Cross-arm Replacements

Post Implementation Review

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DOCUMENT VERSION

Version Number	Change Detail	Date	Updated by
Draft V0.1	Draft	22/09/2023	Engineer Asset Strategy
Draft V4	Draft review post feedback	30/10/2023	Snr Engineer Asset Strategy
V1.0	Finalised	15/11/2023	Manager Asset Strategy

RELATED DOCUMENTS

Document Date	Document Name	Document Type
DEC 2018	EQL SASP AMP Pole Top Structures 21122018 Public Approved	PDF
NOV 2023	Risk Modelling - Weibull – Pole Tops v0.1	Docx & Excel
JUN 2023	RIN 2.2 Compare 2021-22 (Rosetta)	Excel
NOV 2019	Ergon 2018-19 - Category Analysis - RIN Response - Consolidated - 6 November 2019 - PUBLIC D19-174436(v2)	Excel
AUG 2023	Maintenance Activity Frequency (MAF) – Release 2	PDF
JUN 2023	Maintenance Acceptance Criteria (MAC) – Release 11	PDF
OCT 2023	Lines Defect Classification Manual	PDF
JUL 2023	Substation Defect Classification Manual	PDF
10/2023	Australian Government, Department of the Prime Minister and Cabinet (Office of Best Practice Regulation) – Best Practice Regulation Guidance Note - Value of a Statistical Life:	PDF
ND	Australian major natural Disasters.xlsx (a compendium of various sources)	Excel

1 SUMMARY

Title	Pole Top Structures – Crossarms – Post Implementation Review (PIR)
DNSP	Ergon Energy Network
Expenditure category	☒ Replacement ☐ Augmentation ☐ Connections ☐ Tools and Equipment ☐ ICT ☐ Property ☐ Fleet
Purpose	The purpose of this Post Implementation Review (PIR) is: • to evaluate the benefits of the increased volume of replacement for pole top structures, mainly crossarms, undertaken between 2018-19 and 2022-23. • to support the Ergon's capital expenditure over the ex post review period 2018-19 to 2022-23 via a cost benefit analysis.
Identified need	☒ Legislation ☒ Regulatory compliance ☒ Reliability ☐ CECV ☒ Safety ☒ Environment ☒ Financial ☐ Other 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, we have employed Net Present Value (NPV) modelling. This commitment is in line with their efforts to maximise the value for our customers. Ergon Energy observed that the replacement volume was tracking higher than expected. The improved replacement data confirmed an escalating replacement rate for pole top structures. This analysis revealed that even though we have declining number of defects since 2018-19, predominantly the step change in pole top structures replacement volumes is due to consequential replacements because of the pole replacement and overhead conductor programs, aimed at improving asset performance and operation efficiency result in cost effective replacement strategy. The increase in replacements within these programs has consequently led to an increase in the volume of pole top structure replacements. The justification for the increase is detailed on the respective PIRs. This PIR covers only the defective pole top structure replacement volume.
Alternate options	Four different options were considered as per following over the continuation of the counterfactual# (AER Final Determination - approx. 80% of actual defect): 1. Option 1 – Historical Volumes – Avg /yr (8,357/yr) 2. Option 2 – Actual Delivery + 50% - Avg 12,334/yr 3. Option 3 – Actual Delivery - 50% - Avg 4,112yr 4. Option 4 – Actual Delivery – Avg 8,535/yr. # - For modelling purpose only, the AER determination has been assumed as 80% of defect, more details in Appendix 1

Expenditure	This PIR relates only to defective including failed pole top structure crossarm replacement. Review and improved data analysis indicated that many crossarms are also replaced under other different programs such as defective pole replacement, targeted reconductoring, Clearance to Ground (CTG) and Clearance to Structure (CTS). The consequential investment, and their respective benefit is included in their respective PIR business cases.

Year $m, nominal	2018-19	2019-20	2020-21	2021-22	2022-23	Total
RIN Total	38.5	57.3	62.4	57.6	66.2	282.0
- Defect*	**17.8**	**21.7**	**19.9**	**20.6**	**25.6**	**105.6**
- Consequential (Pole & Reconductor)	20.7	35.6	42.5	37.0	40.6	176.4
(2022/23 real $)	21.0	25.4	22.5	21.6	25.6	**116.0**

** Expenditure considered for this PIR.*

Benefits	After a thorough evaluation of all available options, it has been determined that the 'Option 4 – Actual delivery' comprising 100% of defective crossarms replacements is the most cost-effective option. This option has been chosen over other options, as it provides the best balance of benefits, deliverability, and risks for the Ergon Energy. Option 4 provides a positive NPV of $100m and customer benefits of $117m compared to counterfactual option over a modelling period of 20 years. .

2 PURPOSE AND SCOPE

The purpose of this PIR is to review the increased expenditures and volumes related to pole top structure (crossarms) during the PIR period. This PIR covers only the defect-based replacements of crossarms. Consequential replacement investment and benefits related with other programs such as pole replacement and reconductoring are included in their respective PIR. The PIR also includes the analysis of different options, to ascertain efficiency and prudency through financial NPV modelling, considered to manage the asset and network performance and improve the risk to public safety and reliability of the network.

