Business Case
Pole Top Structures Replacement

ERGON ENERGY NETWORK

Executive Summary

The intent of this replacement expenditure is to comply with regulatory obligations, maintain service delivery performance, including customer reliability standards and customer quality standards, and maintain the safety of the network for all the regional Queensland community.

Pole top structures' condition and failure consequence risks (safety, customer reliability, environmental and business) are regularly assessed through asset inspection and defect identification processes. Specific pole top structure replacements are managed as part of the defect replacement programs.

Ergon Energy aims to minimise expenditure in order to keep pressure off customer prices, however understands that this must be balanced against critical network performance objectives. These include network risk mitigation (e.g. safety, bushfire), regulatory obligations (e.g. safety), customer reliability and security and preparing the network for the ongoing adoption of new technology by customers (e.g. solar PV). In this business case, safety and customer reliability are strong drivers of the need for this work.

Ergon Energy has around 1.5 million pole top structures in service, over 280,000 of which are more than 35 years old. The expected service life of such assets is 25-35 years. The in-service failure of pole top structures can result in customer outages and present major safety risks to staff and the public. As such, it is important that aged assets, and those in poor condition, are replaced proactively to reduce the risk of in-service failure.

Two options have been considered as follows:

- Counterfactual: Historical Replacement Volumes – Defect Based
- Option 1: Defect Plus Proactive Replacement Program (Proposed)

Detailed quantitative risk analysis has shown an escalating trend of expected pole top failures for the counterfactual case and customer safety and reliability risks increase over time.

The quantified economic value of the risks exceeds the costs of a significant replacement program as in Option 1 and as such Option 1 provides a preferable NPV to the counterfactual.

The proposed Option 1 also provides the least regret value of all options. This option includes a total proposed program of 80,545 pole top structures to be remediated at a total estimated cost of $142M for the 2020-25 period, in $2018/19.

Note that all figures are expressed in 2018/19 dollars and apply only to costs incurred within the 2020-25 regulatory period for the preferred option.

Regulatory Proposal	Draft Determination Allowance	Revised Regulatory Proposal
$142M	Unknown	$142M

Contents

1. Introduction

This program is targeted at remediation of pole top structures to comply with regulatory obligations, maintain service delivery performance, including customer reliability standards and customer quality standards, and maintain the safety of the network for all the regional Queensland community.

Pole top structures' condition and failure consequence risks (safety, customer reliability, environmental and business) are regularly assessed through asset inspection and defect identification processes. Specific pole top structure replacements are managed as part of the defect replacement programs. Some additional replacements occur through a proactive program targeting poles, conductor and associated pole top equipment.

1.1 Purpose of document

The purpose of this document is to outline the forecast volumes of replacement and expenditure associated with pole top structures in accordance with the lifecycle management strategies detailed in the Asset Management Plan (AMP). This document also provides a summary of replacement scenarios as well as the impact in terms of performance and cost to demonstrate prudence and efficiency.

This is a preliminary business case document and has been developed for the purposes of seeking funding for the required investment in coordination with the Ergon Energy Revised Regulatory Proposal to the Australian Energy Regulator (AER) for the 2020-25 regulatory control period. Prior to investment, further detail will be assessed in accordance with the established Energy Queensland investment governance processes. The costs presented are in $2018/19 direct dollars.

This document is to be read in conjunction with the *AMP - Pole Top Structures* which contains detailed information on the asset class, populations, risks, asset management objectives, performance history, influencing factors and the lifecycle strategy.

1.2 Scope of document

The scope of this forecast expenditure includes all pole top structures proposed to be replaced under the various capital replacement programs including Condition and Risk as well as Reactive programs as outlined in the Regulatory Proposal document and in accordance with the forecast volumes presented in the Reset Regulatory Information Notice (RIN) template.

1.3 Identified Need

Ergon Energy aims to minimise expenditure in order to keep pressure off customer prices, however understands that this must be balanced against critical network performance objectives. These include network risk mitigation (e.g. safety, bushfire), regulatory obligations (e.g. safety), customer reliability and security and preparing the network for the ongoing adoption of new technology by customers (e.g. solar PV). In this business case, safety and customer reliability are strong drivers of the need for this work.

Ergon Energy has around 1.5 million pole top structures in service, over 280,000 of which are more than 35 years old. The expected service life of such assets is 25-35 years. The in-service failure of pole top structures can result in customer outages and present major safety risks to staff and the public. As such, it is important that aged assets, and those in poor condition, are replaced proactively to reduce the risk of in-service failure. This proposal aligns with the CAPEX objectives and criteria from the National Electricity Rules (NER) as detailed in Appendix C.

1.4 Energy Queensland Strategic Alignment

Table 1 details how this proposal contributes to Energy Queensland (EQL) corporate and asset management objectives. The linkages between these Asset Management Objectives and EQL's Corporate Objectives are shown in Appendix D.

Table 1: Asset Function and Strategic Alignment

Objectives	Relationship of Initiative to Objectives
Ensure network safety for staff contractors and the community	Diligent and consistent operations and maintenance of pole top structures supports asset performance and therefore safety for all stakeholders. Asset failure of pole top structures may result in safety hazards.
Meet customer and stakeholder expectations	By reducing the risk of in-service failure, reliability of the network service will be improved and safety of staff and public improved.
Manage risk, performance standards and asset investments to deliver balanced commercial outcomes	Failure of pole top structures can result in increased public safety risk and disruption of the electricity network. Asset longevity assists in minimising capital and operational expenditure.
Develop Asset Management capability & align practices to the global standard (ISO55000)	The AMP and this justification statement are consistent with ISO55000 objectives and drive asset management capability by promoting a continuous improvement environment
Modernise the network and facilitate access to innovative energy technologies	This justification statement promotes replacement of assets at end of economic life as necessary to suit modern standards and requirements. Innovation in the lifecycle management of pole top structures has a significant potential to deliver ongoing efficiencies through the use of technology because of the high volume and geographic spread of these assets. Inspection technologies are a particular focus of opportunity.

1.5 Applicable service levels

Corporate performance outcomes for this asset are rolled up into Asset Safety & Performance group objectives, principally the following Key Result Areas (KRA):

- Customer Index, relating to Customer satisfaction with respect to delivery of expected services
- Optimise investments to deliver affordable & sustainable asset solutions for our customers and communities

Corporate Policies relating to establishing the desired level of service are detailed in Appendix C.

Under its Distribution Authority, Ergon Energy is expected to operate with an 'economic' customer value-based approach to reliability, with "Service Safety Net Targets" for extreme circumstances. These are intended to mitigate against the risk of low probability and high consequence network outages. Safety Net targets are described in terms of the number of times a benchmark volume of energy is undelivered for more than a specific time period. Ergon Energy is expected to employ all reasonable measures to ensure it does not exceed minimum service standards (MSS) for reliability, assessed by feeder types as

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

Both Service Safety Net Targets and MSS performance information are publicly reported annually in the Distribution Annual Planning Reports (DAPR). MSS performance is monitored and reported within EQL daily.

1.6 Compliance obligations

Table 2 shows the relevant compliance obligations for this proposal.

