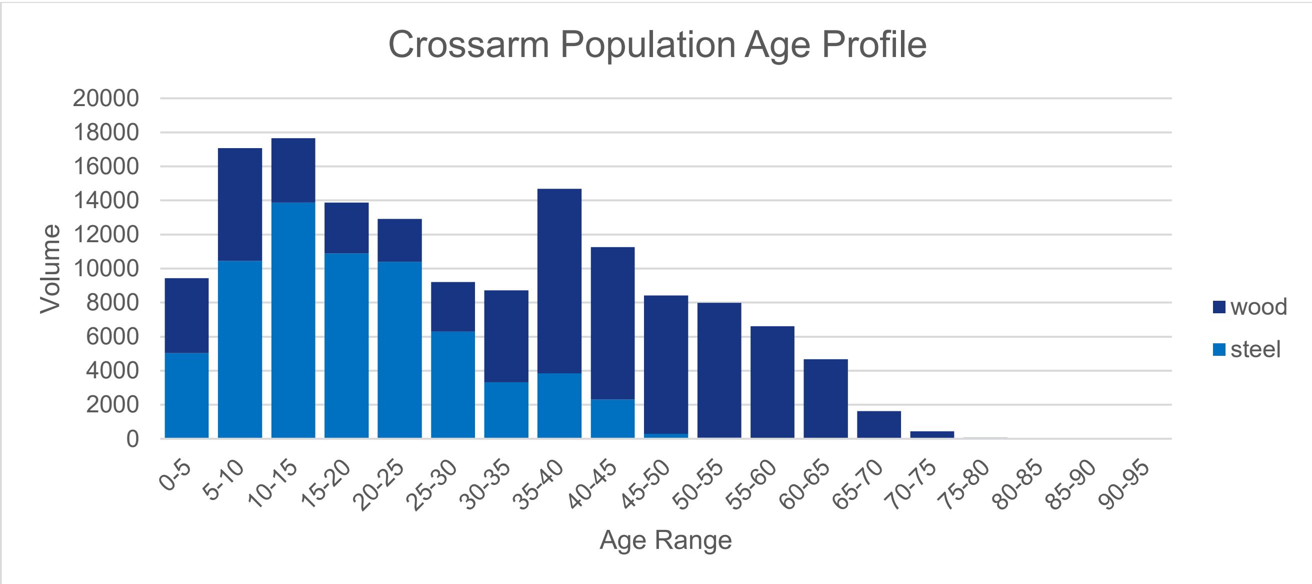


Figure 2 JEN Crossarm Population Age Profile

Wood ST Crossarms

There are 239 ST wood crossarms and these represent 0.2% of the total population of crossarms. Of the population of wood crossarms they represent 0.4%. There are **161 ST wood crossarms** that **exceed nominal life of 45 years**.

Wood HV Crossarms

There are 5,582 HV wood crossarms and these represent 4.4% of the total population of crossarms. Of the population of wood crossarms they represent 9.3%. There are **2,515 HV wood crossarms** that **exceed nominal life of 45 years**.

Wooden LV Crossarms

There are 53,950 LV wooden crossarms and these represent over 42% of the total population of crossarms. Of wooden crossarms they represent over 90%. LV wooden crossarms have an average longevity of 41.25 years.

There are over **17,993 LV wooden crossarms** that **exceed the nominal life of 45 years**, **one third of the LV wooden crossarms**.

If nominal life was considered to be 41.25 years i.e. the average replacement age of LV crossarms, then the volume of LV crossarms that have exceeded nominal life would be higher.

6.3 Life Expectancy

The nominal useful life expectancy has been determined through engineering experience and modelling. A substantial proportion of the population of wooden crossarms have exceeded the nominal life expectancy for this asset class as is shown in Figure 3 below. This cohort will continue to degrade with age, resulting in increased condition driven replacement volumes over the coming years.

- Nominal life expectancy of wooden crossarm: 45 years
- Nominal life expectancy of steel crossarm: 70 years

Average age at replacement for wooden crossarms:

- HV wooden crossarm: 42.5 years
- LV wooden crossarm: 41.3 years
- ST wooden crossarm: 48.1 years

The average age of replaced wooden crossarms is 41 years, which is slightly lower than the nominal life expectancy. This reduction is likely influenced by the inclusion of crossarms replaced early due to infant mortality or other premature failures.

Figure 3 below shows crossarm replacement volumes at replacement age. It is apparent from this chart that despite the nominal lifespan of 45 years crossarms are utilised substantially past their nominal lifespan if condition permits. **20,600 wooden crossarms** were installed pre 1980 and have **exceeded their nominal lifespan of 45 years**, which represents around one fifth of the total population of crossarms. A negligible quantity steel crossarms have exceeded their nominal lifespan.