This document is to be read in conjunction with the Pole Top Structure Asset Management Plan.

3 BACKGROUND

Crossarms are the predominant asset in pole top structure expenditure and this document predominantly focuses on crossarms.

Crossarms are critical components of the Ergon overhead distribution network. Their integrity is critical for safety as well as for continuity of supply to deliver minimum services standards.

The step change in expenditure after 2018-19 required a review of increased expenditures and volumes and also to find improvement opportunity to ensure that our future programs are more accurate and based on informed decisions.

Accordingly, Ergon Energy continues, on regular basis, to review the current crossarm inspection and assessment processes and methodologies to ensure they align with industry best practice, were accurate and reliable, and will provide credible results consistent with expectations.

Ergon Energy wishes to assure itself, the regulator, and internal and external stakeholders that the crossarm asset management strategies proposed, provide value to the community and shareholders over time through the provision of safe and reliable networks and a more secure electricity supply for consumers in rural and regional Queensland.

As a result of the review, the quality of the collected field, population and failure data has improved. Coupled with a new asset modelling methodology using (the Weibull model) to predict the probability of failure, a reliable and prudent replacement program can be proposed.

3.1 Asset Population

In 2018-19 Ergon Energy had a total of 911,000 crossarms including 864,000 timber crossarms, as detailed in Figure 1 below. The age profile of timber crossarms reflects that 266,000 crossarms are over 35 years old. Composite crossarms were introduced in 2010 and can be seen to be increasing steadily.

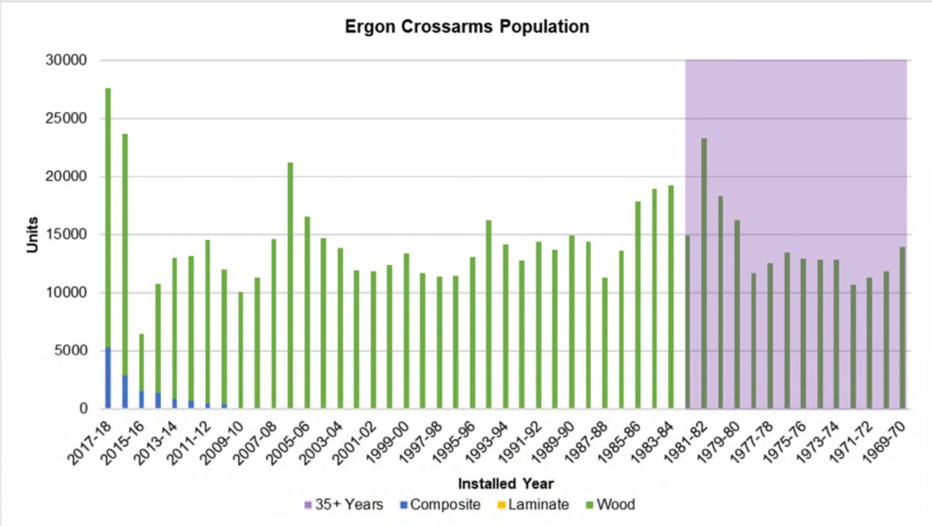

Figure 1: Crossarm Materials and Age Profile

3.2 Asset Management Overview

Crossarm replacements are mostly driven by well-established inspection programs which identify severe structural strength degradation. They are actively managed through a condition-based approach including:

- Visual inspection of physical condition from ground level
- Aerial visual inspection carried out from helicopters/aircrafts/drones.
- Pole top structures inspection carried out from elevated work platform or climbing.

Physically defective crossarms identified through inspection are replaced. They may also be proactively replaced based on risk. Proactive replacement is typically undertaken with other work such as feeder refurbishment programs or bundled into logical groups for efficiency of delivery and cost.

The current strategy is to transition away from wood crossarms in favour of alternatives such as composite crossarms.

3.3 Asset Performance

Two functional failure modes of crossarms defined in this model are found in Table 1:

Functional Failure Type	Description
Catastrophic (Unassisted failure)	• Loss of structural integrity of a crossarm, excluding any associated hardware or crossarm mounted plant, such that the residual strength of the crossarm required immediate intervention. • Functional failure of a crossarm asset under normal operating conditions not caused by any external intervention such as abnormal weather or human.
Degraded (Defects)	A crossarm asset deemed defective based on observed serviceability that if not rectified within a prescribed timescale (P0/P1/P2) could cause to an unassisted catastrophic failure.

Table 1: Description of Functional Failure

Identified defects are scheduled for repair according to a risk-based priority scheme (P0/P1/P2/C3/no defect). The P0, P1 and P2 defect categories relate to priority of repair, which effectively dictates whether normal planning processes are employed (P2), or more urgent repair works are initiated (P1 and P0).

Figure 2 displays the number of unassisted failures. There have been no reports of composite or steel crossarm unassisted failures. The main cause of defects is rot and decay, due to the high population of wood crossarms. The number of failures has been consistently around 300 per year for the last eight years with some yearly fluctuations. Notably in year 2020-21, the wet weather season caused increased level of rot in timber which led to elevated failure.

