Business Case
Clearance to Ground and Clearance to Structure
2020-2025

ERGON ENERGY NETWORK

Executive Summary

This document seeks funding for a program to address known Clearance to Structure (CTS) and Clearance to Ground (CTG) compliance issues for overhead lines in the Ergon Energy (Ergon) network to the total value of $150M.

Under the Queensland Electrical Safety Act and associated regulations, Ergon Energy has an obligation to ensure that its works are electrically safe, are operated in a way that is electrically safe and to ensure the electrical safety of all persons and property likely to be affected by the electrical work. This includes a duty to ensure that it does all that is reasonably practicable (including that which was reasonably able to be done at a particular time to ensure electrical safety risks are managed to the level So Far as Is Reasonably Practicable (SFAIRP). In addition to this, the Regulations impose specific CTS/CTG measurement requirements which require strict compliance (that is, compliance with these requirements is not subject to what is reasonably practicable).

The CTS/CTG program is one important part of delivering an overall safe outcome for the community. This issue was highlighted by the 24 July 2019 submission from the Queensland Electrical Safety Office (ESO) which states that "*rectification of Clearance to Ground (CTG) and Clearance to Structures (CTS) non-compliances with safety regulations is an important safety issue which has not been adequately addressed*." EQL has told the ESO that works to address these issues will be carried out in the next three years, and as such EQL is required to carry out this program in order to be compliant with the Queensland Electrical Safety Act.

While these clearance defects are required to be remediated to comply with Queensland Electrical Safety legislation, in addition this business case compares the benefits of the $30.0M annual program of remediation work with the quantified risks associated with unmitigated clearance defects.

This business case provides an overarching view of this work in Ergon Energy and includes an existing annual program of $2.8M previously submitted as part of various Ergon Energy Replacement Expenditure (Repex) justification statements, plus an additional $27.2M annual program identified directly and modelled from recent LiDAR[1] survey data. The program includes directly identified known defects, plus an additional set of calculated defects. The calculated defects have been identified through a modelling process to determine clearances during high temperature, low wind speed conditions. Since the assets would be non-compliant during these conditions, remediation is still required.

Three network options for addressing clearance defects have been evaluated in this business case, assessed relative to a counterfactual case:

Counterfactual Case - do not remediate known defects

Option 1 – Remediate the known defects over the 2020-25 regulatory control period

Option 2 - Remediate the known defects over a 7-year period up to 2027

Option 3 - Remediate the known defects over a 10-year period up to 2030

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 case safety and compliance are strong drivers, based on the need

[1] LiDAR means Light Detection and Ranging – this technique provides clearance information base on aerial surveys of overhead lines.

to rectify known clearance defects within the network and comply with the Queensland Electrical Safety Act.

To this end, Option 1 is the preferred option, as it provides the highest Net Present Value (NPV) of the three options. Remediation of the defects through the proposed option also addresses all regulatory compliance obligations.

The direct cost of the program for each submission made to the AER is summarised in the table below. 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
N/A	N/A	$150M

This business case was developed after the Draft Determination, as it brings together clearance defect remediation works that were previously spread across a range of other repex business cases. As such no direct costs figures are available for the Regulatory Proposal or Draft Determination Allowance stages.

Contents

1. Introduction

Safety by design is fundamental to Ergon Energy's (Ergon's) network strategy of providing safe and reliable electricity to customers across regional Queensland and is at the core of its corporate values. This proposal addresses specific clearance to ground (CTG) and clearance to structure (CTS) issues identified through periodic system-wide Light Detection and Ranging (LiDAR) scans of the Ergon Energy network.

1.1 Purpose of document

This document recommends the optimal capital investment necessary for remediating clearance to ground and clearance to structure issues for overhead conductor, in a timely way and in accordance with the lifecycle management strategies detailed in the Energy Queensland (EQL) Asset Management Plan (AMP) – Overhead Conductors Asset Management Plan.

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 Energex 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 EQL investment governance processes. The costs presented are in $2018/19 direct dollars.

This document is to be read in conjunction with the AMP – Overhead Conductors, 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

This document seeks funding endorsement from the AER for a consolidated program of statutory clearance improvement activities. It compares the benefits of options to remediate the known defects, with the risks associated with unmitigated clearance problems. This business case provides an overarching view of this work in Ergon Energy and includes an existing annual program of $2.8M previously submitted as part of various Ergon Energy Replacement Expenditure (Repex) justification statements, plus an additional $27.2M annual program identified from recent survey data. This data has been obtained since the Regulatory proposal was made in January 2019 and is detailed further in Appendix H. The expected spread of the additional $27.2M spend across various components of the network is consistent with previous spend and is detailed in a spreadsheet previously supplied to the AER[2] through IR017. The allocation of spend by program is approximately 49% poles, 14% pole top structures, 12% overhead conductor, 4% services, 15% distribution transformers, 5% pole top switches and 1% streetlights.

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 case safety and regulatory compliance are the drivers of the work, based on the need to identify known clearance defects within the network and comply with the Queensland Electrical Safety Act.

