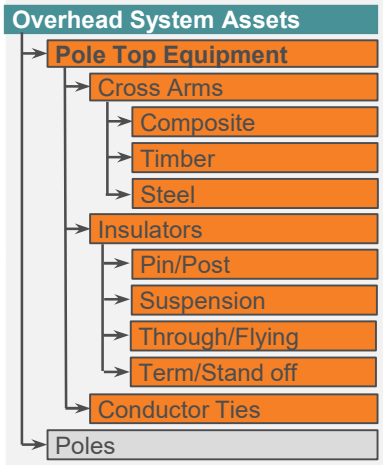
Pole Top Equipment Investment Case

Pole top equipment (PTE) is one of the most visible asset classes across Essential Energy's network and is a major contributor to cost, risk and performance. The primary components of PTE are crossarms, insulators and conductor ties, and their function is to insulate conductors and support/restrain them within a specific spatial envelope. This is to ensure the required clearance between the conductors or equipment and other objects is maintained in order to avoid inadvertent contact or unintentional discharge of electricity and bushfire starts.

Scope

This investment case addresses pole top equipment and the related ancillaries which directly support their installation, safety, and maintainability. This includes pole top equipment fitted to high voltage and subtransmission towers and privately owned poles.

The investment is required to meet the capital expenditure objectives (NER 6.5.7) for quality, reliability, safety and security of electricity supply and to meet regulatory and legislative obligations for Standard Control Services.



Forecast $FY24

The PTE forecast accounts for **20.67%** of the total Repex portfolio for FY25 to FY29.

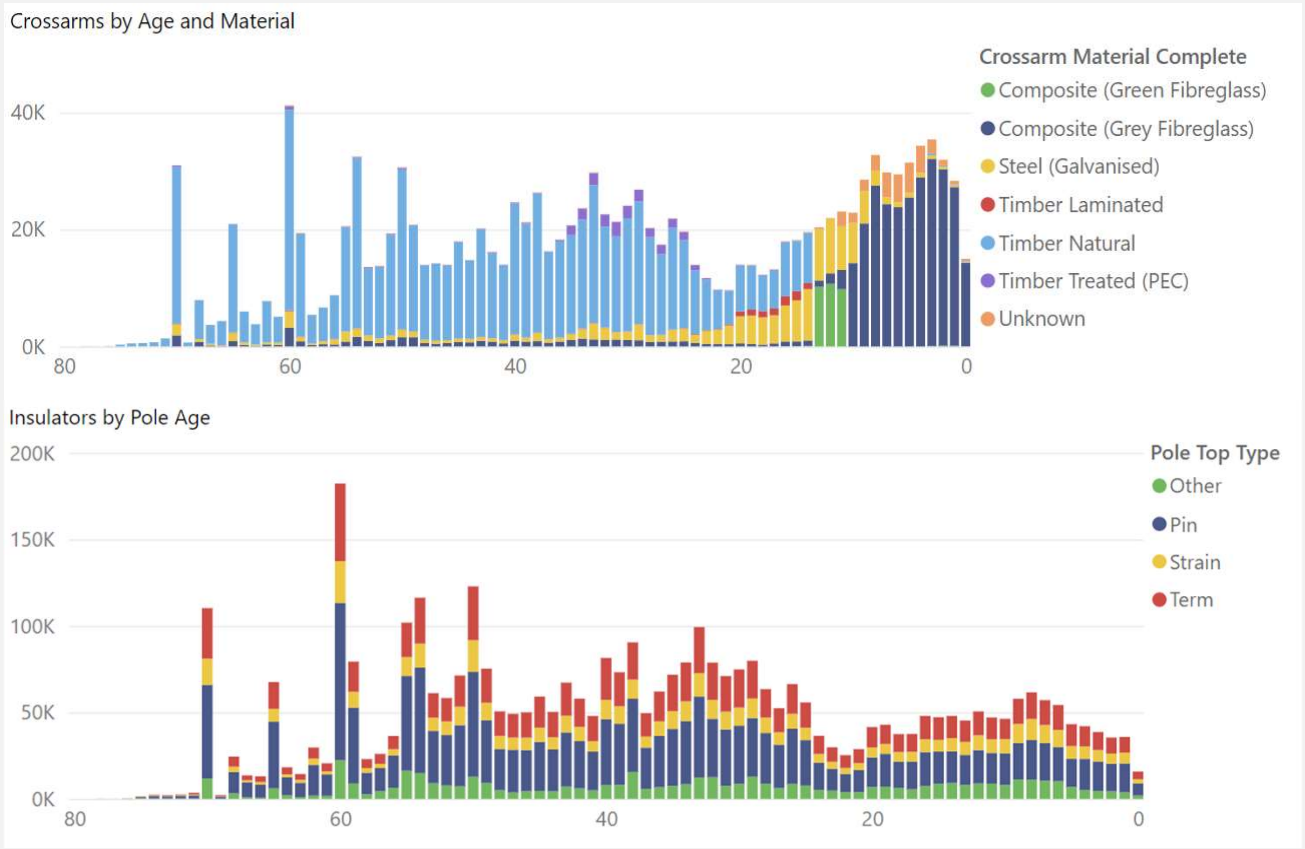
FY25	FY26	FY27	FY28	FY29
$46M	$46M	$46M	$46M	$46M