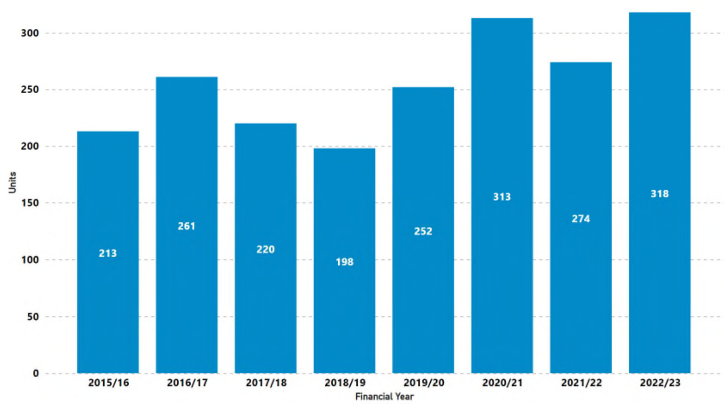

Figure 2: Crossarm Unassisted Failures

Figure 3 displays the number of crossarm defects since 2015-16 which shows that the number of crossarm defects per year had step up changes between 2016-17 and 2018-19. The reason for lower 2015-16 figure is due to missing data. However, after reaching a peak in 2018-19, the number declined slightly and stabilised at approximately 8,000 per year due to the introduction consequential replacements especially under conductor programs. However, the defects are still considered to be a level that is too high and is a matter of concern.

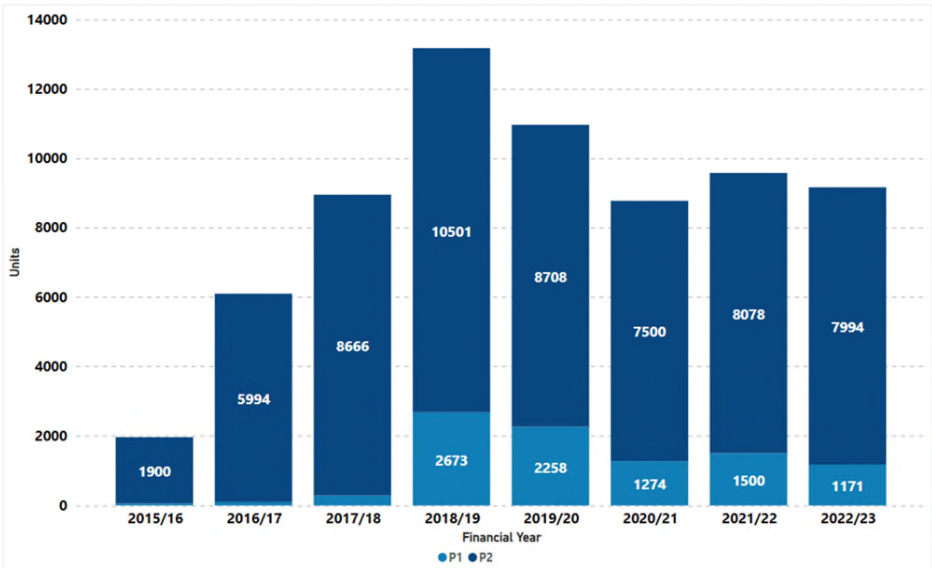

Figure 3: Crossarm Defects

4 RISK EVALUATION

Our cost-benefit analysis aims to optimize our risk calculation at the program level, so that we can maximize the benefits to our customers. After conducting a cost-benefit analysis using net present value (NPV) modeling, we will select the preferred replacement option based on the most positive NPV of the volumes considered. In the case of this PIR, the most positive NPV validates that the volume of replacement undertaken over the review period is a prudent approach.

The monetised risk is simply calculated as per the calculation in Figure 4.

Figure 4: Monetised Risk Calculation per Category

Ergon Energy broadly considers five value streams for investment justifications regarding replacement of widespread assets. These are shown in Figure 5. For crossarms, only four of the value streams are considered; the 'Export' is not material to crossarms.

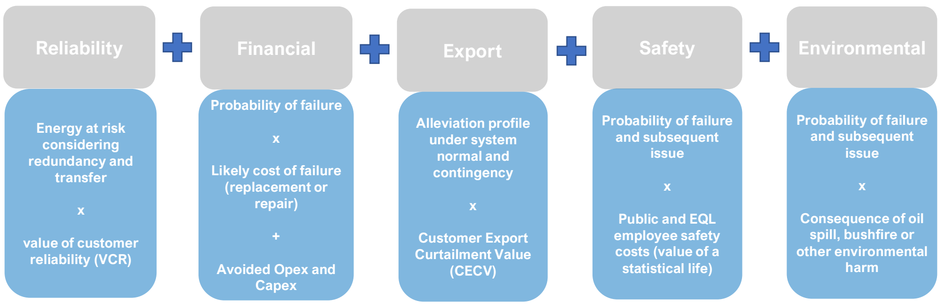

Figure 5: Total Risk Cost Calculation

4.1 Probability of Failure (Weibull Analysis)

Due to the limited or nil condition data available for the implementation of an Asset Health Index (AHI), the Weibull distribution model was utilised instead. The Weibull distribution is widely used due to its flexibility and ability to model skewed data. It's ability to work with extremely small number of sample (less than 20 samples) makes it the best choice, if not the best practice. By modelling the crossarm failures against the Weibull curve, the probability of failure (PoF) for each asset age group is derived.