Table 2: Compliance obligations related to this proposal

Legislation, Regulation, Code or Licence Condition	Obligations	Relevance to this investment
QLD Electrical Safety Act 2002 **QLD Electrical safety Regulation 2013**	We have a duty of care, ensuring so far as is reasonably practicable, the health and safety of our staff and other parties as follows: • Pursuant to the Electrical Safety Act 2002, as a person in control of a business or undertaking (PCBU), EQL has an obligation to ensure that its works are electrically safe and are operated in a way that is electrically safe.[1] This duty also extends to ensuring the electrical safety of all persons and property likely to be affected by the electrical work.[2]	This proposal sets out a plan to proactively replace aged and poor-condition assets in order to reduce the risk of in-service failure of pole top structures and the associated safety risks.
Distribution Authority for Ergon Energy issued under section 195 of *Electricity Act 1994* (Queensland)	Under its Distribution Authority: • The distribution entity must plan and develop its supply network in accordance with good electricity industry practice, having regard to the value that end users of electricity place on the quality and reliability of electricity services. • The distribution entity will ensure, to the extent reasonably practicable, that it achieves its safety net targets as specified. • The distribution entity must use all reasonable endeavours to ensure that it does not exceed in a financial year the Minimum Service Standards (MSS)	This proposal helps to maintain the reliability of service to customers by reducing the risk of in-service failure of pole top structures which can result in customer outages.

[1] Section 29, *Electrical Safety Act 2002*
[2] Section 30 *Electrical Safety Act 2002*

1.7 Limitation of existing assets

The existing population of pole top structures in service within Ergon Energy is predominantly cross arms, as shown in Figure 1. By the end of the 2020-2025 regulatory period, over 450,000 of the pole top structures will have exceeded the upper limit of a 35-year design life. This age profile presents a high likelihood of failure within the overall population.

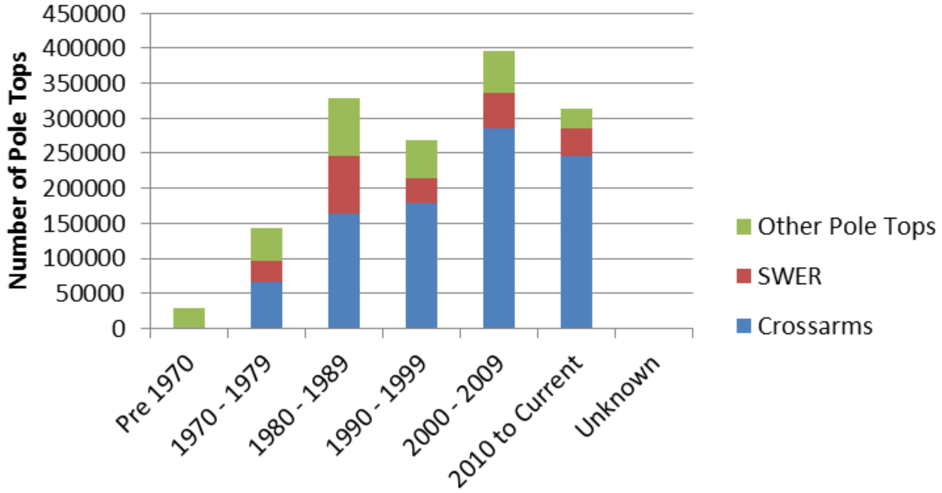

Figure 1: Pole top structures asset population – Ergon Energy

There are a number of factors that limit the life of cross arms, which make up the majority of the population. These are detailed in Table 3.

Table 3: Life-limiting factors for cross arms

Factor	Influence
Age	• Deterioration of strength over time. • Wood cross arm splitting due to age.
Environment	• Outdoor, corrosive or coastal environments, ultra-violet radiation, high rainfall areas, and environmental factors such as lightning, resulting in degradation of the cross arm and other pole top components. • Wood cross arms are susceptible to termite attack, fungal fruiting bodies, rot and decay, and splitting due to weathering. • Environmental influences make composite cross arms more prone to tracking and blooming. • Steel and other pole tops metallic hardware are susceptible to corrosion.
Design	• Wood cross arm design can result in burning due to leakage currents – leakage mitigation such as gang nail plates are used to reduce this issue. • Laminated wood cross arms present a greater risk of premature failure due to their design. Delamination leads to rot forming between laminations. • Composite cross arm tracking and blooming issues resulting from environmental influences detailed above have been mainly associated with first generation cross arms. Design of the second-generation cross arms has reduced this issue. • Weld cracks compromise strength in steel cross arms and other pole tops metallic hardware.

The historical data for pole top structure failures can be used as a guide for forecast failure rates. The details of failures since 2012 can be seen in Figure 2.

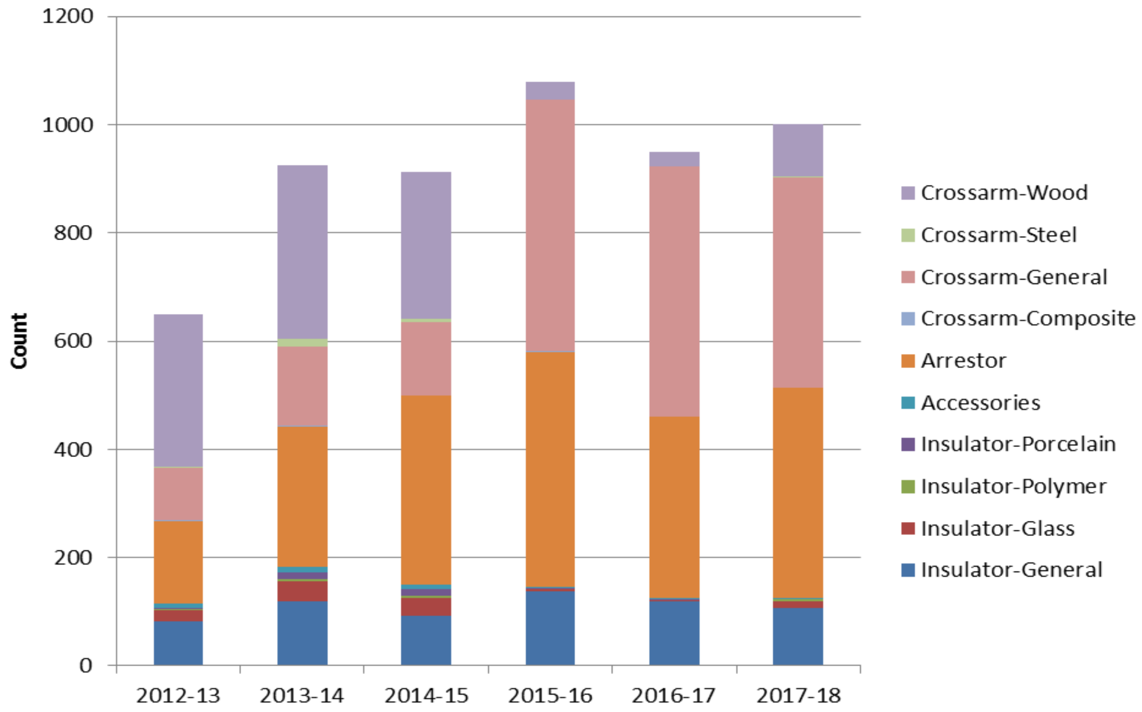

Figure 2: Historical pole top structure failure count by component – Ergon Energy