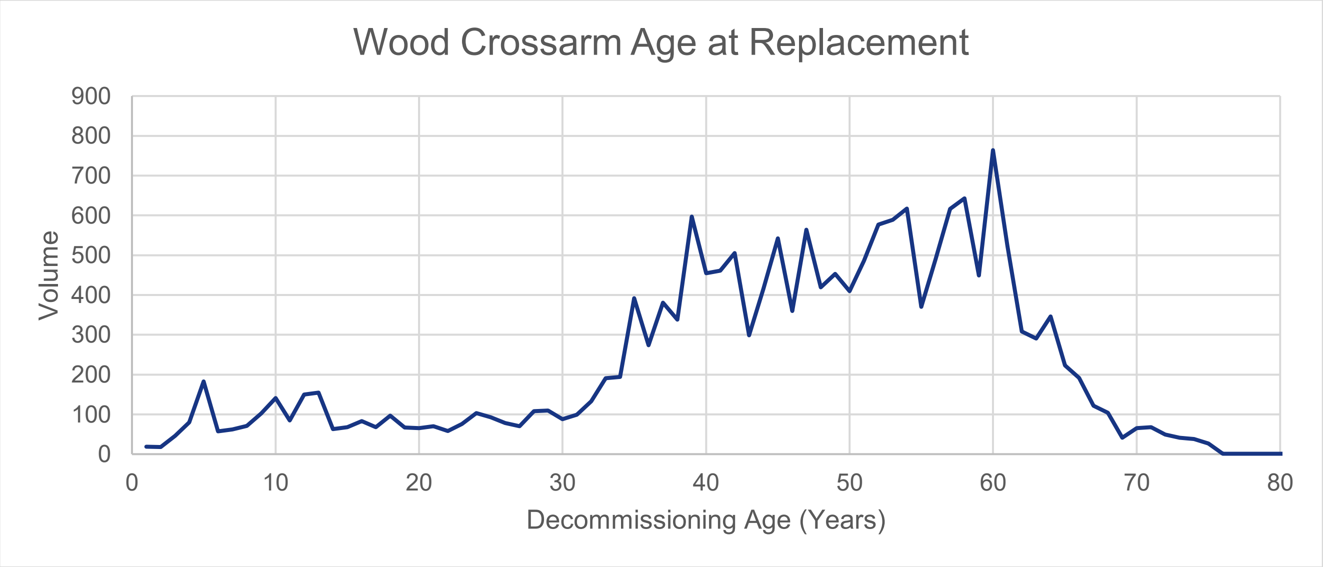


Figure 3 Wooden Crossarm Age at Replacement Trend

6.4 Installation Volume Trend

Figure 4 below shows crossarm installation volumes over the last 90 or so years. Installations occur due to both replacement and network growth. Between 1960 and 1990 there was a large amount of network growth in the JEN region, that drove high volumes of new crossarm installations over this period. The great majority of these crossarms are wooden type.

The primary driver of recent crossarm installations has been condition-based replacements. The notable surge in activity during 2020 reflects the increasing need to replace aging wooden crossarms that are failing inspection. This spike illustrates the potential volatility in replacement rates driven by degrading asset condition and highlights the possible resourcing challenges that could eventuate due to unexpected variations in condition-based replacement volumes.

As the large cohort of wooden crossarms installed prior to 1980 continues to age and exceed their nominal 45-year service life, condition-related issues within this group are expected to escalate, driving increased replacement volumes. Figure 4 below shows installation volumes by crossarm type, including both new installations and replacements. Due to the period of network growth between 1960 and 1990, a substantial quantity of crossarms have reached, or will soon reach, 45 years of age.

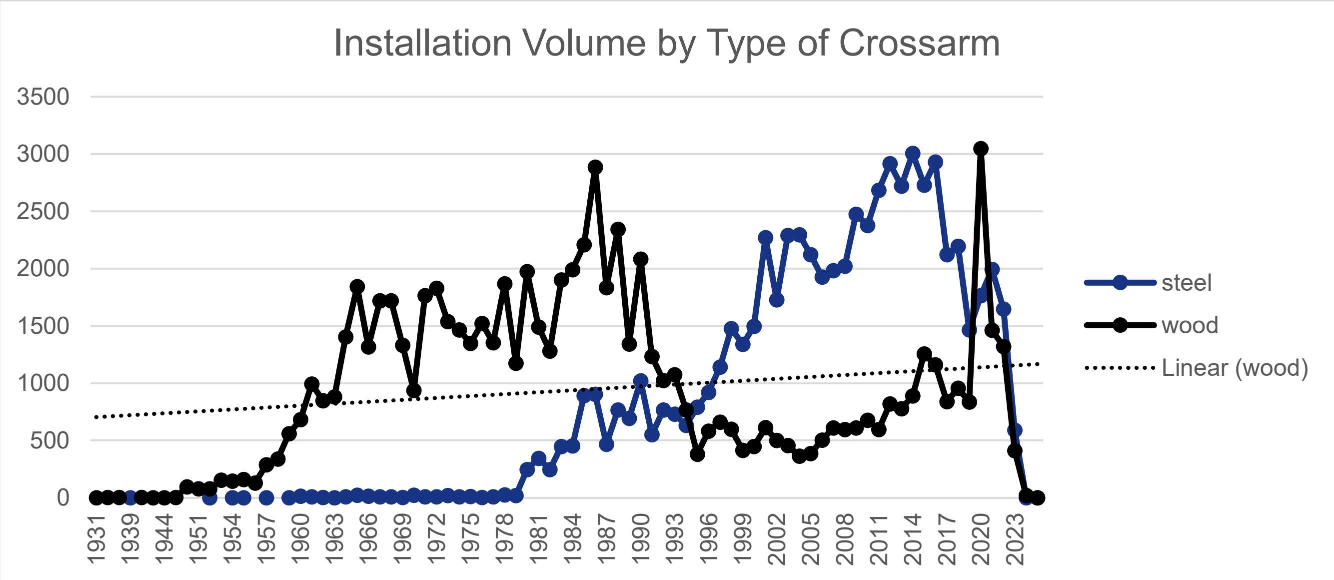


Figure 4 Installation Volume by Crossarm Type

Figure 5 below shows crossarm replacement volumes only, no new installations. Wooden LV crossarms with condition issues due to age are the main driver of recent replacement volumes. Further increases in replacement volumes associated with these aging wooden crossarms are expected and the volatile fluctuation in replacement volumes in years 2020 and 2021 is more clearly visible.