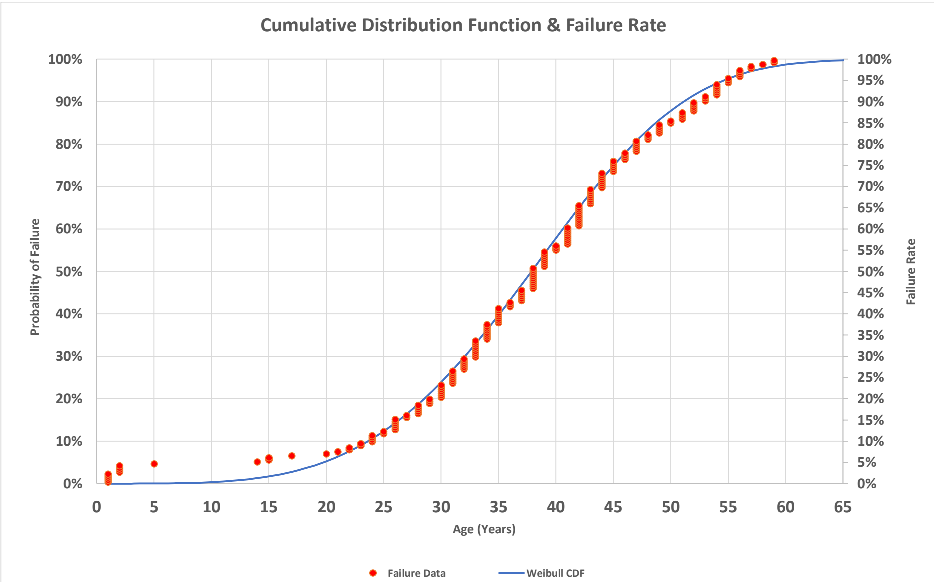

Figure 6: Ergon Crossarm Failures Plotted Against Weibull CDF Curve

The resultant curve produced the following characteristics:

Weibull Variables	Value
Beta β	4
Eta η	41.5

Table 2: CDF Weibull Variables

4.2 Consequence of Failure (CoF) and Likelihood of Consequence (LoC)

The key consequence of crossarm failures that have been modelled are reliability, financial, safety and environmental. The CoF refers to the financial or economic outcomes if an event were to occur.

The LoC refers to the probability of a particular outcome or result occurring because of a given event or action. To estimate the LoC, Ergon Energy has utilised a combination of historical performances and researched results. Ergon Energy has analysed past events, incidents, and data to identify patterns and trends that can provide insights into the likelihood of similar outcomes occurring in the future. Additionally, Ergon Energy also has conducted extensive research to gather relevant information and data related to the respective risk criteria such as bushfire.

To the extent possible the CoF and LoC are crossarm age band specific. This is particularly the case for the reliability and benefits stream, where the site-specific location and bushfire risk informs the benefits calculations for preventing unassisted crossarm failures.

4.2.1 Reliability

Reliability represents the unserved energy cost to customers of network outages and is based on an assessment of the amount of Load at Risk during three stages of failure: fault, initial switching and repair time. The following assumptions are used in developing the risk cost outcome for a crossarm failure:

Lost load: Each crossarm in our network is modelled individually, with the relationship developed between a crossarm and the pole and feeder/conductor that it is supporting. The historical average load on each feeder in our network is utilised to determine the kW that would on average be lost following a crossarm failure. We have utilised half of the historic average load on the feeder, which represents the most likely outcome, as the data regarding the exact electrical location of the crossarm in a feeder is not feasible to obtain as Crossarm is not an uniquely identified asset.

Load transfers and Restoration timeframe: The average loss of supply has been estimated for a period of average 4 to 9 hours based on locality, staged restoration approach, and historical data for outages/durations. This is based on the average load on our fleet of feeders, divided under 'Rural Short, rural long, urban, and sub-transmission.

Value of Customer Reliability Rate: We have used the Queensland average VCR rate.

Probability of Consequence: For modelling purpose, crossarm failures results in the conductor drop has been assumed to cause an outage to customers.

4.2.2 Financial

The Financial cost of failure is derived from an assessment of the likely replacement costs incurred by the failure of the asset and replaced under emergency. The same unit cost has been taken for replacement in both planned and unplanned circumstances. Historical average cost has been used for this purpose and is approximately $2,500.

4.2.3 Safety

The safety risk for a crossarm failure is primarily that a member of the public is in the presence of a fallen conductor which was caused by crossarm failure. This could result in a fatality or injury. For our modelling we have used *August 2022 published document from, Australian Government, Department of the Prime Minister and Cabinet (Office of Best Practice Regulation) – Best Practice Regulation Guidance Note - Value of a Statistical Life.*

- Value of a Statistical Life: $5.4m
- Value of an Injury: $1.35m
- **Disproportionality Factor:** 6 for members of the public
- **Probability of Consequence**: Following an unassisted asset failure in Ergon Energy, there is a 1 in 20 years chance of causing a fatality and 25 in 20 years chance of a serious injury based on historical data evidence. The average number of safety incidents has been derived by analysing 20 years of Significant Electrical Incident data comprising 26 incidents where unassisted asset failure has driven a safety incident of the appropriate severity.