While the number of failures of cross-arms has increased in recent years, the number of cross arm related Dangerous Electrical Events (DEEs) has remained consistent, as shown in Figure 3. Insulator failure DEEs have shown some improvement. DEEs are defined in legislation as circumstances involving a high voltage asset, where a person would not have been electrically safe had they been exposed to the event. EQL assigns DEEs into two categories as follows:

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

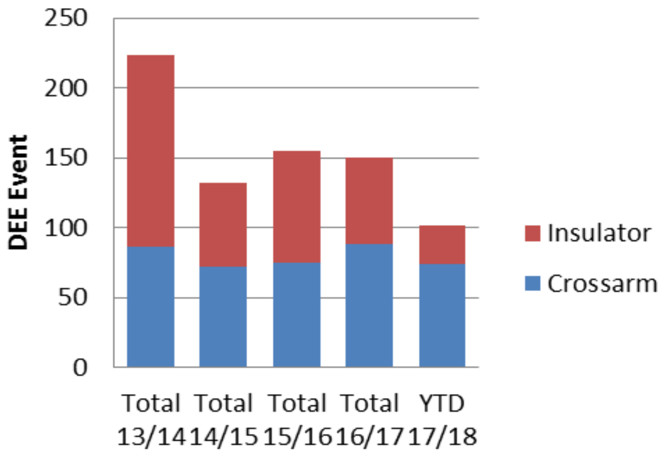

Figure 3: Unassisted cross arm related DEEs – Ergon Energy

Since 2003/4, 2 Serious Electrical Incidents (SEIs) related to cross arms have occurred as a result of these DEEs. The rate of cross arm related DEEs going forward is not reduced So Far as Is Reasonably Practicable (SFARIP) and as such an increase in the replacement works is required in order to meet Ergon Energy’s duty of care under the Electrical Safety legislation.

2 Counterfactual Analysis

2.1 Purpose of asset

Pole top structures refer to the structures, insulators, and hardware at the top of a pole that support and position conductors and other pole top equipment such as air break switches. Cross arms are predominately used as part of the pole top. Some pole top designs utilise insulators and steel brackets directly attached to the pole instead of cross arms. Transformer platforms, surge arrestors, and raiser brackets also form part of the pole top structure. Raiser brackets are treated in a similar fashion to cross arms for the purposes of maintenance.

2.2 Business-as-usual service costs

The business as usual (BAU) service costs for these assets are the inspection and replacement costs associated with ongoing operations. In addition to these costs, significant emergency response and replacement costs are incurred when failures occur.

2.3 Key assumptions

The counterfactual case is considered to be where pole top structures are replaced upon identification of a defect, or upon failure. The defect identification process aims to replace assets in poor condition prior to failure and is subject to continuous process improvement.

The planned replacement volumes are based on historical replacement volumes and are set out in Table 4.

Table 4: Forecast[3] pole top structure replacement volumes Counterfactual

	20/21	21/22	22/23	23/24	24/25
Forecast Volume	14,162	14,162	14,162	14,162	14,162

The volumes would be replaced on a like-for-like basis, except wooden or laminated cross arms, which would be replaced with composite cross arms (as per AMP). This proposed program results in an increase in the risk profile over the 2020-25 period, due to the increase in the number of aged pole top structures (those over 35 years old). The risk in subsequent periods is forecast to escalate significantly if replacement volumes remain at the historical levels.

2.4 Risk assessment

Figure 4 provides the results of a quantitative forecast of emerging risk associated with Ergon's pole top structure asset population failure due to condition related failure modes. This counterfactual risk is based on known failure rates now and escalated failure rates based on current trends.

[3] Based on EQL Justification Statement 2019 - Defect Volumes

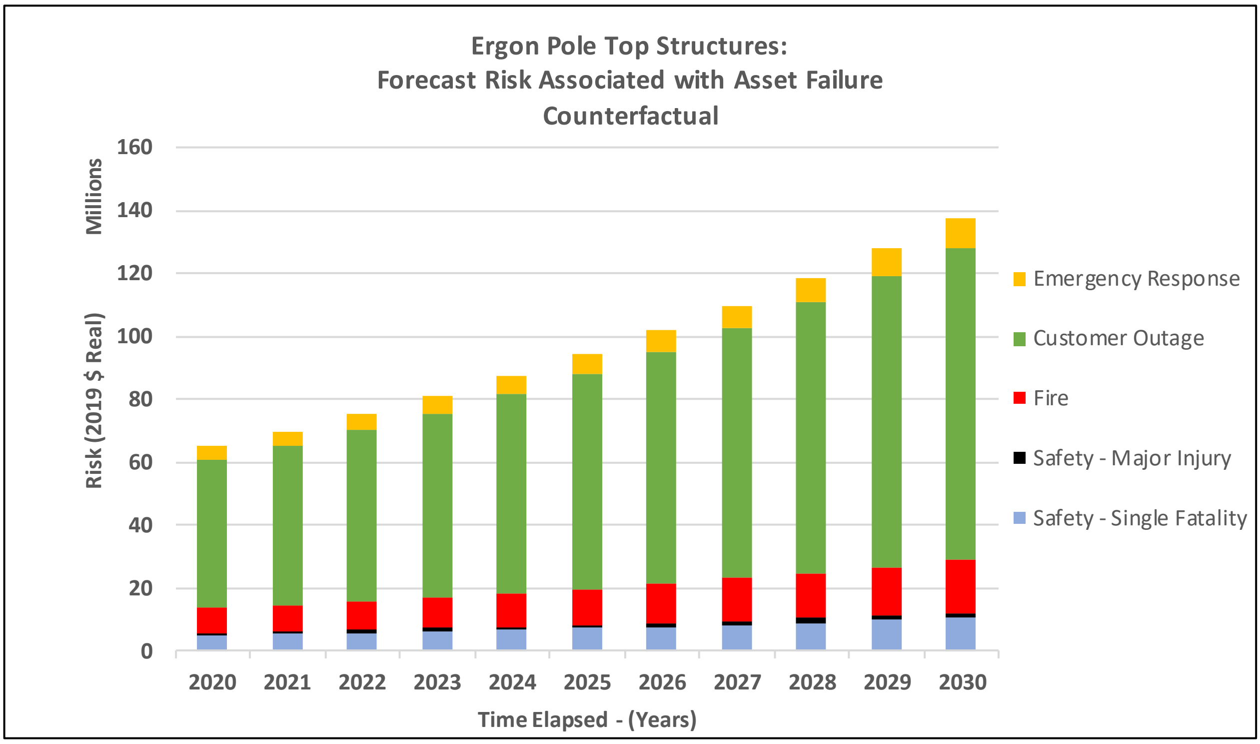

Figure 4: Quantified Risk for Pole Top Structures Counterfactual

Significant risk costs arise in the counterfactual, due to customer outages, safety and fire risks. The cost of these risks increases substantially over the 10-year period shown, driven mainly by the age profile of the existing population and expected failure rate increases in the absence of increased remediation.