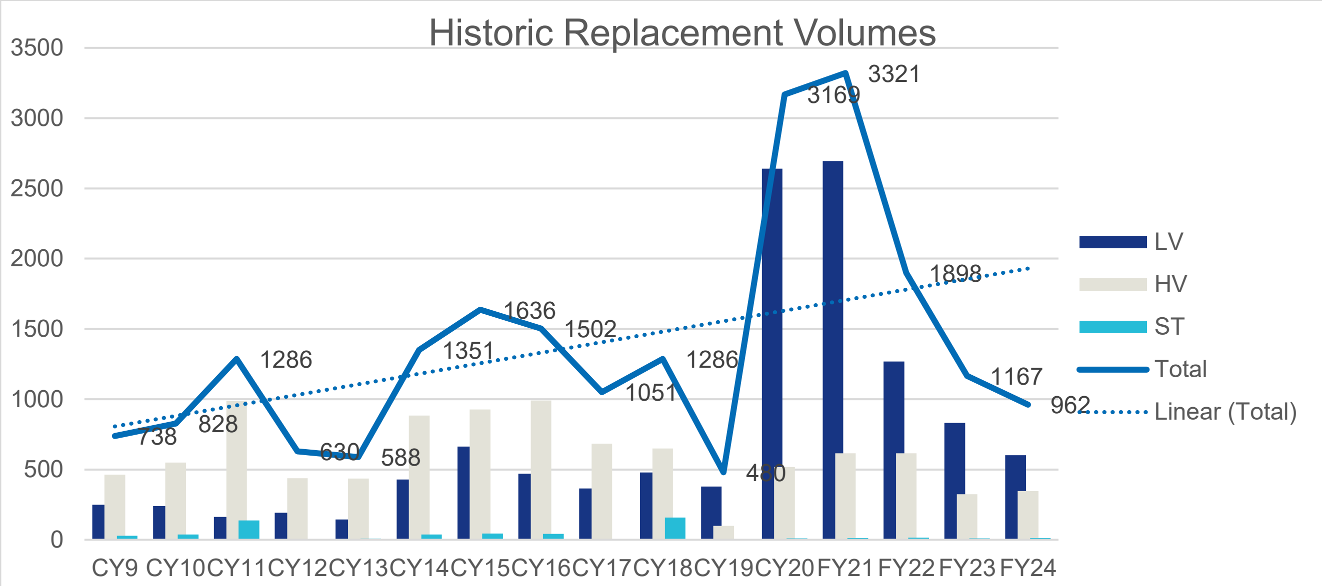


Figure 5 Historic Replacement Volumes

6.5 Pole Top Structures Management Practices

The program aims to efficiently and effectively strike a predictable and sustainable balance between OPEX and CAPEX expenditure while delivering a safe and reliable network in line with obligations under the AFAP principle.

6.5.1 Pole Top Structures Replacement Program

Pole top structures are replaced based on assessment and identification of inadequate condition or when they fail. Defective or significantly deteriorated pole top components identified during inspection are assigned a priority for replacement according to the JEN Asset Inspection Manual (AIM).

The AIM priorities have mandated response intervals before which they must be resolved. This priority is based upon assessment of criticality. Significant faults and defects are corrected immediately. The inspection program and techniques are optimised to avoid the replacement of crossarms, with adequate residual life remaining for the crossarm to last until next inspection, while managing risk of failure to acceptable levels.

HV and ST Crossarms Replacement

HV and ST wooden crossarms of unacceptable condition or brown pin, post or disc insulators are replaced with steel crossarms. All wooden HV and ST crossarms are expected to be replaced over the next 10 years based on their condition. All wooden HV and ST crossarms in HBRA network areas have already been replaced.

LV Crossarm Replacement

LV wooden crossarms of unacceptable condition are replaced with a new wooden crossarm or an ABC bracket where the LV mains are replaced with LV ABC.

6.5.2 Inspection Program

The condition monitoring program is designed to assess the state of pole top structures to ensure they remain in acceptable condition until the next scheduled inspection. Poles and pole tops are inspected every three years in High Bushfire Risk Areas (HBRA) and every four years in Low Bushfire Risk Areas (LBRA), in accordance with Energy Safe Victoria requirements. If an inspector determines that any component of the pole top structure is likely to fail before the next inspection, a notification for corrective action is raised.

Inspections

- Inspections are conducted at ground level and note any obvious signs of deterioration such as:
  - Detached, damaged or missing pole top hardware;
  - Splits, cracks or bends in crossarms;
  - Fungal fruiting bodies on timber;
  - Rot;
  - Missing pole caps;
  - Corrosion; and
  - Deterioration of galvanised layer on LV ABC brackets
- The inspection can include an aerial inspection, viewing the top of the crossarm and associated hardware where it is difficult to determine the extent of deterioration through observation from the ground;
- Inspections are used to prioritise maintenance and replacement programs; and
- Maintenance and replacement programs are intended to maintain network performance at desired levels.

Inspection Program Performance

Performance of the asset inspection program is monitored through crossarm failure rates or breakdown frequency monitored on a monthly basis from fault notifications. Close out of notifications are monitored to verify timely completion of corrective maintenance tasks (notifications).

Notifications

Notifications are only raised against assets that are anticipated to require maintenance or replacement prior to the next inspection. Crossarm and pole top structure inspection guidance is outlined in Chapter 8 of the JEN Asset Inspection Manual (AIM). The AIM notes that inspection of pole top structure equipment is subjective and contains photographs and criteria to assist in appropriate assessment of condition of pole top structures and allocation of notification priority according to criticality. Defects are resolved within the time interval nominated by the allocated priority notification (see Section 6.4.3).

Insulator Replacement Programs

When identified during inspection, 5 shed 22kV post insulators mounted on concrete poles are replaced with the 'stretched' 9 shed version. These insulators have a history of faults caused by animal flash-over. They are suitable for use on wooden poles only.

6.5.3 Notifications and Condition Monitoring

The condition of pole top structures is monitored through a rigorous inspection program. Where a crossarm is inspected and determined to be of unacceptable condition, a notification is raised and is classified by priority depending on the severity or criticality of an issue. There are six notification priorities with varying response times. Crossarms are considered to have unacceptable condition when degradation is likely to result in them being in unsatisfactory condition upon next inspection.

Inspections are conducted on a 3-year cycle in HBRA network regions and on a 4-year cycle in LBRA network regions. The reduced inspection cycle period in HBRA areas is to further reduce any risk of fire starts associated with JEN assets. The JEN Asset Inspection Manual [4] contains specific criteria and photographic guidance to assist with allocation of the appropriate priority against a defect. The allocation of priority is determined by severity of condition and criticality of associated likely failure mode.

Priority	Response Time
Fault	Immediate notification to Dispatch. Rectification determined as part of triage process
Priority 1	Immediate or 24 hours
Priority 3	Requires assessment by a planner or be rectified within 12 weeks.

Priority	Response Time
Priority 4	Requires assessment by a planner or be rectified within 6 months.
Priority 5	Requires assessment by planner or be rectified within 12 months.
Priority 9	Recorded for opportunistic Maintenance purposes and may not be addressed before the next inspection cycle.

Table 1 JEN Notification Priorities

Crossarms that have been determined to be of unacceptable condition are replaced as there is currently no way to refurbish the timber in a rotten wooden crossarm and the cost of materials is low relative to the cost of labour for crossarm replacement.