Historically, the data shows, pole top structure has not been the cause of fatality, therefore the fatality incident due to a conductor asset unassisted failure has been considered for the modelling purpose.

4.2.4 Environment (Bushfire)

The value of a Bushfire Event consists of the safety cost of a fatalities and the material cost of property damage following a failed crossarm and conductor. For our modelling we have used:

- **Value of Bushfire:** $22.3m – which includes average damage to housing and fatalities following a bushfire being started. In Queensland *as per Australian major natural Disasters.xlsx (a compendium of various sources)*, there were 122 homes lost and 309 buildings lost during bushfires between 1990 and present (2021) across 12 significant fire records. Homes were estimated an average cost of $400,000 while the buildings were estimated at an average cost of $80k. The weighted average cost of bushfire consequence per pole top has been estimated as $2,295.
- **Safety Consequence of Bushfire -** Safety consequences are evaluated on same assumptions as safety incident consequence in 4.2.3 with a frequency of 0.5 per incident as there has been 6 fatalities recorded across those 12 bushfire incidents in Queensland.
- **Probability of Consequence:** Following the failure of a crossarm, we have estimated that there is a 0.0260 chance of causing a fire. This is based on a historical full year when there were 22 fires recorded due to electrical asset failures in Ergon Energy. In that year there were 114 pole failures, 265 cross-arm failures and 467 conductor failures that had potential to cause fire ignition, giving a probability of 0.0260 (22/846).
    - Also, bushfire consequence weighting and probability of containing/non-containing the fire has been incorporated into calculations along with % number of days considerations during no-forecast to extreme/catastrophic danger rating forecasts. A fire is also only considered to be possible if the conductor has dropped and made contact with the ground due to the failure of a pole top. In 2021, a total of 56 conductors dropped in the 274 failures recorded. Therefore a 20.4% factor has been considered as part of the probability of consequence.

Commented [GH1]: Might have questions from the AER on why 2021. Perhaps we could just say based on a full year's data? Would suggest if you have time to re-do later this year and see how different this is in in case they ask questions.

Commented [SC2R1]: We can do it year on year, but it takes time

Commented [GH3R1]: No worries, no need to do right now, I think we go with this, but look to do it in the coming months.

5 CONSEQUENTIAL REPLACEMENT

In addition to defective crossarm replacements, many crossarms are replaced because of pole and conductor replacement as it is considered delivery efficient to replace both pole and crossarm together in place of just replacing the pole and then dismantling and reinstalling the old crossarm. This is called the consequential replacement of crossarm and is undertaken wherever a pole or conductor is replaced. However, the cost and benefit associated with consequential replacements of pole or conductor replacements are excluded from this PIR and has been included in their respective PIRs.

The volume and cost of consequential cross arm replacement information covered under other PIR has been provided in Table 3.

Actual Delivery Volume Consequential Replacement	2018-19	2019-20	2020-21	2021-22	2022-23	Total
Pole Program	6,690	9,714	7,719	8,619	8,445	41,187
Reconductoring Program	1,033	1,645	3,197	5,373	4,431	15,679

Table 3: Consequential Replacement with Pole and Reconductoring Programs

6 IDENTIFIED NEED

6.1 Problem Statement

From 2015 onwards, Ergon Energy experienced consistently high level of unassisted crossarm failures. As a result, we reviewed our asset management practices with respect to crossarms. Additionally, a significantly higher volume of replacements was observed during the review period.

This PIR looks back at this level of replacement and evaluates the benefits to customers from these replacements. Other options that would have been available at the time are identified and benefits evaluated and compared to demonstrate the prudency of our approach.

The purpose of this PIR is to ensure that we delivered the maximum benefits to customers through ensuring the right level of investment was undertaken to efficiently limit the reliability, safety, environmental and financial risks from pole failures.

6.2 Compliance

Ergon Energy's crossarm assets are subject to a number of legislative and regulatory obligations.

- The Electrical Safety Act 2002 (Qld) s29 imposes a specific duty of care on a prescribed Electrical Entity to ensure that its works—
  - are electrically safe; and
  - are operated in a way that is electrically safe.
- The duty includes the requirement that the electricity entity inspects, tests and maintains the assets and works.

The Electrical Safety Regulation 2013 details requirements for electric lines, specifically about safety clearances, of which crossarms are classed as associated equipment. These include various general obligations related to the safety of works of an electrical entity. The desired level of service for crossarms in the Energy Queensland network is to achieve in-service crossarm failure numbers which deliver a safety risk outcome which is considered SFAIRP, and as a minimum, maintains current performance standards.

6.3 Counterfactual Analysis (Base case)

To provide a comparison of the potential alternatives to our actual delivery for our cost benefit analysis, we have set the counterfactual to AER final determination final budgets/volumes for replacement program estimated using final determination pole top structure allowance divided by actual unit cost.