Asset Profile/Health

PTE replacements are frequently undertaken concurrently with the replacement of a pole or tower, and this has led to some historical under-reporting of PTE replacement numbers. Systems are being configured to allow improved delineation of PTE tasks vs Pole tasks in the future.

Due to the combination of asset volume, failure modes, and replacement costs, asset age has been used as a proxy for asset health for this asset class.

Crossarm Material Complete	Crossarms	Median of Crossarm Age
Composite (Green Fibreglass)	31689	12.15
Composite (Grey Fibreglass)	320639	5.67
Steel (Galvanised)	142955	17.57
Timber Laminated	11003	17.57
Timber Natural	783896	41.59
Timber Treated (PEC)	25848	30.98
Unknown	34772	6.31
Total	**1350802**	**31.08**



This risk section provides an overview of the PTE risk model. It is supported by documents **6.03.02 Network Risk Management Manual, 6.03.03 Appraisal Value Framework and 6.03.04 System Capital Risk and Value Based Investment** methodology.

Probability of Failure (PoF)

The failure modes for PTE have been identified through the Failure Mode Effects Analysis (FMEA) with subsequent analysis focusing only on those failure modes that can lead to a functional failure. Analysis of historical data from 2015 – 2019 identified ~169,000 asset replacements or interventions as either, asset failure, augmentation, or related asset failures.

The PTE risk model currently in use was calibrated using "unassisted" probabilities of failure. Weibull parameters used in the risk model are shown on the right.

Weibull Functional Failure Parameters

Material	Characteristic Life / Scale (η)	Shape (β)
Timber	256	2.05
Steel (galv)	350	2.2
Composite (Green)	450	2.2
Composite (Grey)	450	2.2
Timber (PEC)	89	4.39
Timber Laminated	70	2.79

Consequence of Failure (CoF)

The consequence from failure of PTE describes the impact of a functional failure. Consequences have been evaluated using the **6.03.03 Appraisal Value Framework**. Event Trees combining the likelihood of consequence and cost of consequence have been developed at an individual pole level to determine the key contributors to consequence criticality associated with each pole and the associated pole top equipment. The PTE consequence modelling has been developed using a combination of data where available and Subject Matter Expert (SME) elicitation where insufficient data was available. For PTE, consequences are determined using the following Value Framework categories. The consequence categories have been ranked based on consequence cost assuming all PTE, specifically crossarms, in the network will fail (i.e. Total Consequence).