[2] Line Defects Spreadsheet IR017-Ergon-IR017-3-Distribution Reset RIN Apportionment

The need for this work is driven primarily from legislative and regulatory obligations regarding conductor clearances on the network. Specifically, the Queensland Electrical Safety Regulation 2013, Schedule 4 details minimum clearances from overhead conductors to both ground and structures. The clearances in Schedule 4 require strict compliance.

This proposal aligns with the CAPEX objectives and criteria from the National Electricity Rules (NER) as detailed in Appendix C.

1.4 Nature of risk

If the energised overhead electrical lines forming part of the Ergon Energy electrical network come into contact with people, the outcome can be fatal. For this reason, the *Electrical Safety Regulations 2013* prescribed minimum clearance distances which must exist between electrical lines and structures (CTS) and electrical lines and the ground (CTG). These clearances are designed to minimise the risk that people or their property/equipment will come into contact with high voltage electrical lines. There are a number of factors which influence what the minimum clearance is in particular circumstances for example, whether the land is cultivation land (where people are likely to be working and using equipment such as cranes etc) or non-trafficable land (where it is less likely people will be present). There are also a number of factors which can influence whether a particular line meets the clearance or not (for example temperature and wind) and these are elaborated below.

While compliance with the statutory minimum clearances does not guarantee that persons will not come into contact with overhead electrical lines, applying these clearances is a central aspect of mitigation of this serious risk.

1.5 Energy Queensland Strategic Alignment

Table 1 details how this CTS/CTG initiative contributes to EQL's corporate and asset management objectives. The linkages between these Asset Management Objectives and EQL's Corporate Objectives are shown in Appendix D.

Table 1: EQL Strategic Alignment

Objectives	Relationship of Initiative to Objectives
Ensure network safety for staff contractors and the community	Clearances of electricity infrastructure to external structures and to ground are key factors in managing electrical safety risks and are compliance obligations related to Queensland Electrical Safety Regulation 2013, Schedule 4.
Meet customer and stakeholder expectations	Adequate clearances of electricity infrastructure to external structures and to ground supports the safe, cost-effective, secure, and reliable supply of electricity to consumers.
Manage risk, performance standards and asset investments to deliver balanced commercial outcomes	Inadequate clearances of electricity assets to structures or to ground creates an increased risk to public safety, disruption of the electricity network, and disruption of customer amenity. Prudent management of these issues assists in minimising capital and operational expenditure while managing risks.
Develop Asset Management capability & align practices to the global standard (ISO55000)	This documented approach is consistent with ISO 55000 objectives and drives asset management capability by promoting continuous improvement.
Modernise the network and facilitate access to innovative energy technologies	This approach uses modern technology to identify safety risks associated with the overhead electricity network.

1.6 Compliance obligations

Table 2 shows the relevant compliance obligations for this proposal.

Table 2: Asset Function and Strategic Alignment

Legislation, Regulation, Code or Licence Condition	Obligations	Relevance to this investment
QLD Electrical Safety Act 2002 **QLD Electrical Safety Regulation 2013**	EQL has a duty of care, ensuring so far as is reasonably practicable, the health and safety of staff and other parties as follows: • Pursuant to the Electrical Safety Act 2002: (a) as a person in control of a business or undertaking (PCBU), EQL has an obligation to ensure that its undertaking is electrically safe[3]. This duty also extends to ensuring the electrical safety of all persons and property likely to be affected by the electrical work (b) as an electricity entity, Ergon Energy has a duty to ensure that its works: (i) are electrically safe; (c) are operated in a way that is electrically safe[4]: (ii) This duty includes ensuring that CTG and CTS clearance requirements are complied with • Pursuant to the QLD Electrical Safety Regulation 2013 which prescribe CTG and CTS clearance requirements	This proposal is a key component in the management of safety for electricity customers. Inadequate clearances to structures or ground are in breach of the Queensland Electrical Safety Regulation 2013, Schedule 4.
Distribution Authority for Ergon Energy or Energex 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)	Fundamentally, this proposal aims to ensure that clearances are adequate and in accordance with standards. This aligns with good electricity industry practice. proposal.

This program focuses on improving clearances in line with Queensland Electrical Safety Regulation 2013, Schedule 4. Ergon Energy also considers the public safety risks associated with overhead lines and where considered necessary, will improve clearances to better suit modern community risk requirements.

1.7 Limitation of existing assets

The basic intent of this expenditure is to comply with legislative and regulatory obligations maintain service delivery performance including customer reliability standards and customer quality standards, and maintain the safety of the network for all of the Queensland community. The engineering strategies employed are consistent with best practice strategies employed by Distribution Network Service Providers (DNSPs) across Australia.

[3] Section 30, *Electrical Safety Act 2002*
[4] Section 29, *Electrical Safety Act 2002*

The scope of the proposed works includes minimum prudent works necessary to achieve regulatory standard clearance for energised overhead assets. This work varies from retensioning conductors through to conductor, pole or crossarm redesign. In some cases, works cost recovery may be possible through enforceable actions with third parties who erect structures or alter ground profiles within regulatory defined exclusion zones.