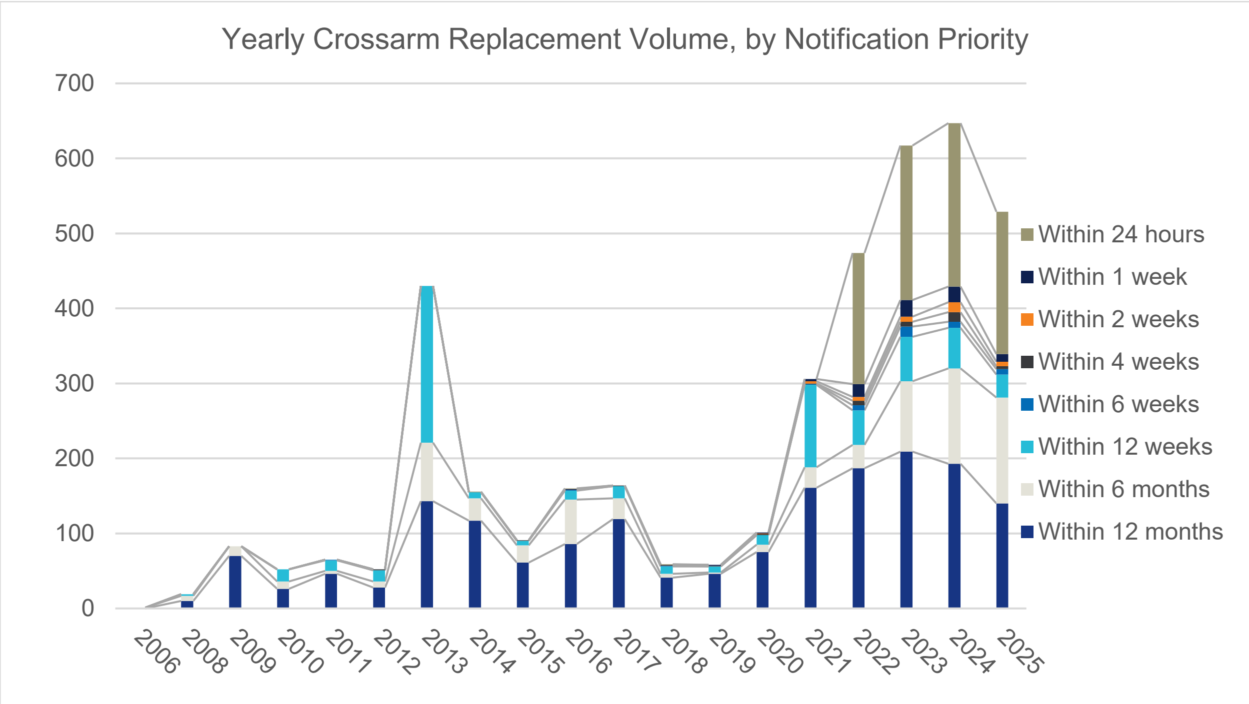


Figure 6 Yearly Crossarm Replacement Volume by Notification Priority

Figure 6 above shows a significant step increase in crossarm replacement notifications, reflecting the aging population of assets that are at or beyond their nominal lifespan of 45 years. This increase is expected to continue as more crossarms deteriorate over the coming review period. Actual notifications currently fall below modelled forecasts, due to effective asset management practices that maximise utilisation of asset residual life. The proportion of Priority 1 notifications raised has also increased over the last few years.

Despite effective asset management, the underlying condition of the population continues to degrade. Notifications will continue to rise and drive higher replacement volumes. It is essential that crossarms with unacceptable condition issues continue to be replaced upon identification. This expenditure will facilitate efficient asset management, network safety and reliability.

6.5.4 Failures

Figure 7 below presents the annual volume of crossarm failures over the past 15 years, showing a consistent upward trend. This increase is driven by age related condition degradation of the population of wooden crossarms. Although inspection programs continue to identify and remove crossarms in poor condition, helping to keep failure rates relatively low, the number of failures is rising. If the population of wooden crossarms is allowed to continue degrading, crossarms that remain in service beyond their expected lifespan with unacceptable condition issues, will drive increased failures.

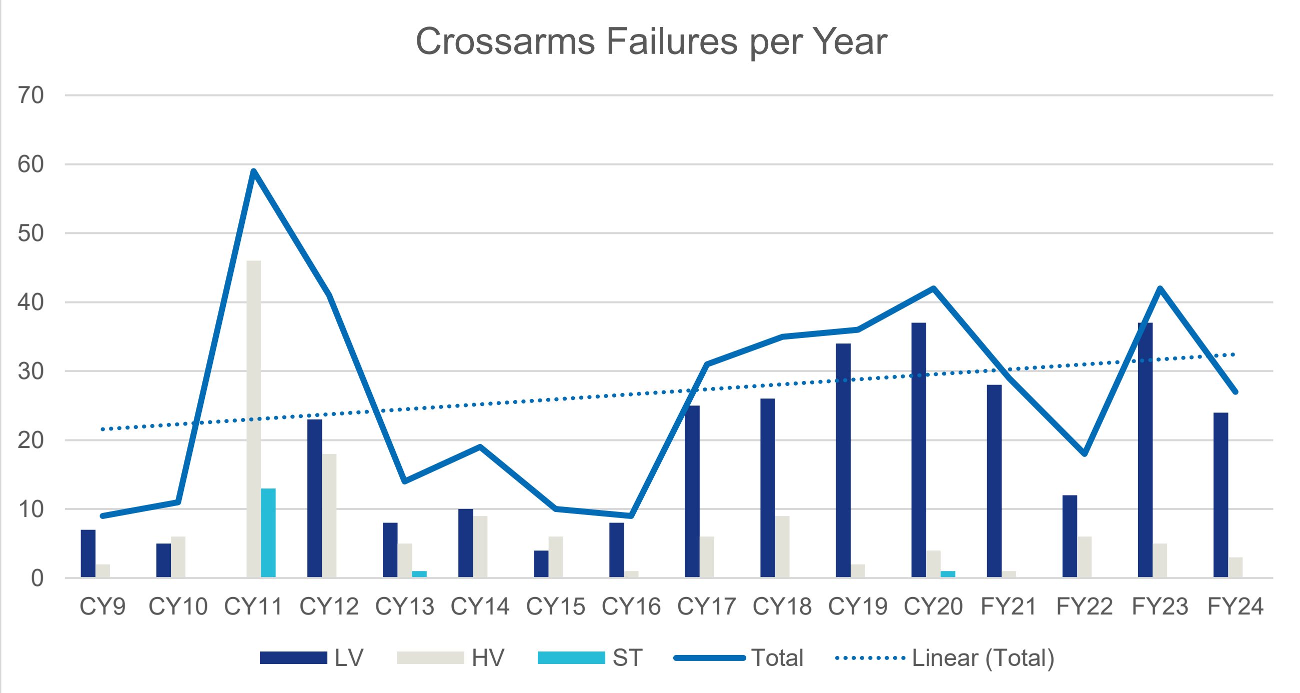


Figure 7 Crossarm Failure Rates

Voltage	2017	2018	2019	2020	2021	2022	2023	2024
LV	25	26	34	37	28	12	37	24
HV	6	9	2	4	1	6	5	3
ST	0	0	0	1	0	0	0	0
Total	**31**	**35**	**36**	**42**	**29**	**18**	**42**	**27**

Table 2 Crossarm Failure Volume

The majority of failures occurring are LV crossarms. HV and ST crossarms are failing at significantly lower rates than LV crossarms.