A semi-quantitative risk assessment has also been conducted in accordance with the EQL Network Risk Framework and the Risk Tolerability table from the framework is shown in Appendix F. Given the increase in failure rates over time in the counterfactual case, the following risks have been considered for the end of the regulatory control period, i.e. 2025, when the failure rate will be at its highest within the period.

Table 5: Counterfactual risk assessment

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Failure of pole top structure leads to live conductors coming into contact with circuit or system, causing a **customer interruption >3 hours**.	Customer Impact	2 *(Customer interruption <3hrs)*	5 *(Very Likely)*	**10** ***(Low)***	2025
Failure of pole top structure leads to live conductors hanging low or falling to the ground and member of public or staff contacting live conductor resulting in a **single fatality**.	Safety	5 *(single fatality/ incurable fatal illness)*	3 *(Unlikely)*	**15** ***(Moderate)***	2025
Failure of pole top structure leads to live conductors falling to the ground, sparking a bushfire and **medium-term disruption to ecosystem**	Environment	4 *(medium term disruption to ecosystem)*	2 *(Very Unlikely)*	**8** ***(Low)***	2025

This presents a level of safety risk that has not been reduced SFAIRP and as such the counterfactual case is not considered to be a viable option. Further details of the risk ratings and descriptions can be found in Energy Queensland’s Network Risk Framework. Further to this the service performance could put at risk the MSS targets should failure rates significantly increase.

2.5 Retirement or de-rating decision

Pole top structures provide a critical function in supporting conductors and as such retirement of the structures is unfeasible. De-rating is not an available option.

The replacement assets used are based on the current standards for this equipment. For crossarms, these include mainly composite and steel cross-arms depending on the circumstances. In all regions, aged Low Voltage (LV) network timber crossarms are now replaced with either composite crossarms or removed entirely; by replacement with Aerial Bundled Cable (ABC) construction (full rollout of ABC is limited by cost associated with related pole replacements). Specific designs are being developed to facilitate the rollout of composite crossarms across the entire High Voltage (HV) network. In this way timber cross-arms are being progressively retired and replaced with longer-life alternatives. In the longer term this should reduce ongoing failures, and replacement rates.

3 Options Analysis

3.1 Options considered but rejected

Age-based replacement, of all pole top structures over 40 years of age, was considered but rejected due to the large volumes (around 300,000 over the 2020-25 regulatory control period). This option would be prohibitively expensive and would replace many cross arms which do not show any sign of defect. Resourcing for this approach would also not be feasible and hence this approach is not deemed to be practicable in relation to reducing risks in line with the principles of SFAIRP.

It should also be noted that higher proactive replacement volumes will provide increased positive NPV results compared to the counterfactual. This reflects the ageing population of pole top structures and the increasing failures. Higher volume options have not been proposed in this business case, to maintain a balance between cost and risk. It is likely that higher replacement volumes will be required in future periods based on increasing failure rates.

3.2 Identified options

3.2.1 Network options

Option 1 – Defect Remediation at increased replacement volume (Proposed Option)

Ergon Energy has several programs that make up the overall Pole Top program.

- A reactive replacement approach results in a proposed forecast program of replacement of 11,947 pole top structures per annum, resulting in an annual estimated CAPEX cost of $19.4 million.
- Conductor and poles are proactively replaced through targeted programs which result in the proactive replacement of some pole top structures. The criteria used for pole top replacement identification is priority based, considering assets with the highest likelihood of in-service failure and presenting the highest risk in the event of in-service failure. Pole tops are also replaced as part of clearance-to-ground and clearance-to-structure replacement programs, where the cheapest engineering solution can include pole top reconfiguration. These combined targeted approaches contribute an additional average estimated replacement volume of 4,054 pole top structures per annum with annual estimated CAPEX costs of $7.7 million.
- An additional 540 66kV pole top structures are required for the 66kV feeder M028 (Childers – Degilbo – Gayndah) replacement project. This project is detailed in a standalone business case. The pole top structure apportionment is included in Table 6.

The defect identification process aims to replace assets in poor condition prior to failure and is subject to continuous process improvement. For example, recent defect classification changes are expected to result, in future, in a reduction in pole top defects related to laminated cross arms and pin insulator corrosion, and these changes have been catered for in the proposed forecast replacements.

The planned replacement volumes are set out in Table 6. It should be noted that this program is a conservatively low estimate of expected volumes, due to increases in pole replacements forecast using the revised pole strength algorithm and noting that pole replacements drive cross-arm replacement volumes[4].

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[4] Cross-Arms are generally replaced as part of every pole replacement job

Table 6: Forecast pole top structure replacement volumes Option 1

	20/21	21/22	22/23	23/24	24/25	Total
Forecast Volume	16,001	16,271	16,271	16,001	16,001	80,545
Cost ($M)	$28.1	$28.2	$29.0	$29.4	$27.1	$141.9M

The volumes will be replaced on a like-for-like basis, except wooden or laminated cross arms will be replaced with composite cross arms (as per AMP). This proposed program results in a moderate increase in the risk profile over the 2020-25 period, due to the increase in number of aged pole top structures. However, the safety risk is reduced compared to the counterfactual case. The risk in subsequent periods is forecast to escalate significantly if replacement volumes remain at the proposed levels. The issue of sustainability is being addressed in a staged approach in order to deliver balanced outcomes and avoid over-investment. Under this option the forecast failure rate is expected to rise from approximately 1,000 to approximately 2,100 by 2030, indicating that a larger program will be required in future periods to address the ageing population.

3.2.2 Non-network options

During the course of the 2020-25 regulatory control period, Ergon Energy will continue to investigate technology-based techniques to monitor condition and alternatives to like-for-like replacement such as the use of distributed generation, batteries and isolated grids in order to mitigate the risk in rural areas by retiring some existing aged assets. This may be feasible for larger groups of assets; however, it is unlikely to be effective for individual pole top replacements.

3.3 Economic analysis of identified options

3.3.1 Cost versus benefit assessment of each option

The Net Present Value (NPV) of each option has been determined by considering costs and benefits compared to the counterfactual over a 20-year period, using EQL's standard NPV analysis tool.

The forecast associated NPV for the options are outlined in Table 7. The Regulated Real Pre-Tax Weighted Average Cost of Capital (WACC) rate of 2.62% has been applied as the discount rate for this analysis (as per EQL's Standard NPV Tool).

The Net Present Value (NPV) of Option 1 is +$14M compared to the counterfactual and as such is the preferred option.

Table 7: NPV analysis of options

Option	NPV ($M)	PV of costs	PV benefits
Option 1: Defect remediation at Increased Volumes (proposed)	$14M	-$23M	$37M
Counterfactual: Defect Remediation – Historical Volumes	$0	$0	$0

3.4 Scenario Analysis

3.4.1 Sensitivities

A range of sensitivities on this analysis have been conducted as shown in Table 8. The sensitivities tested include the Weibull parameters (failure rates), Cost of Consequence (CoC), and Probability of Severity (PoS). While two sensitivities result in the counterfactual having a better NPV, Option 1 remains the preferred option.