A detailed explanation of the CTS/CTG inspection and defect determination process is provided in Appendix H.

The key programs which drive the volume forecast in the 2020-25 Regulatory Control Period are as follows:

- CA52: CAPEX LiDAR Defect Remediation (Condition and Risk)
- CA56: Maintain Statutory & Standard Requirements (Condition and Risk)

The present LiDAR approach is a point-in-time geospatial solution – clearance issues are identified based upon simple calculation of overhead asset to ground or structure clearance. Ergon Energy has continued to identify clearance issues post the initial survey and remediation indicates an ongoing number of clearance issues being identified annually. There are multiple reasons for this, notably pole movement in the ground, changes in land use, ongoing community and building construction, and basic conductor temperature and tension physics impacting line sag at different points in time. Additionally, continuous improvement in the LiDAR technology over time has increased Ergon Energy's capacity to identify defects leading to an increase in the number of clearance issues identified.

Calculated Defects Methodology

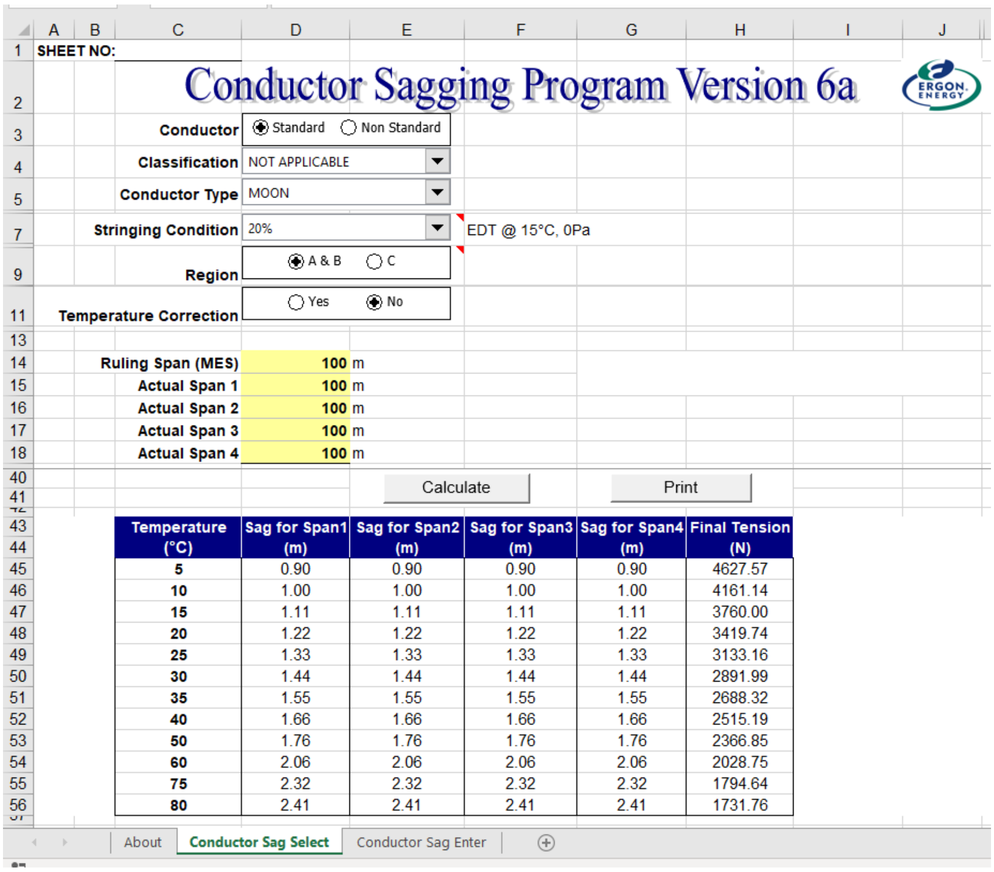
Ergon Energy has further combined the LiDAR data with design information, and environmental data to establish those overhead assets that are expected to experience clearance issues as a result of dynamic conductor sag. The use of modelling to identify clearance issues is expected to deliver greater efficiency of remediation delivery and reduce the need to return to the same area within a short period.

The design of power lines in Energy Queensland is based on the Australian Standard AS7000.