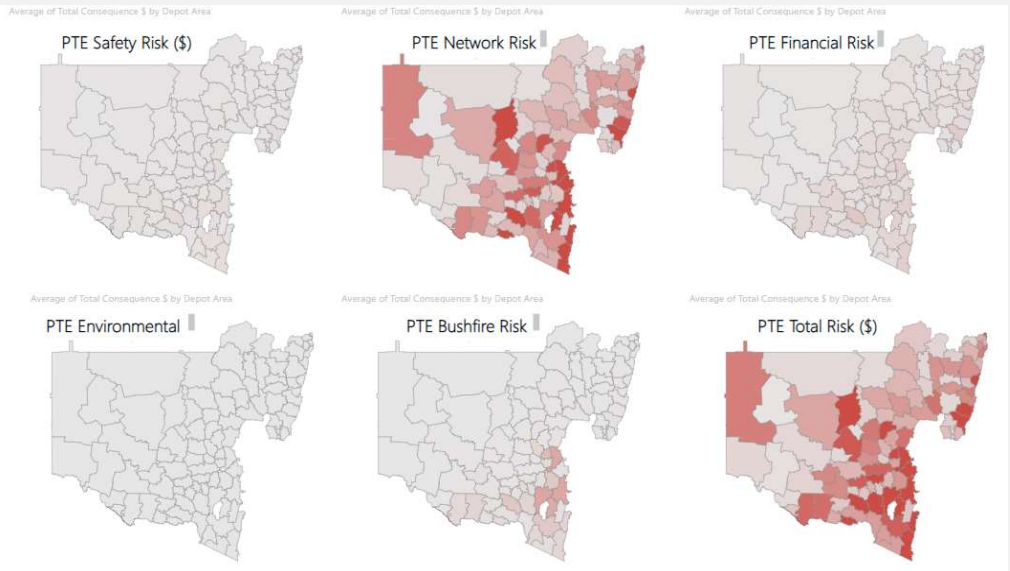
Value Measure	Consequence		
	Total $B	Average ($ per crossarm)	Median ($ per crossarm)
Network	$15.5	$13,138.3	$2,337.9
Safety	$8.2	$6,033.9	$6,543.5
Bushfire	$17.3	$12,699.6	$1,018.6
Environment	$0.001	$1.0	-
Financial	$0.4	$264.7	$225.3

Risk Calibration

Asset risk is calculated by applying the PoF and CoF models to individual assets. Asset risk is then aggregated to the total population level to determine the asset class risk.

Model outputs have been calibrated against top-down performance figures for **unassisted** failures. The table opposite compares the unscaled model outputs with the monetised top-down performance. For implementation, scaling factors are applied to risk model outputs, to align risk forecasts with realised performance.

Value Measure	Safety	Network	Bushfire	Financial	Total
Unscaled Model Outputs ($M)	0.9	16.0	3.2	1.3	21.6
Top-Down Performance ($M)	0.8	17.0	1.7	2.2	21.9



Risk Heatmap (Scaled)

The figure opposite displays the breakdown of the total and individual (residual) risk for PTE by depot area*.

The primary differentiators of criticality for PTE are Bushfire area consequence, and the network consequence associated with radial fed sub-transmission poles.

* As of August 2022

Minimum $0

Maximum >$400,000

Forecasting Approach

The replacement Capex forecast (FY25-FY29) has been calculated using Essential Energy's optimisation software (Copperleaf). It utilises a risk based methodology to maximise the value of the investment portfolio within constraints established by Essential Energy that are consistent with our Corporate Risk Framework, Asset Management System, applicable standards, rules, regulations and licence conditions. To assure efficiency our portfolio has been constrained to meet customer and stakeholder expectations.

In line with NER capital objectives, the objectives of our total replacement portfolio have been informed through extensive stakeholder engagement and consist of:

- Maintain reliability performance (network risk)
- Long term reduction of bushfire start risk by 20% over 20 years (2.5% FY25-29)
- Maintain safety performance