To estimate the total replacement volume from the AER final determination budget allocation, we have applied the unit cost to derive the number. When we exclude the consequential replacements to obtain defect only volume, the estimation resulted in 20% of actual defect volume. This limited 20% defect value is then applied in risk cost benefit analysis and the evaluation delivered an unrealistic outcome for benefits in all intervention options, refer Appendix 1. Therefore, for modelling purpose we have adopted the 80% actual defect in this counterfactual option.

6.3.1 Costs/Volumes

Ergon Energy continued with counterfactual option, the actual volume and expenditure is shown in the table below:

Year	2018-19	2019-20	2020-21	2021-22	2022-23	Total
$m, nominal	17.22	20.81	19.10	19.98	24.60	101.72
Volume	8,209	8,876	7,749	8,346	7,933	41,113

Table 4: Counterfactual Option Replacement Costs/Volumes

6.3.2 Risk Quantification

Figure 7 provides the results of a quantitative forecast of emerging risk associated with pole top structure failure. The risk increases substantially as the counterfactual AER allowance enables delivery of only 80% of defective crossarm replacements. On the remaining unattended 20% defects, a minimum of 2% is assumed to result in an unassisted failure.

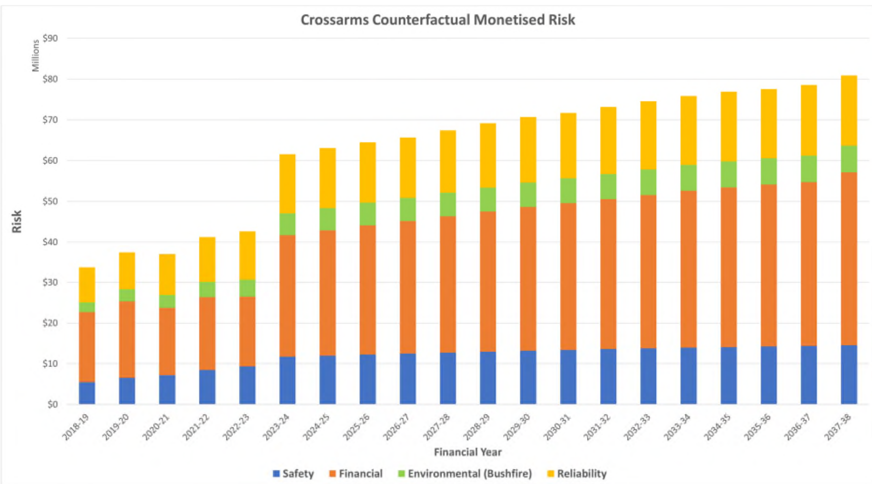

Figure 7: Counterfactual Quantitative Risk Assessment

Figure 8: Counterfactual Unassisted Failures

Figure 8 represents the failure forecast where the rate continues to rise slightly due to 20% unattended defects.

7 OPTIONS ANALYSIS

In assessing the prudency of our actual delivery, we have compared a range of interventions against the counterfactual (AER final determination) to assess the options that would have maximised value to our customers. We have sought to identify a practicable range of technically feasible, alternative options that would have satisfied the network requirements in a timely and efficient manner.

7.1 Option 1 – Historical Volumes

This option assumes continuation of replacements of defective and failed switches as per historical approach with volumes estimated on the basis of last three years replacements prior to PIR period, this is estimated to be very close to current defect rate excluding consequential replacement volumes.

7.1.1 Cost/ Volumes

The cost and volumes under this option has been provided in Table 5 below.

Year	2018-19	2019-20	2020-21	2021-22	2022-23	Total
$m, nominal	17.48	19.56	20.60	20.04	26.00	103.68
Volume	8,331	8,341	8,359	8,370	8,383	41,785

Table 5: Option 1 Replacement Costs/Volumes

7.1.2 Risks/Benefits

In this option, our modelling shows the assets performing slightly better than. Accordingly, this option is a minimum essential program to be continued in addition to consequential replacements as this option is very close to actual delivery.

7.2 Option 2 – Actual Delivery +50%

This option is equivalent to the 'Actual Delivery' replacement program plus 50% targeted replacement. It is evident with a increase in replacement volume leads to a reduction of safety, financial and reliability risk.

7.2.1 Cost/ Volumes

The cost and volumes under this option has been provided in Table 6 below.

Year	2018-19	2019-20	2020-21	2021-22	2022-23	Total
$m, nominal	25.84	31.21	28.65	29.97	36.90	152.58
Volume	12,314	13,314	11,624	12,519	11,900	61,671

Table 6: Option 2 Replacement Costs/Volumes

7.2.2 Risks/Benefits

Under this approach our modelling has indicated that this option provides better customer benefits (safety and reliability), compare to counterfactual option, and reduce the failures make a substantial impact in asset performance. Additionally, this option provides the transition toward performance improvement, but not without moderate impact on budget and resources. However, the benefits overweigh this minor impact to the program.

Considering transition towards improving the performance we have decided to implement more targeted replacement in future regulatory program to delivery benefits to customer and community.

7.3 Option 3 – Actual Delivery -50%

This option is equivalent to the 'Actual Delivery' replacement program minus 50% defective replacement.

7.3.1 Cost/ Volumes

The cost and volumes under this option has been provided in Table 7 below.