Data required for the calculation which include:

- Conductor type and physical properties
- Span length
- Attachment heights
- Conductor tension
- Reference temperature of the conductors

Energy Queensland Standards Department has developed a conductor sagging program based on AS7000 to calculate the sag for different parameters. This generates the sagging charts produced for the Overhead Line Design Manual


SHEET NO:

Conductor Sagging Program Version 6a

Conductor	Standard (selected) / Non Standard
Classification	NOT APPLICABLE
Conductor Type	MOON
Stringing Condition	20% — EDT @ 15°C, 0Pa
Region	A & B (selected) / C
Temperature Correction	Yes / No (selected)
Ruling Span (MES)	100 m
Actual Span 1	100 m
Actual Span 2	100 m
Actual Span 3	100 m
Actual Span 4	100 m

Calculate Print

Temperature (°C)	Sag for Span1 (m)	Sag for Span2 (m)	Sag for Span3 (m)	Sag for Span4 (m)	Final Tension (N)
5	0.90	0.90	0.90	0.90	4627.57
10	1.00	1.00	1.00	1.00	4161.14
15	1.11	1.11	1.11	1.11	3760.00
20	1.22	1.22	1.22	1.22	3419.74
25	1.33	1.33	1.33	1.33	3133.16
30	1.44	1.44	1.44	1.44	2891.99
35	1.55	1.55	1.55	1.55	2688.32
40	1.66	1.66	1.66	1.66	2515.19
50	1.76	1.76	1.76	1.76	2366.85
60	2.06	2.06	2.06	2.06	2028.75
75	2.32	2.32	2.32	2.32	1794.64
80	2.41	2.41	2.41	2.41	1731.76

About | Conductor Sag Select | Conductor Sag Enter

Figure 1: Output from Conductor Sagging Program

It can be seen from the from figure 1 that the sag increases as conductor temperature rises.

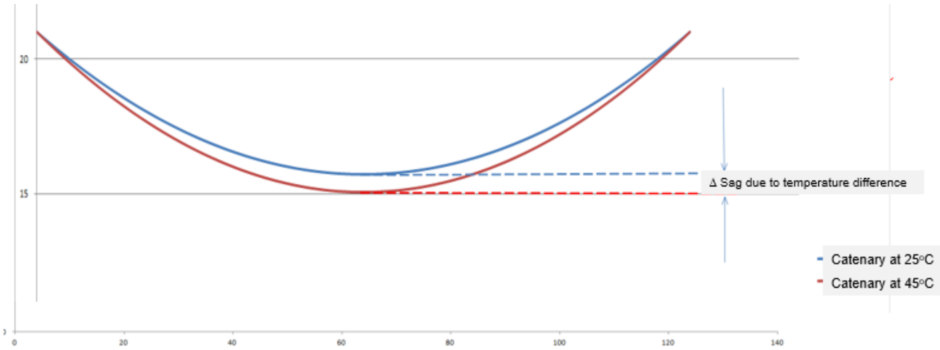


Figure 2: Effect of Temperature on Conductor Sag

LiDAR Survey Data

The LiDAR survey employed by Energy Queensland provides the physical measurement of the overhead power line. The measured quantities include:

- Date and time of survey
- Geolocation of the pole
- Topographical reference level
- Height of attachment on each pole
- The span length (distance between the pole)
- The conductor length
- The clearance height from the ground
- Minimum clearance height and where it occurs

Methodology for determining clearance breach at 35ºC

The LiDAR survey data does not provide all the inputs necessary to perform the sag calculations. The missing input values are derived based on engineering assumptions and practices. These derived values include:

- Ambient temperature - obtained by associating the time of the survey and the closest Bureau of Meteorology Site
- Conductor Type – Obtained by matching spans in Asset Database
- Conductor Tension – based on typical values for the span length and conductor type

For each surveyed span, the following calculation is done

1. The value of the clearance at the survey temperature is noted, $CL_{Ambient}$
2. The sag at the survey temperature using the actual and derived values, $S_{Ambient}$
3. the sag at the 35ºC using the same the actual and derived values, S_{35}
4. The additional sag due to temperature is $\Delta S = (S_{35} – S_{Ambient})$
5. The clearance at 35ºc is $CL35 = CL_{Ambient} – \Delta S$

A breach is determined when CL_{35} is less than the statutory height requirement

From this methodology it has been identified that there are some 22,486 defects existing in the network to be addressed. This includes current clearance defects plus forecast defects expected to occur during maximum temperature conditions (temperature related defects), refer Appendix H. The unit cost of defect remediation is estimated at $6,667 based on historical actual costs. The total expenditure is forecast at $150M and several options have been identified as to the timing of this work.

Historical and Forecast Defect Volumes

The intent of this replacement expenditure is to maintain safety of the network, comply with legislative requirements and regulatory obligations, and maintain service delivery performance (customer reliability and quality standards) for all the Queensland community. Table 3: Historical and Forecast Volumes and Costs provides a summary of the historical and forecast remediation expenditure. It should be noted that expenditures in 17/18 and 18/19 spiked due to the backlog of remediation issues arising from the first ever complete network LiDAR scanning. Expenditure in prior years was based on ground patrols and visual assessment, which failed to detect many of the issues found using LiDAR scanning and analysis.

Based on the outcomes of recent LiDAR scan data and network analysis, an additional $27.2M annual program identified over and above previous submitted annual program of $2.8M is forecast. The investment forecast is consistent with the recent past three years average expenditure of $24M expenditure, expected across the various components of network as detailed in a spreadsheet previously supplied to AER2 through IR017[5].