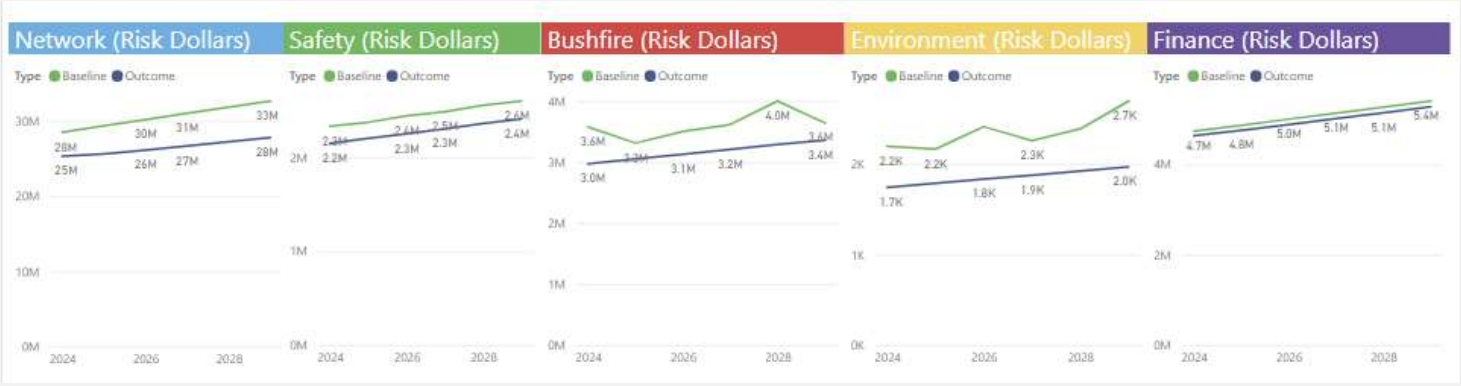
The replacement quantities of PTE consist of the sum of:

1. Forecast **conditional replacement** volumes
2. Forecast **functional failures** volumes
3. Optimised **risk-based replacements to maintain overall network risk values within defined objectives.**

The above asset interventions utilise a probabilistic approach that has been developed through detailed analysis of historical asset performance to establish Weibull parameters (refer 6.03.03.22)
The probabilistic method has been tested and validated against historic volumes to ensure that it is accurate at the population level.
Forecast investment expenditure has been determined by multiplying the forecast replacement quantities of PTE assets by applicable unit rates.
Refer to **6.03.04 System Capital Risk and Value Based Investment** methodology for details on the **portfolio** wide optimisation planning approach and risk outcomes, and **10.01.04 Capital Unit Rates** for unit rates.

Optimised Portfolio Outcomes

Risk Trend (2024-29 Optimised portfolio)
Over the 5 year regulatory window, total **baseline** monetised risk due to **functional** PTE failure is estimated to increase to $44.3M by 2030. The figure below depicts the **baseline** scenario and investment **outcomes** ($38.8M) of the optimised program for PTE.



Asset Grouping

The PTE assets have been grouped into three broad categories for investment optimisation purposes according to the different modes of replacement:

1. **Conditional** replacement - where an inspection has identified a defect that must be rectified in a predetermined timeframe by asset replacement;
2. **Functional** failure replacement - where the PTE is no longer able to perform its function due to damage and requires immediate replacement;
3. **Risk-based** replacement - e.g. The risk attributed to a crossarm through its combination of probability of failure and consequence of failure is high and replacement is the prudent action to reduce this risk. Assets within this risk-based replacement group have been included in the optimisation process where they will have reached Equivalent Annualised Cost (EAC) positive by FY34.

- 412,337 asset groups were loaded into 444 investments in Copperleaf to provide flexibility in portfolio optimisation.

Options

1. Pole Top Equipment replacement expenditure has been modelled on a replace with current company standard (composite) and PTE elements based on like-for –like replacements.
2. Risk based asset groupings are treated as additional optional investments for consideration in the total optimised portfolio to meet overall portfolio objectives.