Table 8: Sensitivity analysis variables and results

Sensitivity	Baseline	Applied Parameter	Preferred Option	Relative NPV of Preferred Option 1
Weibull β (Low)	5	4.5	Option 1	$15M
Weibull β (High)		5.5	Option 1	$8M
Weibull η (Low)	95	93	Option 1	$7M
Weibull η (High)		97	Counterfactual	-$6M
Pole Top unit rate (Low)	$1,762	$1,400	Option 1	$41M
Pole Top unit rate (High)		$2,100	Counterfactual	-$11M
CoC single fatality (Low)	$49M	$45M	Option 1	$14M
CoC single fatality (High)		$54M	Option 1	$14M
PoS single fatality (Low)	0.03%	0.01%	Option 1	$12M
PoS single fatality (High)		0.05%	Option 1	$16M

3.4.2 Value of regret analysis

In terms of selecting a decision pathway of 'least regret', Option 1 presents an economically efficient, balanced approach to investment by targeting replacement works based on asset criticality and assessed condition and reducing risk to the greatest extent without bringing forward unnecessary expenditure. The key regret in this analysis is the possible fatality of a member of the public due to a pole top failure. The risk costs associated with the fatality risk are shown in Table 9.

Table 9: Risk costs in each option

Option	Fatality Risk Cost 2021 ($M)	Fatality Risk Cost 2030 ($M)	Total 2021-2030 Fatality Risk Cost ($M)
Option 1: Defect remediation at Increased Volumes (proposed)	5.2	10.2	74
Counterfactual: Defect Remediation – Historical Volumes	5.3	10.4	76

The proposed option 1 provides a lower risk cost compared to the counterfactual and remains the preferred option.

3.5 Qualitative comparison of identified options

3.5.1 Advantages and disadvantages of each option

Table 10 details the advantages and disadvantages of each option considered.

Table 10: Assessment of options

Options	Advantages	Disadvantages
Option 1: Defect remediation at Increased Volumes (proposed)	• Replaces pole top structures with highest risk of failure, i.e. those with defects • Replacements focussed in high-risk areas to achieve maximum impact • Expenditure is in line with available resources • Largest positive NPV • Results in low risk increase compared to current regulatory period	• Results in increase in the 40+ year-old population of pole top structures • Results in the premature replacement of some pole top structures which may not develop defects for several years
Counterfactual: Defect Remediation – Historical Volumes	• Replaces pole top structures with highest risk of failure, i.e. those with defects, and also those most likely to develop defects due to age/environment • Positive NPV	• Results in increase in the 40+ year population of pole top structures • Results in moderate risk increase compared to current regulatory period

3.5.2 Alignment with network development plan

The preferred option aligns with the Asset Management Objectives in the Distribution Annual Planning Report. In particular, it manages risks, performance standards and asset investment to deliver balanced commercial outcomes while modernising the network to facilitate access to innovative technologies.

3.5.3 Alignment with future technology strategy

This program of work does not contribute directly to Energy Queensland's transition to an Intelligent Grid, in line with the Future Grid Roadmap and Intelligent Grid Technology Plan. However, it does support Energy Queensland in maintaining affordability of the distribution network while also maintaining safety, security and reliability of the energy system, a key goal of the Roadmap. Through utilising new designs where improvements can be achieved, the proposed works look to provide critical assets with a view to future development and creating a sustainable pole top structure population over the long-term.

3.5.4 Risk Assessment Following Implementation of Proposed Option

The quantitative risk reduction associated with Option 1 is shown in Figure 5.

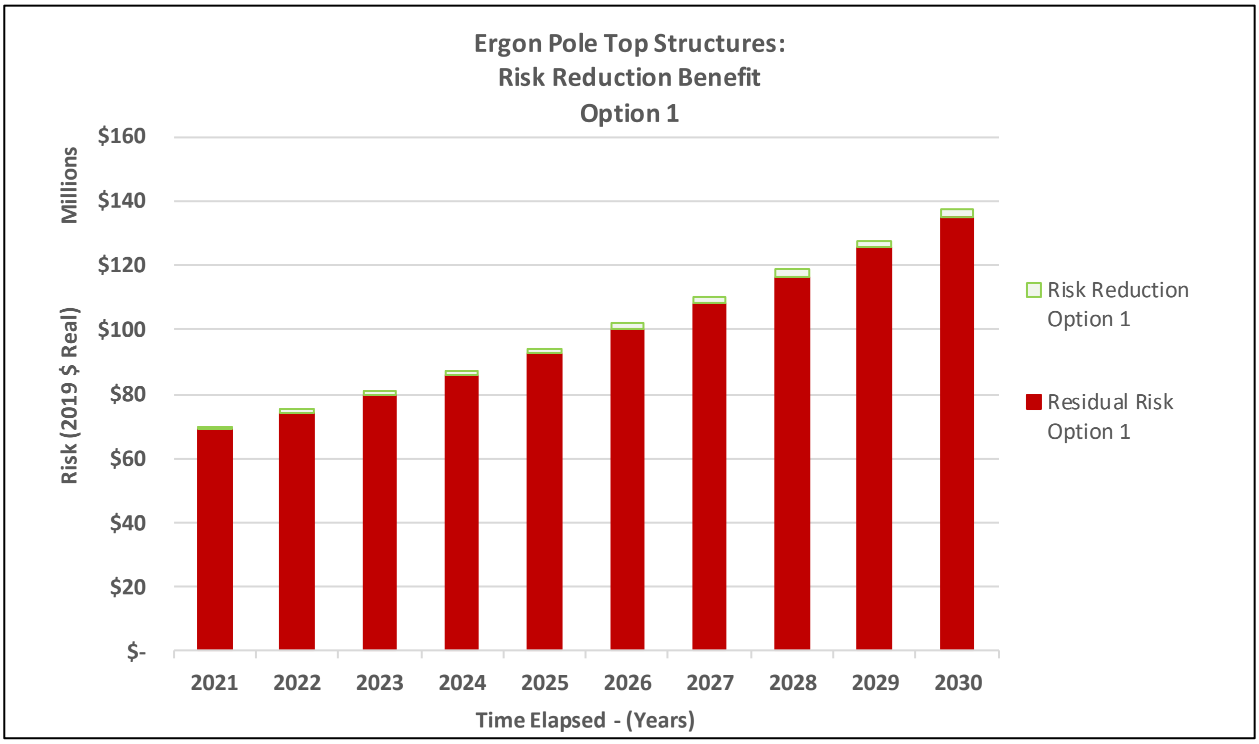


Figure 5: Option 1 risk reduction

The quantified risk reduction from the proposed option is fairly modest compared to the counterfactual. This reflects the ageing population of pole top structures and further increases in replacement programs are likely to be required in future period to manage risks.

The qualitative risk reductions are detailed in Table 11.