[5] Line Defects Spreadsheet IR017-Ergon-IR017-3-Distribution Reset RIN Apportionment

Table 3: Historical and Forecast Volumes and Costs

Volume & Exp.	15/16	16/17	17/18	18/19	19/20	**20/21**	**21/22**	**22/23**	**23/24**	**24/25**	**2020-25**
Actual Volume (defects)	6	6,216	7,495	7,890							
Forecast Volume (defects)					2,782	4,497	4,497	4,497	4,497	4,497	22,486
Actual Expenditure ('$M)	2.3	9.1	21.5	31.1							
Forecast Expenditure ('$M)					18.6	30.0	30.0	30.0	30.0	30.0	150.0

2 Counterfactual Analysis

2.1 Purpose of asset

The purpose of these assets is to safely distribute electricity across the Ergon Energy network. The asset types are quite diverse, and all form part of the overhead distribution network. The issue of CTS/CTG is relevant for all associated assets.

2.2 Business-as-usual service costs

The business as usual service costs for these assets is mainly inspection and maintenance as part of routine programs. The CTS/CTG defects can result in situations where members of the public contact live conductors and in these instances, there are significant costs associated with emergency response, fault investigation, regulatory reporting and physical rectification work. These costs have not been factored into this analysis as the risks associated with leaving CTS/CTG defects in place are not in line with relevant compliance obligations.

2.3 Key assumptions

"Do Nothing" is an unacceptable state given that the remediation of these CTS/CTG defects is a compliance obligation under both the *Electrical Safety Act 2002* and the *Electrical Safety Regulations 2013*. Failing to act creates a potential risk to public safety and would place EQL and potentially its officers at risk of breach of this legislation particularly in circumstances where there has been a failure to address a **known** risk. Serious consequences (including jail terms for individuals) can flow from breach of the safety legislation.

Significant risks occur as a result of inadequate clearances, and these risks are considered in detail below. This issue was highlighted by the 24 July 2019 submission from the Queensland Electrical Safety Office which states that "*rectification of Clearance to Ground (CtG) and Clearance to Structures (CtS) non-compliances with safety regulations is an important safety issue which has not been adequately addressed*."

The work program is based on latest inspection information plus analysis and modelling work carried out to identify clearance defects that will arise based on maximum temperature assumptions.

2.4 Risk assessment

The figure below provides the results of a quantitative forecast of risk associated with Ergon Energy's CTS/CTG defects.

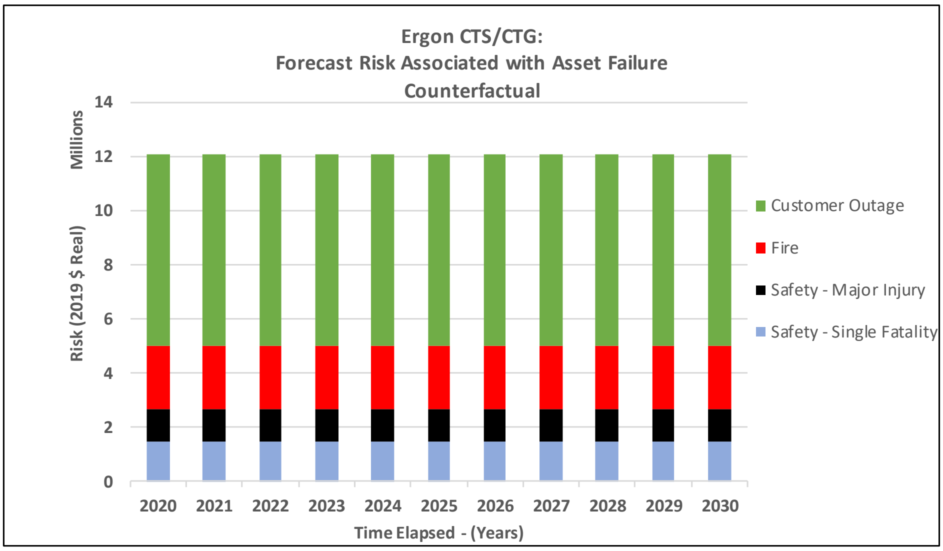


Figure 3: Counterfactual quantitative risk assessment (Graph)

This counterfactual (Do Nothing) risk scenario shows a constant risk over the 10-year period, assuming that no additional defects are added in that period (which is highly improbable). The risks have been modelled based on the known defect quantities and the probability of these defects resulting in a safety incident, a fire or a customer outage.

It is acknowledged that generally the counterfactual case should be the historical expenditure on the mitigation program. In this case however, there is now a large quantity of known defects and this is a significant step change from the historical case. A clear choice must be made between not remediating the defects and remediating them over various periods. Hence in this case the counterfactual of "Do Nothing" has been used to fully understand the risks of not addressing the defects, noting that this is not an acceptable position given that these defects are required to be addressed

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 E.