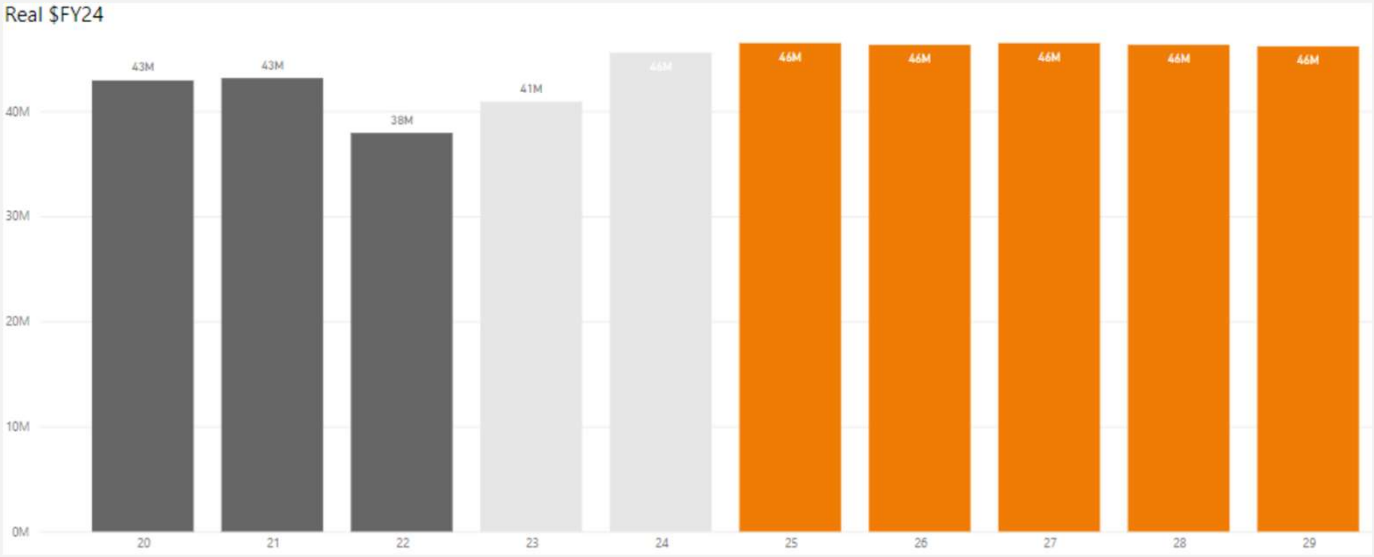
- Non-network solutions are considered when planning the replacement of a specific asset.

Forecast volume replacements shown in the graph below form the basis of the proposed expenditure. The anomaly in FY22 actuals is a result of under delivery due to significant weather impacts.

Due to the progressive roll out of composite crossarms, projections on conditional replacements are reducing into the future as there have been no unassisted failures of composite crossarms since introduction to Essential Energy's network.

Data source: Essential Energy modelling

Forecast replacement expenditure for Pole Top Equipment across the 2024-29 period is $231.8M, averaging $46.4M per annum. Actual and projected expenditure for the remainder of the 19-24 period is $210.5M.



Data source: Actuals: Internal delivery reports, Forecasts: Copperleaf
Note: All values are in FY2023-24 real dollar terms

Justification

We are confident that our approach delivers an efficient and prudent level of investment as:

- **Clear drivers from Asset Management Objectives** for Reliability, Quality, Safety and Compliance (as detailed in **Attachment 10.01 Strategic Asset Management Plan**).
- **NER Capex Objectives:** form the basis of our proposal
- **Review and moderation:** Our forecasts have been tested and reviewed by our executive management and the Board, subject to top-down challenges (as detailed in **6.03.04 System Capital Risk and Value Based Investment**) and the forecasts moderated based on feedback and discussion.
- **Customer needs:** Through customer engagement, refer Chapter 4 of our Regulatory Proposal, customers indicated a desire to maintain current levels of safety and reliability, and increase expenditure for resilience based projects. This asset class does not explicitly have expenditure related to resilience and therefore has a flat forecast for replacements. The investment will contribute to maintaining safety and reliability, within the wider Repex portfolio (as per Copperleaf forecast).

The major benefits from the proposed PTE investments (against the **change nothing** scenario) are:

- **Improved network risk**: reduce overall network risk through renewal of highest risk assets and reduce risk of bushfire starts.
- **Improved safety:** provide the required clearance between the conductors, equipment and other objects in order to avoid inadvertent contact or unintentional discharge of electricity and bushfire starts.
- **Maintained service level outcomes:** management of asset health will result in better control of unplanned failures thus will maintain network reliability.