6.6 Statutory

National Electricity Law, the National Electricity Objective

"to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:
a. price, quality, safety, reliability and security of supply of electricity; and
b. the reliability, safety and security of the national electricity system; and
c. the achievement of targets set by a participating jurisdiction—
i. for reducing Australia's greenhouse gas emissions; or
ii. that are likely to contribute to reducing Australia's greenhouse gas emissions."

6.7 Safety - AFAP

Electricity Safety Act, s83B

The general duty of specified operators, including Jemena, is to minimise bushfire danger.

(1) A specified operator must design, construct, operate, maintain and decommission an at-risk electric line to minimise as far as practicable the bushfire danger arising from that line.

The Electricity Safety Act, s98

The general duty of major electricity companies, including Jemena is to minimise safety risks.

Duties of the Electricity Safety Act 1998 (ESA) which requires a Major Electricity Company (MEC) to design, construct, operate, maintain and decommission its supply network to minimise As Far As Practicable (AFAP) the hazards and risks to the safety of any person, damage to the property and the bushfire danger arising from the supply network.

7. Forecast Model

A replacement volume forecasting model has been developed to support efficient management of the aging population of wooden crossarms within the Pole Top Structures (PTS) asset class. By enabling reliable prediction of future replacement volumes, the model facilitates optimal utilisation of residual asset life and supports the delivery of a cost-effective, forward-looking asset management strategy. This predictive capability ensures replacement activities are both timely and economically justified over the coming years.

The forecasting model is based on Weibull analysis, a very versatile distribution that can model various types of failure behaviors. This makes it ideal for modelling probability of unacceptable condition of an asset such as crossarms given the various degradation modes and wide range of conditions crossarms are subjected to.

This predictive model was developed based on historical crossarm replacement age profile while under best-practice management of the Pole top structure asset class. This model enables the estimation of annual replacement volumes by analysing the age distribution of the asset population and applying a target probability of unacceptable condition.

The purpose of using the Weibull analysis for the pole top asset class is to:

- Predict when crossarms are likely to fail;
- Forecast replacement volumes over time;
- Optimize maintenance schedules and budget planning; and
- Improve asset lifecycle management.

The Weibull distribution is flexible enough to model **Infant mortality failures** (early-life issues), **Random failures** (constant failure rate) and **Wear-out failures** (aging-related deterioration). This makes it ideal for modeling the diverse failure behaviors of crossarms exposed to environmental stress, mechanical load, and aging.

Crossarm Failure Model: Failure Probability (1) and Replacement Volumes Forecast (2)

$$(\mathbf{1})\mathrm{P}(\mathrm{A}) = 1 - \mathrm{e}^{-\frac{\mathrm{A}}{\lambda}^{\beta}}$$

$$(\mathbf{2})R(t) = \sum_{i=1}^{t} N(i) \cdot P(t-i)$$

Where:

$N(t) = Number\ of\ crossarms\ installed\ in\ year\ t$
$A = Age\ of\ crossarm$
$P(A) = Probability\ crossarm\ of\ age\ A\ requires\ replacement$
$R(t) = Number\ of\ crossarms\ to\ be\ replaced\ in\ year\ t$
$\lambda = scale\ parameter\ (related\ to\ average\ lifespan\ of\ the\ crossarm)$
$\beta = shape\ parameter\ (indicates\ failure\ rate\ behaviour)$
$i = Installation\ Year$

7.1.1 Methodology and Application of the Model

Data Collection

148,942 crossarm records have been analysed. This population includes both In-service and replaced (historical) crossarms.

Metadata includes:

- Installation dates;
- Replacement dates;
- Material type; and
- Maintenance/Notification records.

Data Preparation and Analysis

Calculations were added to the initial dataset in preparation to determine the failure probability, such as:

- Time-to-failure for each crossarm;
- Voltage type; and
- Rank failure times and calculate median ranks.

The initial analysis indicates some variability in the dataset with regards to average age on removed/historical crossarms, suggesting further analysis is required to adjust the scale parameter and improve the volume forecasts.

Removed Crossarms	Number of Crossarms	Average of Age (Years)	Min of Age (Years)	Max of Age (Years)	StdDev of Age (Years)	Coefficient of VAR
Steel	**390**	**25.4**	**0.0**	**61.0**	**14.4**	**0.6**
HV	296	27.4	0.2	61.0	14.9	0.5
LV	45	16.2	0.0	46.5	10.7	0.7
ST	49	22.0	1.8	38.0	9.9	0.5
Wood	**17694**	**41.8**	**0.0**	**81.2**	**15.4**	**0.4**
HV	4423	42.6	0.5	81.2	12.2	0.3
LV	12981	41.4	0.0	81.2	16.3	0.4
ST	290	48.2	5.7	69.9	12.3	0.3
Grand Total	**18084**	**41.5**	**0.0**	**81.2**	**15.5**	**0.4**

Table 3 Summary Statistics Table

Parameter Estimation

Weibull parameters as determined through analysis of population data are in Table 4 below. These parameters were used to determine the forecast replacement volumes in Table 5 below.