Table 11: Risk assessment showing risks mitigated following Implementation

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Failure of pole top structure leads to live conductors coming into contact with circuit or system, causing a **customer interruption >3 hours**.	Customer	*(Original)* *2* *(interruption to 100 customers, <3hrs, once per year)* (Mitigated) 2 *(As above)*	 *5* *(Very Likely)* 4 *(Likely)*	 ***10*** ***(Low)*** **8** ***(Low)***	2020-2025
Failure of pole top structure leads to live conductors hanging low or falling to the ground and member of public or staff contacting live conductor resulting in a **single fatality**.	Safety	*(Original)* *5* *(single fatality/ incurable fatal illness)* (Mitigated) 5 *(As above)*	 *3* *(Unlikely)* 2 *(Very Unlikely)*	 ***15*** ***(Moderate)*** **10** ***(Low)***	2020-2025

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Failure of pole top structure leads to live conductors falling to the ground, sparking a bushfire and **medium-term disruption to ecosystem**	Environment	*(Original)* *4* *(medium term disruption to ecosystem)* (Mitigated) 4 *(As above)*	 *2* *(Very Unlikely)* 2 *(Very Unlikely)*	 ***8*** ***(Low)*** **8** ***(Low)***	2020-2025

4 Recommendation

4.1 Preferred option

The preferred option (Option 1) is to undertake a defect remediation-based replacement scheme with replacement volumes of around 16,000 pole top structures per year, comprising defect driven replacements at historic base volumes plus some additional condition and risk-based replacements focussed in high-risk locations such as populated areas.

4.2 Scope of preferred option

The volumes detailed below will be replaced on a like-for-like basis, except wooden or laminated cross arms will be replaced with composite cross arms (as per AMP). This proposed program results in a moderate increase in the risk profile over the 2020-25 period, due to the increase in number of aged pole top structures. However, the risk is reduced compared to the counterfactual case.

Table 12: Scope of Forecast Volume

	20/21	21/22	22/23	23/24	24/25	Total
Forecast Volume	16,001	16,271	16,271	16,001	16,001	80,545
Cost ($M)	$28.1	$28.2	$29.0	$29.4	$27.1	$141.9M

The expenditure information in this business case is represented in the same manner as the Reset RIN Repex template. For example, if a project/program contains multiple assets (e.g. OH conductor, poles & pole top structures), the total expenditure is apportioned to respective RIN assets individually as per the Ergon Energy RIN expenditure allocation methodology.

Appendix A. References

Note: Documents which were included in Energy Queensland's original regulatory submission to the AER in January 2019 have their submission reference number shown in square brackets, e.g. Energy Queensland, *Corporate Strategy [1.001], (31 January 2019).*

Energy Queensland, *Asset Management Overview, Risk and Optimisation Strategy [7.025]*, (31 January 2019).

Energy Queensland, *Asset Management Plan, Pole Top Structures [7.036]*, (31 January 2019).

Energy Queensland, *Corporate Strategy [1.001],* (31 January 2019).

Energy Queensland, *Future Grid Roadmap [7.054],* (31 January 2019).

Energy Queensland, *Intelligent Grid Technology Plan [7.056],* (31 January 2019).

Energy Queensland, *Network Risk Framework*, (October 2018).

Ergon Energy, *Distribution Annual Planning Report (2018-19 to 2022-23) [7.049]*, (21 December 2018).

Appendix B. Acronyms and Abbreviations

The following abbreviations and acronyms appear in this business case.

Abbreviation or acronym	Definition
$M	Millions of dollars
$ nominal	These are nominal dollars of the day
$ real 2019-20	These are dollar terms as at 30 June 2020
2020-25 regulatory control period	The regulatory control period commencing 1 July 2020 and ending 30 Jun 2025
ABC	Aerial Bundled Cable
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AMP	Asset Management Plan
BAU	Business as Usual
CAPEX	Capital expenditure
Current regulatory control period or current period	Regulatory control period 1 July 2015 to 30 June 2020
DAPR	Distribution Annual Planning Report
DC	Direct Current
DEE	Dangerous Electrical Event
EQL	Energy Queensland Ltd
HV	High Voltage
IT	Information Technology
KRA	Key Result Areas
LV	Low Voltage
MSS	Minimum Service Standard
NEL	National Electricity Law
NEM	National Electricity Market
NEO	National Electricity Objective
NER	National Electricity Rules (or Rules)
Next regulatory control period or forecast period	The regulatory control period commencing 1 July 2020 and ending 30 Jun 2025
NPV	Net Present Value
PCBU	Person in Control of a Business or Undertaking
Previous regulatory control period or previous period	Regulatory control period 1 July 2010 to 30 June 2015

Abbreviation or acronym	Definition
PV	Present Value
RIN	Regulatory Information Notice
RTS	Return to Service
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAMP	Strategic Asset Management Plan
SCADA	Supervisory Control and Data Acquisition
SEI	Serious Electrical Incident
SFAIRP	So Far as Is Reasonably Practicable
WACC	Weighted average cost of capital

Appendix C. Alignment with the National Electricity Rules (NER)

The table below details the alignment of this proposal with the NER capital expenditure requirements as set out in Clause 6.5.7 of the NER.

Table 13: Alignment with NER

Capital Expenditure Requirements	Rationale
6.5.7 (a) (2) The forecast capital expenditure is required in order to **comply with all applicable regulatory obligations or requirements** associated with the provision of standard control services	Ergon Energy has an obligation to provide adequate protection of its power system assets as per the QLD Electrical Safety Act 2002 s29. This proposal sets out a plan to proactively replace aged and poor-condition assets in order to reduce the risk of in-service failure of pole top structures and the associated safety risks.
6.5.7 (a) (3) The forecast capital expenditure is required in order to: (iii) maintain the **quality, reliability and security of supply** of supply of standard control services (iv) maintain the **reliability and security of the distribution system** through the supply of standard control services	Under its Distribution Authority, Ergon Energy must plan and develop its supply network in accordance with good electricity industry practice, having regard to the value that end users of electricity place on the quality and reliability of electricity services. This proposal helps to maintain the reliability of service to customers by reducing the risk of in-service failure of pole top structures which can result in customer outages.
6.5.7 (a) (4) The forecast capital expenditure is required in order to maintain the **safety of the distribution system** through the supply of standard control services.	Due to the ageing population of pole top structures, it is necessary for a replacement program to be set out which will help to reduce the risks in line with SFAIRP principles.
6.5.7 (c) (1) (i) The forecast capital expenditure reasonably reflects the **efficient costs** of achieving the capital expenditure objectives	The Unit Cost Methodology and Estimation Approach sets out how the estimation system is used to develop project and program estimates based on specific material, labour and contract resources required to deliver a scope of work. The consistent use of the estimation system is essential in producing an efficient CAPEX forecast by enabling: • Option analysis to determine preferred solutions to network constraints • Strategic forecasting of material, labour and contract resources to ensure deliverability • Effective management of project costs throughout the program and project lifecycle, and • Effective performance monitoring to ensure the program of work is being delivered effectively. The unit costs that underpin our forecast have also been independently reviewed to ensure that they are efficient (Attachments 7.004 and 7.005 of our initial Regulatory Proposal).
6.5.7 (c) (1) (ii) The forecast capital expenditure reasonably reflects the costs that **a prudent operator** would require to achieve the capital expenditure objectives	The prudency of this proposal is demonstrated through the options analysis conducted and the quantification of risk and benefits of each option. The prudency of our CAPEX forecast is demonstrated through the application of our common frameworks put in place to effectively manage investment, risk, optimisation and governance of the Network Program of Work. An overview of these frameworks is set out in our Asset Management Overview, Risk and Optimisation Strategy (Attachment 7.026 of our initial Regulatory Proposal).