Forecast PTE Repex expenditure for the 2024-29 period is $231.8M. The increase from 2019-24 actual/forecast of $210.5M is due to:

- increase in projected volume of replacements after a number of years of impacted delivery due to floods and fires.
- A small number of risk based replacements are included in the forecast to achieve overall risk targets for the portfolio.

Key Assumptions

Probability of Failure

- Probability of Failure Weibull parameters generated using survival analysis of historical data from 2015-2019
- Probabilities of failure for assets with small populations with very limited failure information are based on assets with similar material properties
- Due to inadequacies in historical record keeping for minor components, the assumed age of many crossarms and insulators has been based on the pole age

Consequence of Failure

- Developed in accordance with 6.03.03 Appraisal Value Framework

Risk Calculation

- Application of scaling factors for Safety, Network and Bushfire risk in line with actual performance data where available, in conjunction with SME input.

Strategic Direction

Lifecycle Stages

Acquisition

Selection Criteria

Crossarms. Composite is the default choice for standard installations. Steel or timber only in exceptional circumstances.
Insulators. Polymer or porcelain depending on pole top construction. Polymer avoided in areas with high rates of damage due to wildlife
Conductor tie. Preform or hand ties matched to conductor material

Procurement

Innovation. Continue to evaluate new products and solutions against EE's need.
Investigate opportunities to forecast procurement volumes based on population risk.

Emergency Holdings. Hold emergency pole top equipment stock levels across depots

Ops & Maintenance

Preventative Maintenance (Inspections):

Identification and categorisation of defects for immediate and future treatment as per CEOP2446 and CEOM7005:

Groundline inspection. Scheduled every 4.5 years to detect defects and monitor condition.

PSBI. Annually in bushfire priority areas.

Overhead Aerial Inspection

Aerial surveillance and LiDAR to monitor asset condition. Network wide timing under review by Digital Asset Management

Corrective Maintenance (Repairs):

Tighten hardware and address installation errors. Cleaning of insulators with contamination.

Breakdown Maintenance:

Pole Top equipment failures are rectified in accordance to CEOP8010. Replace broken asset and any dependent assets. i.e. Replace conductor ties when replacing insulators.

Interventions

Serviceability

Asset serviceability as per CEOP2446 and NAHC. Intervention options include:

- **Replacement** – New pole top component selected as per acquisition.
- **Modifications –** Changes that significantly slow the rate of degradation, such as anti-split bolts on crossarms to restore structural integrity.

Prioritisation

Interventions prioritised by defect severity and informally by asset criticality. Increased lead time for interventions decreases cost and reduces pressure on operational staff.

Replacement programs

Assets to be replaced on identification as per CEOM7094:

- PEC and laminate crossarms
- Cycloaliphatic insulators

Disposals

Individual Assets

Pole top Equipment is disposed of as per *CEOM7094.*

Reuse

Reuse pole top components as per CEOM7094 and Technical Brief 19-13 *Guide for Assessing Equipment for Reuse on our Network*

Entire Asset Variant

Develop disposal plan as per *CEOP8074* to ensure asset support systems and data is appropriately managed out of service.

Hazardous Materials

Disposing of Pole Top Equipment in accordance with *CECM1000.10 SSHE Manual: Waste*. This replacement is managed under the same disposal arrangement as PEC Poles.

Asset Support

	Current Approach	Actions
Process & Information	Data quality and availability gradually improving in preparation for EAM	Continue to enhance the utility of existing digital tools to develop use cases for new Enterprise Asset Management (EAM) system.
People & Training	Highly trained workforce with limited elasticity to match demand	Develop accurate long term maintenance forecast to ensure maintainers can be trained to be meet the future demand in a sustainable way.
Supply Chain	Crossarms – Ongoing review is required to manage single supplier risk.	Mitigate the supply risk for crossarms by maintaining a collaborative strategic partnership with current provider while continuing market engagement with other potential suppliers.