Year	2018-19	2019-20	2020-21	2021-22	2022-23	Total
$m, nominal	8.61	10.40	9.55	9.99	12.30	50.86
Volume	4,105	4,438	3,875	4,173	3,967	20,558

Table 7: Option 3 Replacement Costs/Volume

7.3.2 Risks/Benefits

Under this option our cost/benefit analysis has indicated that this worse than counterfactual as it leaves 50% of defect unattended. The asset failures will start to increase similar to counterfactual approach justifying this is not an option Ergon Energy would consider.

7.4 Option 4 – Actual Delivery – Selected Option

This option is the actual delivery of all defective pole top structure replacements within the PIR period.

7.4.1 Cost/ Volumes

The cost and volumes under this option have been provided in Table 8.

Year	2018-19	2019-20	2020-21	2021-22	2022-23	Total
$m, nominal	17.8	21.7	19.9	20.6	25.6	105.6
Volume	8,418	9,095	7,978	8,586	8,184	42,262

Table 8: Option 4 Replacement Costs/Volumes

7.4.2 Risks/Benefits

Under this option, our modelling shows that unassisted in-service failures are projected to improve compare to counterfactual. This option is the most effective choice for maintaining close to the current failure rate and maximizing customer benefits.

While it is accurate that this option does requires more resources and investment than the counterfactual, the benefits for customers outweigh any potential drawbacks of this extra cost. It's considered essential to maintain the same level of investment as a minimum in the future to continue improving customer benefits, to maintain close to the current failure rate and avoid the need for a significant increase in near-term investments.

8 OUTCOME OF OPTION ANALYSIS

8.1 Crossarm Failure Forecast

The pole top structure failure forecast for all main options is shown in Figure 9 below. As stated, the counterfactual option and option 3 in which a volume of defects is left unattended would lead to elevated failures.

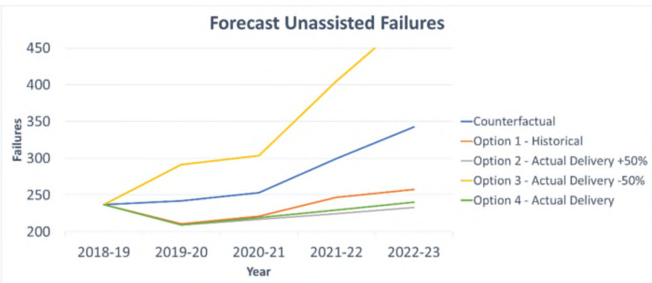

Figure 9: Unassisted Failures Forecast

8.2 Economic Analysis

The NPV of cost benefit analysis of the options is summarised in Table 9 which demonstrates the following:

- Option 2 and 4 – Additional targeted replacement and Actual Delivery, compared to all options provides the best investment to benefit scenario.
- Option 3 provides negative NPV against counterfactual as this option leaves approximately 50% of defects unattended.
- Option 1 provide similar result to 'Actual Delivery' with marginal underperformance in both NPV and customer benefits areas justifying Ergon Energy should continue with business-as-usual suggesting replacing all identified defects as per Option 4.

NPV Analysis to Counterfactual				
Intervention	Rank	Net NPV	Additional Cost	Benefit
Counterfactual	4	$0	$0	$0
Option 1 - Historical	3	$84,666,582	-$16,013,806	$100,680,388
Option 2 - Actual Delivery +50%	2	$98,239,585	-$53,628,529	$151,868,114
Option 3 - Actual Delivery -50%	5	-$151,308,901	$25,243,580	-$176,552,481
Option 4 - Actual Delivery	1	$100,796,075	-$16,829,095	$117,625,170

Table 9: NPV Analysis

Table 10 below summarises the volume replacements for all options.

Intervention Volume	2018-19	2019-20	2020-21	2021-22	2022-23
Counterfactual	8,209	8,876	7,749	8,346	7,933
Option 1 - Historical	8,331	8,341	8,359	8,370	8,383
Option 2 - Actual Delivery +50%	12,314	13,314	11,624	12,519	11,900
Option 3 - Actual Delivery -50%	4,105	4,438	3,875	4,173	3,967
Option 4 - Actual Delivery	8,418	9,095	7,978	8,586	8,184

Table 10: Replacement Volume

Figure 10 illustrates the advantages of all options over their counterfactual and confirms option 4 and option 2 being optimal option for the community.

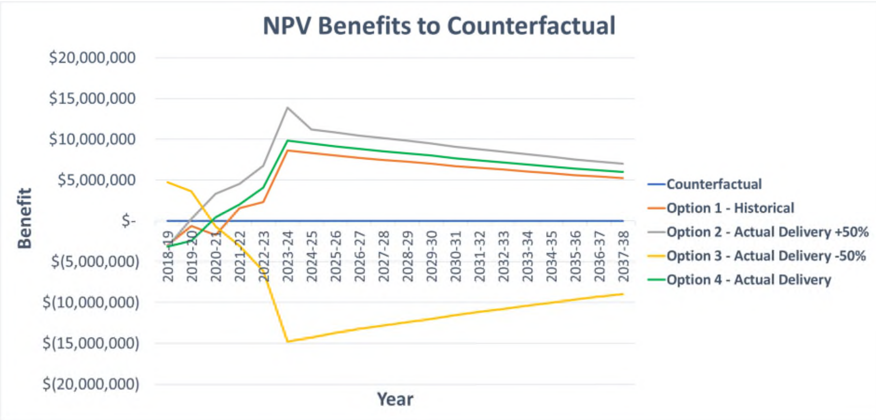

Figure 10: NPV Benefits

The analysis presented here compares the options to their respective counterfactual alternatives.