Scale Parameter (η – Eta)

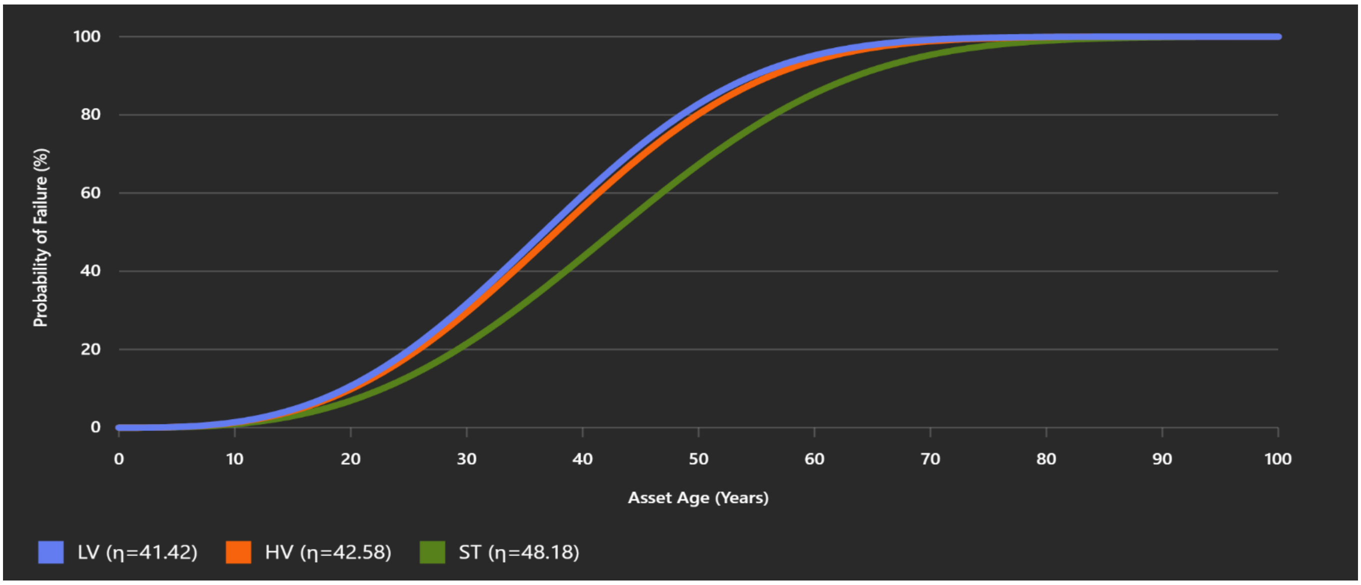
LV	HV	ST
41.42	42.58	48.18

Table 4 Model Eta Parameters

Shape Parameter (β – Beta) → 3

Forecasting Replacement Volumes

Weibull CDF curves for different shape parameters (β) with η = 41.42 years, plotted over 0–100 years:



Replacement volumes forecast by the mode between 2026 and 2031 by voltage are in Table 5 below.

Voltage	2026	2027	2028	2029	2030	2031	Total
LV	1965	1950	2202	2274	2527	2861	13779
HV	456	464	368	506	572	672	3038
ST	40	36	31	30	30	30	197
Total	**2461**	**2450**	**2601**	**2810**	**3129**	**3562**	**17013**

Table 5 Model Forecast Replacement Volumes

8. Risks

Consequences of Failure

The widespread presence of PTS in populated areas amplifies the potential impact of these events. These risks highlight the critical importance of proactive asset management and timely replacement of deteriorated components to prevent life-threatening incidents.

Health and Safety Risks

PTS support high voltage conductors. Mechanical failure can cause live conductors to fall or sag and potentially come into contact with people, vehicles, or other infrastructure. Such failure could create a high-risk environment where accidental contact with live wires could result in severe injury or fatality. Field personnel working near compromised structures are vulnerable, as are members of the public who may unknowingly walk into fallen conductors or energised structures.

Fire Start Risk

PTS failures can also lead to fire ignition, especially in rural or bushfire-prone regions. A falling conductor or broken crossarm can ignite fires that threaten lives, property, and the environment. Beyond the immediate physical damage, such events carry financial consequences under the regulatory F-factor scheme, which penalises networks for fire starts linked to asset failures and can carry significant penalties.

High Voltage Injection (HVI) and Property Damage

PTS failure can cause High Voltage Injection (HVI). This is where a PTS failure causes high voltage conductors to come into contact with low voltage conductors, resulting in dangerous voltage levels being transmitted into customer premises through LV systems. This can damage electrical appliances, pose electrocution risks, and lead to significant claims for property damage.

PTS Inspection and Replacement Program

A significant portion of the low voltage (LV) wooden crossarm population is currently operating beyond its expected asset life and many more will exceed their nominal lifespan of 45 years during the upcoming review period. As these assets continue to degrade, the volume of replacements required due to condition is expected to rise/

To manage this risk effectively, a continued and well-planned replacement program is essential. Without it, unexpected increases in deterioration may lead to unanticipated replacement volumes, placing pressure on resource allocation and disrupting operational efficiency. Continued investment in replacements ensures predictable planning, mitigates safety and reliability risks, and supports the efficient delivery of asset management objectives.

8.1 Pole Top Structure ACS Risks

8.1.1 Failures

Assisted Failures

Assisted in-service crossarm failure is the potential for third-party vehicles or trees impacting on crossarms, resulting in asset failure. An effective emergency management capability is maintained as a control to mitigate the risk associated with assisted failures. The risk of untreated assisted failures is rated high, as the likelihood of this occurring network wide is almost certain and the consequence is serious.

Unassisted Failures

Unassisted failures include the risk of crossarm failure during asset operation due to rot, rust or pole top fire Asset Performance Engineers assess whether a crossarm has experienced an unassisted failure via an investigation.

(refer Chapter 8 of asset inspection manual). The risk of untreated unassisted crossarm failures in considered high as the likelihood of this occurring network wide is almost certain and the consequence is serious. The asset inspection and replacement programs are primary controls placed against unassisted failures.

AFAP Risk Treatment

Upon treatment of the risk associated with both assisted and unassisted crossarm failures, in accordance with the requirements of the AFAP principle the residual risk is reduced from high to a moderate rating due to treated residual consequence being minor. This is achieved through application of a number of controls. One of the key controls is the asset inspection program. Mitigation of assisted failures in accordance with AFAP is dependent upon the effectiveness of the asset inspection program and timely replacement of crossarms of unacceptable condition.

8.1.2 Replacement Program Risks

The large population of LV wooden crossarms and insulators that were installed prior to 1980 and are entering the wear out phase could undergo an unexpected rapid increase in degradation. This would become apparent if greater numbers of crossarms were to fail inspection at increasing rates. This could pose a risk to delivery of an efficient pole top structure program due to issues with allocation of budget and resources. Timely replacement of crossarms of unacceptable condition is important to avoid unassisted failures and their associated consequences.

8.1.3 Model Risks

Modelling of crossarm failures has been conducted utilising Weibull analysis based on target probability of failure. Analysis indicates a large standard deviation in the longevity to replacement of the crossarm population. This indicates that crossarm durability against aging processes varies significantly across the population.