Table 4: Counterfactual semi-quantitative risk assessment

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
EQL identifies clearance defects in accordance with electrical safety regulations resulting in **regulator involvement and an enforceable undertaking being issued.**	Legislative	4 *(Legislative requirement and regulator involvement)*	6 *(Almost Certain)*	***24 (Very High)***	2020
Due to inadequate clearance, a member of the public contacts an energised conductor resulting in **a single fatality** due to electric shock.	Safety	5 *(Single Fatality)*	3 *(Unlikely)*	**15 *(Moderate)***	2020
Due to inadequate clearance, a member of the public contacts an energised conductor resulting in **multiple serious injuries** due to electric shock.	Safety	4 *(Multiple Serious Injuries)*	3 *(Unlikely)*	**12 *(Moderate)***	2020
Due to inadequate clearance, an object contacts an energised conductor resulting in a l**oss of supply to customer premises for >3 hours** while repairs are made.	Customer	2 *(Customer interruption >3hrs)*	3 *(Unlikely)*	**6 *(Low)***	2020
Due to inadequate clearance an object contacts an energised conductor resulting in a **fire causing property damage**.	Customer	2 *(N/A)*	3 *(Unlikely)*	**6 *(Low)***	2020

Further Details of the risk ratings and descriptions can be found in Energy Queensland's Network Risk Framework.

2.5 Retirement or de-rating decision

These assets cannot be retired or de-rated as they form critical components of the Ergon Energy overhead distribution network. The remediation of the clearance issues is a legislative and regulatory obligation and also serves to mitigate safety, fire and reliability risks.

3 Options Analysis

3.1 Options considered and rejected

There is a limited range of options to address known clearance issues. Once defects have been identified there is an obligation to remediate them in a timely way with the currently implemented strategy for classification and remediation ranging from 6 months to 3 years. Options are considered below to remediate the defects over several timeframes, with Option 1 most closely aligned to Energy Queensland strategy and expectations of stakeholders. Long-term deferral of remediating the clearance defects has not been considered as this represents an unacceptable response to a known regulatory breach.

3.2 Identified options

3.2.1 Network options

Several network options have been identified to remediate the known defects as follows:

- Option 1 – Remediate the known defects over the 2020-25 regulatory control period. This option would result in the resolution of 4,497 defects per year over the 5-year period, at a unit cost of $6,667, with resultant annual expenditure of $30.0M. This option provides the maximum rate of remediation within resource constraints.
- Option 2 – Remediate the known defects over a 7-year period up to 2027. This option would result in the resolution of 3,212 defects per year over the 7-year period, at a unit cost of $6,667, with resultant annual expenditure of $21.4M.
- Option 3 – Remediate the known defects over a 10-year period up to 2030. This option would result in the resolution of 2,249 defects per year over the 10-year period, at a unit cost of $6,667, with resultant annual expenditure of $15.0M.

3.2.2 Non-network options

Energy Queensland's strategy in this regard is to implement remedial actions that are prudent in both cost and acceptable outcomes. Non-network options have been utilised to remediate a small portion of defects previously (e.g. Removal of buildings and signs rather than changing the overhead network) and the unit rate used in this business case is inclusive of a proportionate application of these options.

3.3 Economic analysis of identified options

3.3.1 Cost versus benefit assessment of each option

A quantified risk assessment has been carried out in relation to the proposed options of mitigating all known defects over several different periods. As seen below in the figure, the risk is reduced progressing each year with nil residual risk by the end of the final year. Benefits from this risk reduction have been compared to the costs of the programs