Appendix D. Mapping of Asset Management Objectives to Corporate Plan

This proposal has been developed in accordance with our Strategic Asset Management Plan. Our Strategic Asset Management Plan (SAMP) sets out how we apply the principles of Asset Management stated in our Asset Management Policy to achieve our Strategic Objectives.

Table 1: "Asset Function and Strategic Alignment" in Section 1.4 details how this proposal contributes to the Asset Management Objectives.

The Table below provides the linkage of the Asset Management Objectives to the Strategic Objectives as set out in our Corporate Plan (Supporting document 1.001 to our Regulatory Proposal as submitted in January 2019).

Table 14: Alignment of Corporate and Asset Management objectives

Asset Management Objectives	Mapping to Corporate Plan Strategic Objectives
Ensure network safety for staff contractors and the community	EFFICIENCY ***Operate safely as an efficient and effective organisation*** Continue to build a strong safety culture across the business and empower and develop our people while delivering safe, reliable and efficient operations.
Meet customer and stakeholder expectations	COMMUNITY AND CUSTOMERS ***Be Community and customer focused*** Maintain and deepen our communities' trust by delivering on our promises, keeping the lights on and delivering an exceptional customer experience every time
Manage risk, performance standards and asset investments to deliver balanced commercial outcomes	GROWTH ***Strengthen and grow from our core*** Leverage our portfolio business, strive for continuous improvement and work together to shape energy use and improve the utilisation of our assets.
Develop Asset Management capability & align practices to the global standard (ISO55000)	EFFICIENCY ***Operate safely as an efficient and effective organisation*** Continue to build a strong safety culture across the business and empower and develop our people while delivering safe, reliable and efficient operations.
Modernise the network and facilitate access to innovative energy technologies	INNOVATION ***Create value through innovation*** Be bold and creative, willing to try new ways of working and deliver new energy services that fulfil the unique needs of our communities and customers.

Appendix E. Risk Tolerability Table

Network Risks - *Risk Tolerability Criteria and Action Requirements*				
Risk Score	**Risk Descriptor**	**Risk Tolerability Criteria and Action Requirements**		
30 – 36	***Intolerable*** *(stop exposure immediately)*			
24 – 29	***Very High Risk***	***ALARP** Risk in this range managed to As Low As Reasonably Practicable	**Executive Approval** (required for continued risk exposure at this level)	May require a full Quantitative Risk Assessment (QRA) Introduce new or changed risk treatments to reduce level of risk Periodic review of the risk and effectiveness of the existing risk treatments
18 – 23	***High Risk***		**Divisional Manager Approval** (required for continued risk exposure at this level)	Introduce new or changed risk treatments to reduce level of risk Periodic review of the risk and effectiveness of the existing risk treatments
11 – 17	***Moderate Risk***		**Group Manager / Process Owner Approval** (required for continued risk exposure at this level)	Introduce new or changed risk controls or risk treatments as justified to further reduce risk Periodic review of the risk and effectiveness of the existing risk treatments
6 – 10	**Low Risk**			
1 to 5	***Very Low Risk***		No direct approval required but evidence of ongoing monitoring and management is required	*Periodic review of the risk and effectiveness of the existing risk treatments*

SFAIRP Risks in this area to be mitigated So Far as is Reasonably Practicable

Figure 6: A Risk Tolerability Scale for evaluating Semi-Quantitative risk score

Appendix F. Quantitative Risk Assessment Details

Asset Class Data Input			
		Description/Justification	**Source**
Asset Class	Ergon Pole Top Structures	-	-
Asset Median Life (years)	80.2	Calculated from Weibull parameters	-
NPV Period (years)	20	-	-
Historical Unit Rate ($)	1,650	Average historical expenditure within the 2015-2020 regulatory period.	Attachment 7.067 of our initial regulatory proposal.
Forecasted Unit Rate ($)	1,762	Average forecasted expenditure within the 2020-2025 regulatory period.	Attachment 7.067 of our initial regulatory proposal.

Age Profile and Replacements			
		Description/Justification	**Source**
Total Population	1,500,000	Total amount of Cross arms owned by Ergon. Age profile formulated through extrapolation of provided 10-year 'buckets' pole top structure ages.	Attachment 7.036 of our initial regulatory proposal.
Counterfactual	14,162	Average historical annual replacements within the 2015-2020 regulatory period.	Attachment 7.067 of our initial regulatory proposal.
Replacements - Option 1	16,001	Forecasted annual replacements within the 2020-2025 regulatory period.	Attachment 7.067 of our initial regulatory proposal.
Replacements - Option 2	Spare	Spare	-

Safety Risk Inputs				
Consequence	**Monetisation ($)**	**Disproportionality Factor**	**Description/Justification**	**Source**
Single Fatality	4,900,000	10	Cost of a single fatality scaled by factor of 10.	[1] The sources used to develop the Disproportionality Factors are as follows: Ausgrid - Revised Proposal - Attachment 5.13.M.4 - Low Voltage Overhead Service Lines program CBA summary - January 2019 https://www.pmc.gov.au/sites/default/files/publications/value-of-statistical-life-guidance-note_0_0.pdf https://www.hse.gov.uk/risk/theory/alarpcba.htm
Single Series Injury	490,000	8	Cost of a single serious injury scaled by a factor of 8.	
Fire	66,000	4	Cost of a fire scaled by a factor of 4.	
Emergency Response	4,405	1	Cost of an emergency response scaled by a factor of 1 as the DF is not relevant to this consequence.	

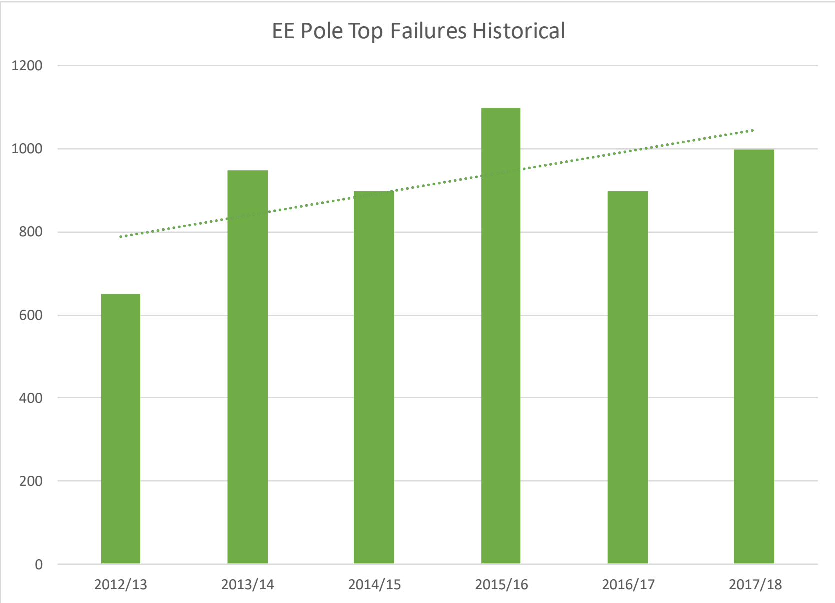
[1] Disproportionality factors are applied to the consequence monetisation to offset the gross disproportion (perceived point at which the cost of implementing a safety measure exceeds its expected benefits). The above factors are based on a review of peer organisations, as well as other industries, to identify a single factor within the approximate median of the range of factors identified in the review.