The model is used to predict replacements for a large population and replacement hence forecast replacements based upon the model should remain relatively predictable despite the large standard deviation. Residual life utilisation of the population of crossarms will always be efficient as crossarms are replaced based upon condition assessment.

Assumption of Distribution Shape

The Weibull model assumes a specific failure pattern (e.g., increasing failure rate with age if $\beta > 1$). If actual failure behaviour doesn't follow this pattern, forecasts may be inaccurate.

- Risk: Over - or underestimating replacements, especially in early or late years.

Ignoring External Factors

Historical data on removed steel crossarms is very small compared to the complete dataset. Material differences (wood vs. steel vs. concrete) are not captured unless modelled separately.

- Risk: Uniform model may misrepresent localized failure risks.

Static Parameters

Weibull parameters (λ and β) are often assumed constant over time. Maintenance practices, pole design, and installation quality may evolve over time.

- Risk: Forecasts may become outdated if parameters aren't periodically recalibrated.

8.2 Benefits

Continued replacement of pole top structures of unacceptable condition will drive more predictable safety and reliability performance of the network. The asset inspection program has been developed through years of engineering expertise and operational experience to balance network safety and performance against expenditure. Reductions in replacement volumes despite the presence of crossarms of unacceptable condition would either require assessment criteria to be changed or for crossarm replacements to be triaged.

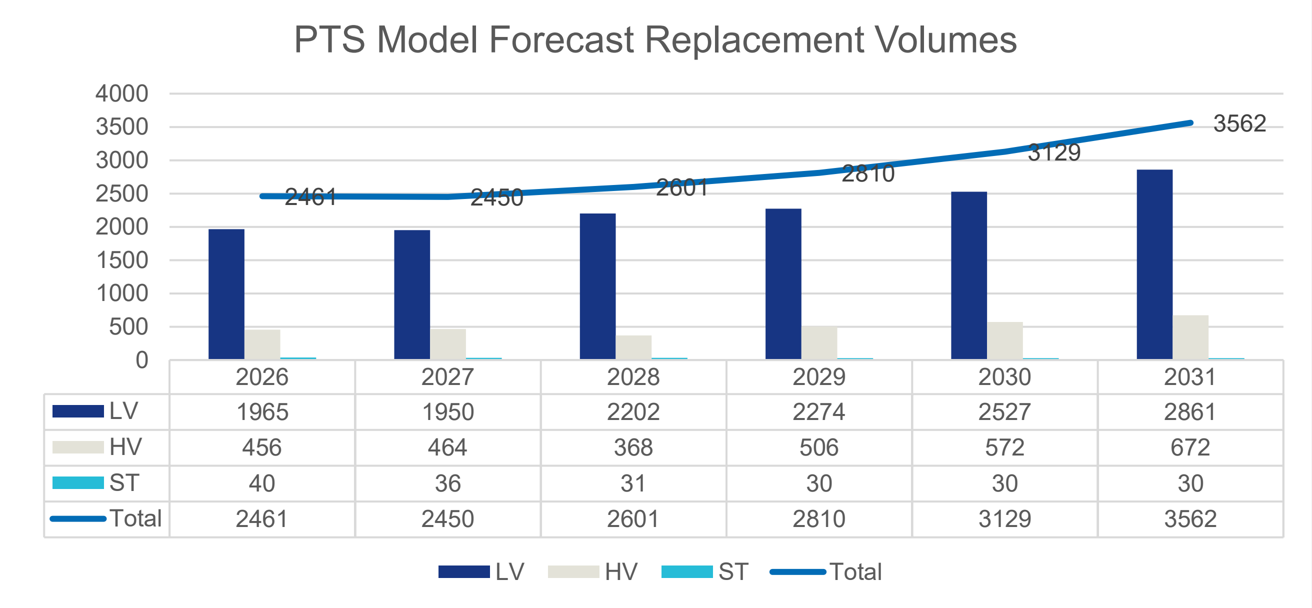
Such variation of approach could lead to unintended consequences, including inefficient asset management, potential damage to network or customer equipment, adverse safety outcomes and poor reliability. Ongoing replacement of crossarms of unacceptable condition will preserve the overall asset base condition, reduce the risk of unassisted failures, and support the safety and system security standards expected.

Timely replacement of pole top structures will also produce a network that is less likely to fail during adverse weather events that are expected to become more frequent and severe. The Victorian government released a network outage review following the 2024 February weather event that resulted in many customers off supply for a sustained period. One the key findings of this review was that a reliable electricity supply is an embedded function of essential services. A properly maintained network that is less prone to failure will lead to less adverse outcomes for society during such weather events.

9. Replacement Volume Expectations

9.1 PTS Replacement Model

The projected trend below in Figure 8 has been determined by the JEN PTS model which is based on historical replacement data of JEN crossarms and the required failure probability.



	2026	2027	2028	2029	2030	2031
LV	1965	1950	2202	2274	2527	2861
HV	456	464	368	506	572	672
ST	40	36	31	30	30	30
Total	2461	2450	2601	2810	3129	3562

Figure 8 PTS Model Forecast Volumes

The model trend in Figure 8 does not align with current regulatory period replacements in Figure 9 because PTS assets are replaced when inspections identify unsatisfactory condition. Replacement volumes are subject to variation as degradation processes are not linear. This approach enables extraction of the maximum practicable economic life from these assets.

The model estimates average replacement volumes based on the wear-out characteristics of JEN's PTS population. It does not predict exact year-on-year variation or pinpoint when an individual crossarm will fail. However, it does provide a reliable indication of the total number of crossarms requiring replacement across the population over time.

Despite the rigorous inspection program, replacing crossarms with deteriorating condition remains essential. An expectation of continued low replacement rates is not realistic, as continued degradation of these aging assets will drive higher replacement volumes. Deferring action would lead to significant safety and reliability risks. The high replacement activity observed in FY20 and CY21 signals the beginning of this trend.

9.2 Expected Replacement Volumes

Replacement volumes in Table 6 for pole top structures, primarily crossarms, are lower than those forecast by the Pole Top Structures (PTS) model. This deviation reflects JEN's asset and risk management strategy, which prioritises condition-based replacement informed by a rigorous inspection program rather than relying solely on asset age. This approach maximizes residual asset life while maintaining reliability and safety in accordance with AFAP principles.