Criteria	Option 1 – Historical Volumes	Option 2 - Actual Delivery +50%	Option 3 - Actual Delivery -50%	Option 4 - Actual Delivery (**Selected**)
Net NPV	$84m	$98m	-$151m	$101m
Investment Risk	Med	Med/High	Low	Med
Benefits	High	Very High	Low	High
Delivery Constraint	Low	Med	Low	Med
Detailed analysis – Advantage	• Customer benefit of 100m • Low impact on delivery requirement • Maintains current asset performance.	• Customer benefit of 151m • Best asset performance option • Customer benefit outweigh the additional investment • Best option for transitioning towards improving the asset performance.	• Do minimum scenario • Saving of $25m investment.	• Customer benefit of $117m • Maintain current level of service • Best optimum option for customer benefit against investment requirement.
Detailed analysis – Disadvantage	• Additional investment of $16m • Not an option to improve asset performance.	• Additional investment of $53m • Additional resource requirement.	• Additional risk of $176m • Leaving 50% of defect unattended • Failure and defect increase • Requiring long term investment • Not a sustainable option.	• Additional investment of $17m • Not improving asset performance.

Table 11: Options Analysis Scorecard

9 SUMMARY

We have assessed and modelled four feasible options that we could have undertaken over the review period from 2018-19 to 2022-23 period. To ensure that the analysis is robust and comprehensive.

- The modelling confirms that the total investment in defective pole top structure replacements of $105.6m provided a positive NPV benefit compared to the counterfactual option of the AER's forecasted volume replacement.
- Detailed quantitative risk analysis for the options where defects were left unattended has shown an escalating trend of expected asset failures and defect leads to increasing customer safety and reliability risks. The risk reduction value over the next 20 years of undertaking this program is $117m. This equates to around NPV of $101m including asset failure reduction, demonstrating the value of the total program for our customers.

It is noted that the modelled result for Option 4 shows that pole top structure performance is likely to maintain close to the current level.

However, it is evident in Option 2 - Counterfactual +50% that by introducing a program to target specific defective crossarms on top of the counterfactual program, further reduction in failures and an improvement in asset performance is expected. This option will be considered as proposed option in the following regulatory period to target an improvement in asset performance.

9.1 Sensitivity

To further test the effectiveness and prudency of the preferred option, a number of sensitivity analysis criteria have been applied, with ± 25% values, to compare the outcomes of the modelling in different scenario. The main sensitivity criteria are:

- Annual Risk cost
- Weighted Average Capital Cost (WACC)
- Probability of Failure (PoF).

In most of the sensitivity analysis outcomes, the Actual Delivery option has been demonstrated as the most prudent option.

10 CONCLUSION

The Actual delivery option is reflective of our commitment to provide maximum customer benefit. It provides a tolerable risk position which balances the achievement of our asset management objectives and customer service levels and ensures a sustainable level of investment.

It is also recommended to introduce targeted replacements in the future regulatory period as per Option 2. Incidental replacements are not continuous and will be dependent on the pole and conductor replacement programs. By implementing targeted replacement, not only will it produce a positive NPV when compared against its equivalent total volume replacement counterparts, it will also improve customer benefits through improved safety and reliability and reductions in in-service failures.

APPENDIX 1: COST BENEFIT ANALYSIS – AER FINAL DETERMINATION

To estimate the total replacement volume from the AER final determination budget allocation, we have applied the unit cost to derive the number. When we exclude the consequential replacements to obtain defect only volume, the estimation resulted in 20% of actual defect volume. This limited 20% defect value is then applied in risk cost benefit analysis and the evaluation delivered an unrealistic outcome for benefits in all intervention options as set out in the Table below. Therefore, it has been decided to ignore this estimation and for modelling purpose the 80% actual defect is considered.

The below table is the outcome of cost benefit analysis when counterfactual option is considered as delivering only 20% of the defect. This option result in leaving 80% of defect unattended leading to elevated risk in network, and recurring unattended defects year on year deliver unrealistic benefits when all the intervention options compared against this counterfactual AER final determination option.

NPV Analysis to Counterfactual				
Intervention	Rank	Net NPV	Additional Cost	Benefit
Counterfactual	5	$0	$0	$0
Option 1 - Historical	3	$1,813,678,337	-$72,376,044	$1,886,054,381
Option 2 - Actual Delivery +10%	1	$1,855,870,653	-$80,616,824	$1,936,487,477
Option 3 - Actual Delivery -10%	4	$1,653,110,997	-$64,638,562	$1,717,749,558
Option 4 - Actual Delivery	2	$1,851,852,566	-$73,256,940	$1,925,109,506