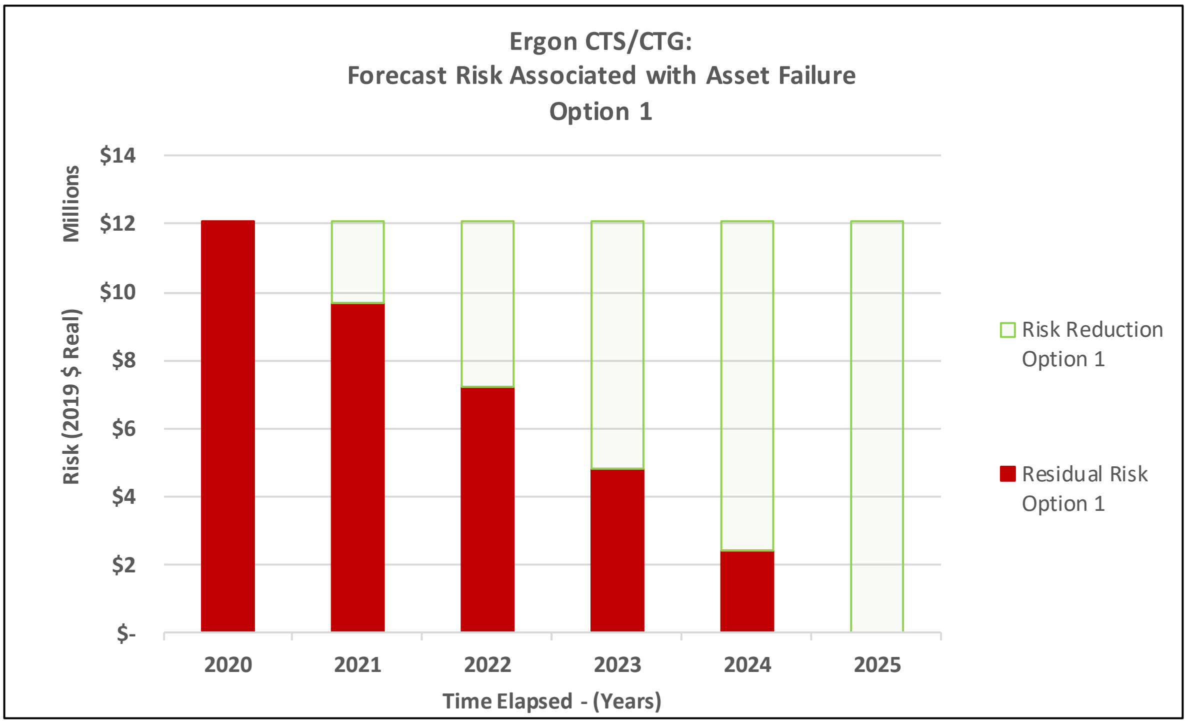


Figure 4: Benefits Provided through Risk Reduction – Option 1

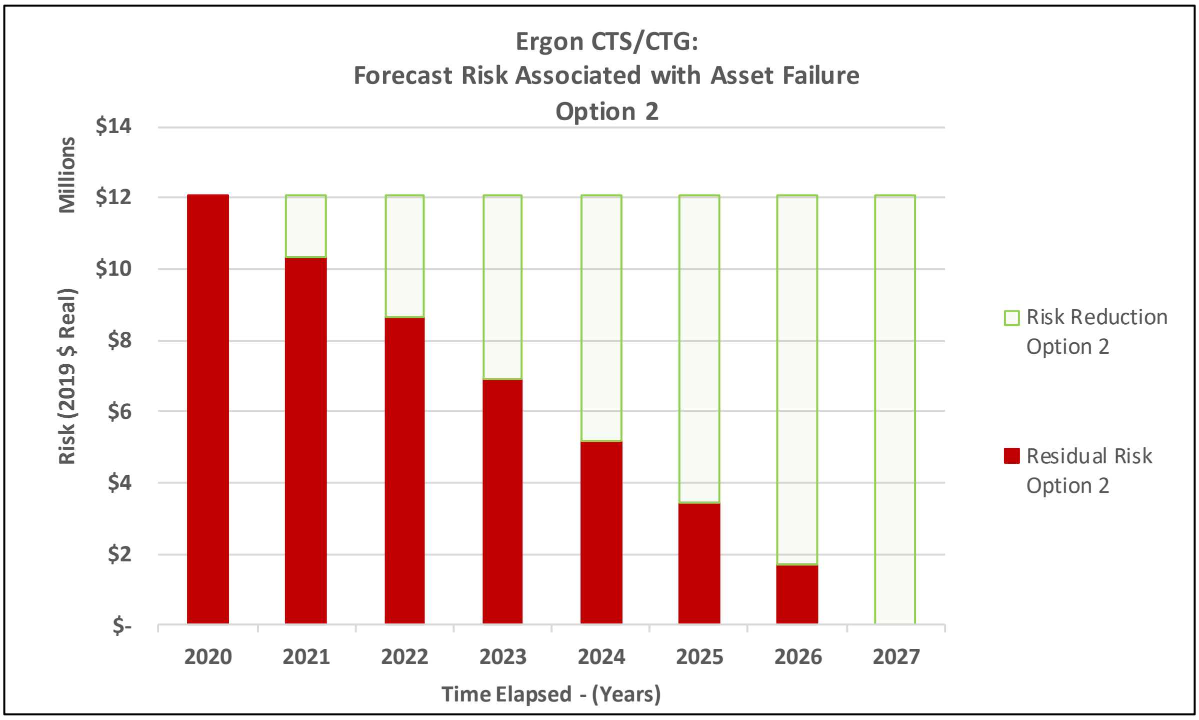


Figure 5: Benefits Provided through Risk Reduction – Option 2

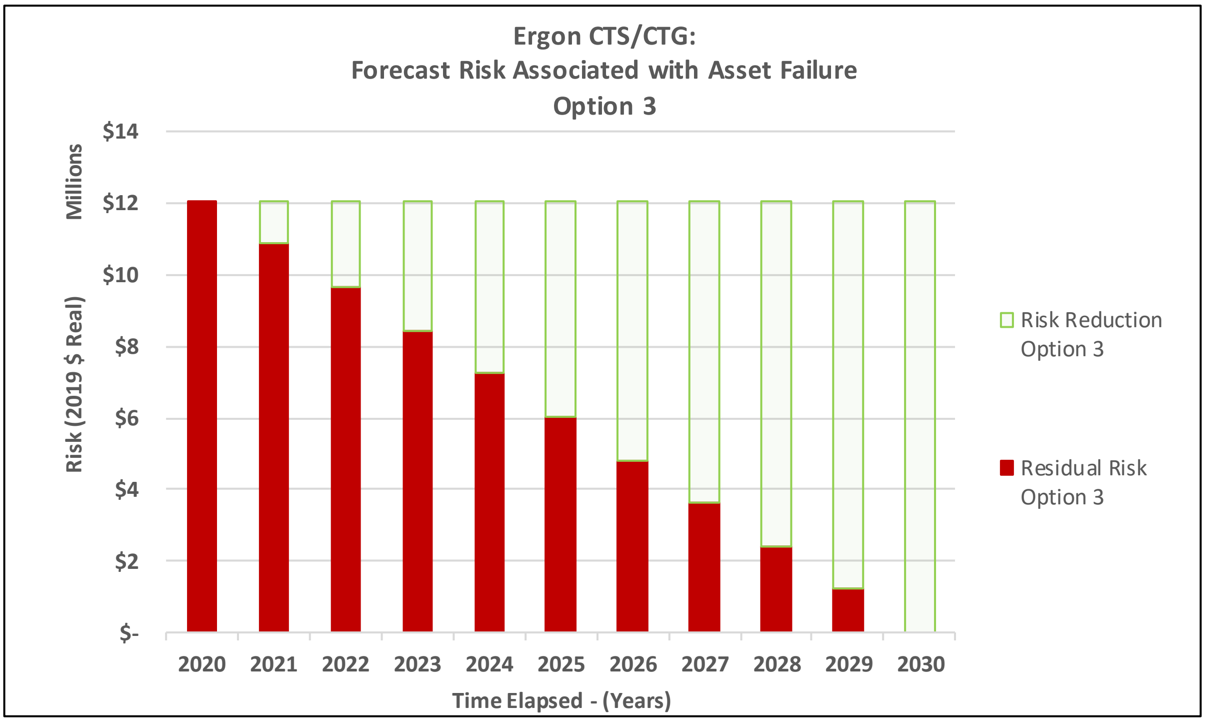


Figure 6: Benefits Provided through Risk Reduction – Option 3

Economic assessment and comparison of options was carried out using the EQL Net Present Value (NPV) Tool, discounting cashflows over a 20-year period, at the Regulated Real Pre-Tax Weighted Average Cost of Capital (WACC) rate of 2.62%. The NPV of these options is outlined in Table 5, along with the Present Value (PV) of costs and benefits modelled in each option.

Table 5: Summary of Net present value of options

Option	NPV	PV of costs	PV benefits
Option 1: Replace Known Defects over 5 years	$24.4M	$138.8M	$163.2M
Option 2: Replace Known Defects over 7 years	$16.9M	$135.4M	$152.3M
Option 3: Replace Known Defects over 10 years	$6.2M	$130.4M	$136.6M

3.4 Scenario Analysis

3.4.1 Sensitivities

Table 6 outlines the variables from quantitative risk assessment considered in sensitivity analysis for these options. Key variables considered were remediation unit rate, Cost of Consequence (CoC), and Probability of Severity (PoS).

Table 6: Sensitivity Analysis

Sensitivity	Baseline	Applied Parameter	Preferred Option	NPV of Preferred Option 1
Remediation unit rate (High)	$6,667	$7,000	Option 1	$17.5M
Remediation unit rate (Low)		$6,200	Option 1	$34.1M
CoC single fatality (Low)	$4.9M	$4.5M	Option 1	$22.8M
CoC single fatality (High)		$5.4M	Option 1	$26.4M
PoS single fatality (Low)	0.01%	0.003%	Option 1	$10.5M