However, replacement volumes driven by asset condition are expected to rise over the next regulatory period. This trend is largely due to the aging population of wooden crossarms, many installed between 1960 and 1990, which are now entering the wear-out phase and exceeding their nominal lifespan. The inspection program continues to provide valuable insights into asset condition, enabling Jemena to manage this emerging demand efficiently and proactively.

Historically, replacement volumes have been lower because JEN's rigorous inspection strategy has allowed early identification and remediation of issues, which enabled deferment of replacement and extension of asset life. As these assets now approach end of life and exhibit worsening condition, further deferral is neither prudent nor sustainable, as it would compromise safety and reliability. The forecast increase in replacement volumes represents a necessary shift from short-term remediation to long-term asset renewal, ensuring continued safety and network performance.

Forecast crossarm volumes and associated expenditure are presented in Figures 9 and 10. As outlined above, expected volumes are lower than modelled projections due to JEN's effective asset management approach, which leverages condition-based decision-making. Forecasts submitted through the RIN process are informed by a combination of modelling, asset population data, inspection outcomes, and engineering judgement. This integrated approach enables prudent and efficient management of the PTS asset class.

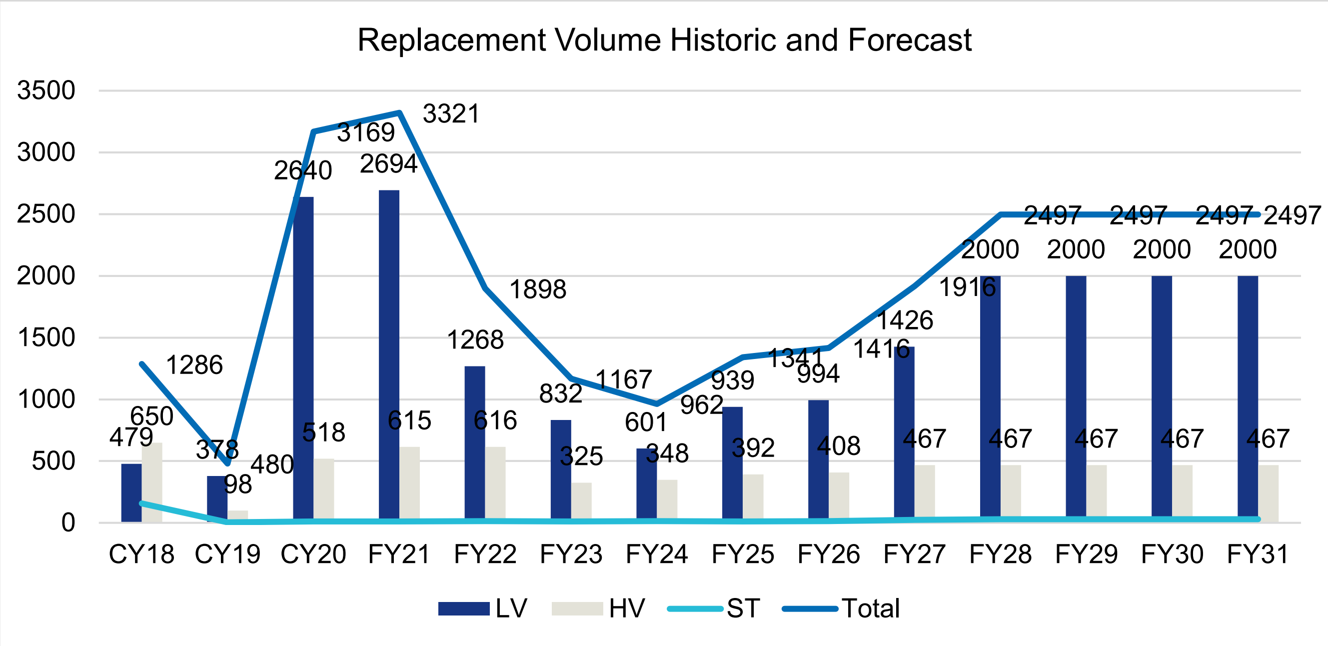


Figure 9 Replacement Volume Historic and Forecast

Pole Top Structures	Forecast Replacement Volumes by Financial Year					
	FY26	**FY27**	**FY28**	**FY29**	**FY30**	**FY31**
ST Insulators Replacement	7	10	10	10	10	10
HV Insulators Replacement	21	49	49	49	49	49
HV Crossarms Replacement	378	410	410	410	410	410
LV Crossarms Replacement	994	1426	2000	2000	2000	2000
ST Crossarm Replacement	7	13	20	20	20	20
Bird/Animal Proofing	19	18	18	18	18	18

Table 6 RIN Forecast PTS Replacement Volumes

10. Conclusion

A significant portion of JEN's wooden crossarms, particularly those in LV applications, are now exceeding their nominal service life and exhibiting condition-related deterioration. While LV crossarms dominate this aging cohort, a notable number of HV crossarms also remain in service. This concentration of aged assets stems from a period of rapid network expansion that occurred between 35 and 65 years ago. JEN's asset management strategy focuses on condition-based replacement rather than age-based intervention, enabling the extraction of maximum practicable life from pole top structures.

As degradation accelerates, inspection-driven replacement volumes are expected to increase. These volumes are inherently variable due to the non-linear nature of aging and deterioration. Inspection and timely replacement of crossarms in unsatisfactory condition are critical AFAP controls, mitigating risks such as electrocution and fire starts. The safety, reliability, and efficiency of the network are closely tied to the effectiveness of this inspection and replacement program.

The PTS forecasting model, developed using historical JEN data, estimates average replacement volumes over time. While forecast volumes are lower than model projections, this reflects the success of JEN's condition-based asset management approach. Forecasts are informed by asset data, inspection outcomes, engineering judgement, and operational experience, ensuring that replacement volumes remain both prudent and efficient.

Given the advanced age of many assets, the low replacement volumes observed during the current regulatory period are unlikely to continue. The increased activity in FY20 and CY21 signals the beginning of a sustained trend in higher replacement volumes driven by condition. Ongoing replacement of crossarms identified as unsatisfactory through inspection is essential to maintain the safe, reliable, and efficient operation of this critical asset class.

11. References

[1] Overhead Line Design Manual (ELE 999 OM DN 001)

[2] Distribution Construction Manual (ELE 999 OM CN 001)

[3] Electricity Distribution Asset Class Strategy (ELE-999-PA-IN-007)

[4] Asset Inspection Manual (JEN-MA-0500)