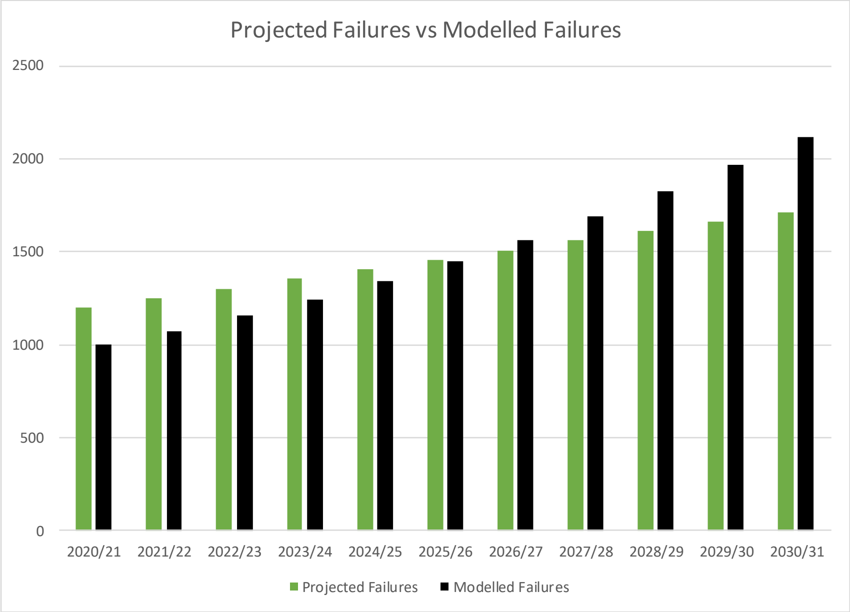
Customer Risk Inputs				
			Description/Justification	Source
Residential	VCR ($/MWH)	25,420	The value different types of customers place on having reliable electricity supplies under different conditions. Determined from survey results conducted by AEMO.	AEMO Value of Customer Reliability Fact Sheet
	Load (MVA)	1.61	Load lost per pole top failure. Calculated as a weighted average of load data for wooden poles.	Input data provided by EQL
	Hrs to restore	14	Time taken to get a failed pole top operating as usual. Based on typical travel and labour involved with residential pole tops.	As agreed with EQL.
	Power Factor	0.85	The ratio which determines the real power used by EQL residential customers. Based on the typical uncompensated power factor for an EQL zone substation.	EQL 2018 DAPR – typical values
	Load Factor	0.2	A ratio of average load to peak load within a specific time. Acts as a measure of EQL's utilisation rate. Conservative value based on typical values for EQL residential load profiles.	As agreed with EQL.
	Percentage of Mix	88%	Percentage of EQL customers who are considered as residential loads. Based on the approximate mix of residential versus commercial customers in the EQL network as informed by customer type information.	As agreed with EQL.
Commercial	VCR ($/MWH)	44,390	The value different types of customers place on having reliable electricity supplies under different conditions. Determined from survey results conducted by AEMO.	AEMO Value of Customer Reliability Fact Sheet
	Load (MVA)	0.22	Load lost per pole top failure. Calculated as a weighted average of load data for wooden poles.	Input data provided by EQL
	Hrs to restore	14	Time taken to get a failed pole top operating as usual. Based on typical travel and labour involved with commercial poles.	As agreed with EQL.
	Power Factor	0.85	The ratio which determines the real power used by EQL commercial customers. Based on the typical uncompensated power factor for an EQL zone substation.	EQL 2018 DAPR – typical values
	Load Factor	0.6	A ratio of average load to peak load within a specific time. Acts as a measure of EQL's utilisation rate. Conservative value based on typical values for EQL commercial load profiles.	As agreed with EQL.
	Percentage of Mix	12%	Percentage of EQL customers who are considered as commercial loads. Based on the approximate mix of residential versus commercial customers in the EQL network as informed by customer type information.	As agreed with EQL.

Incident Conversion Rate (ICR) & Probability of Consequence (PoC)						
ICR		PoC				
Consequence	Incidents Attr. to Cons.	Category	Risk Scale	Probability of Severity	Description/Justification	Source
Single Fatality	350	Safety	5	0.03%	ICR - 350 of historical incidents involving pole top incidents are considered to be dangerous. PoC - Calibrated to represent 1 fatality every 10 years. Based on EQL data which showcases 0 pole related fatalities within approximately the last 10 years.	ICR - Attachment 7.036 of our initial regulatory proposal. PoC – Input Data provided by EQL
Major Injury	350	Safety	4	0.06%	ICR - 350 of historical incidents involving pole top incidents are considered to be dangerous. PoC - Calibrated to represent the historically expected 1 major injury every 5 years.	ICR - Attachment 7.036 of our initial regulatory proposal. PoC – Input Data provided by EQL
Fire	100	Fire	2	30%	ICR – 10% of incidents are attributed to fire. Calibrated based on the expected costs involved with fire risks relative to costs involved with safety in the case of Pole Top Structures. PoC - 30% of incidents result in a fire. Based on the severity of the consequence being considered as moderate.	ICR – As agreed with EQL. PoC - Assumed based on EQL and peer organisation industry experience.
Customer Outage	500	Customer	1	100%	ICR - 50% of incidents are attributed to outages PoC - 100% of incidents result in an outage Based on 50% of Ergon Pole Top Structures	ICR - Assumed based on EQL and peer organisation industry experience. PoC - Assumed based on EQL and peer organisation industry experience.

					having a redundancy scheme in the case of a failure.	
Emergency Response	1000	Environment	1	100%	ICR - 100% of incidents are attributed to emergency response PoC - 100% of incidents result in emergency response	ICR - Attachment 7.036 of our initial regulatory proposal. PoC - Assumed based on EQL and peer organisation industry experience.
Total No. of Incidents	**1000**	-	-	-	Based on known pole unassisted failures within the 2018/2019 period.	ICR - Attachment 7.036 of our initial regulatory proposal.

Statistical Calibration			
		Description/Justification	**Source**
Reliability Model Used	Weibull	Weibull parameters are calibrated to project the trend in historical failures as shown in the below charts	ICR - Attachment 7.036 of our initial regulatory proposal.
Shape parameter (β)	5		
Characteristic life (η)	95		
Guaranteed Min Life (γ)	0		





Projected Failures vs Modelled Failures
2500
2000
1500
1000
500
0
2020/21
2021/22
2022/23
2023/24
2024/25
2025/26
2026/27
2027/28
2028/29
2029/30
2030/31
Projected Failures
Modelled Failures

Appendix G. Reconciliation Table

Reconciliation Table Conversion from $18/19 to $2020	
Business Case Value (M$18/19)	$142.00
Business Case Value (M$2020)	$148.19