Sensitivity	Baseline	Applied Parameter	Preferred Option	NPV of Preferred Option 1
PoS single fatality (High)		0.05%	Option 1	$103.9M

3.4.2 Value of regret analysis

The key potential regret in this case is a fatal injury to a member of the public arising from a known clearance issue. This regret is only addressed through timely remediation of the known defects, hence the proposed option 1 addresses this key regret. This is a compliance-driven program, however the quantified risk also supports the proposed approach which balances the need for timely remediation of the defects within resource constraints.

3.5 Qualitative comparison of identified options

3.5.1 Advantages and disadvantages of each option

The table below details the advantages and disadvantages of each option considered.

Table 7: Qualitative Assessment of Options

Options	Advantages	Disadvantages
Proposed Option 1 - Remediation of known defects over the 5-year period	• Provides a safety and customer risk reduction benefit • Deliverable within resource constraints* • Removes known defects from the network • Reduces delivery, compliance and financial risks associated with known defects	• Nil identified
Option 2 - Remediation of known defects over the 7-year period	• Provides a safety and customer risk reduction benefit • Deliverable within resource constraints* • Removes known defects from the network • Reduces delivery, compliance and financial risks associated with known defects	• Slower delivery results in longer non-compliance • Slower delivery results in longer known defects and associated risks existing in the network
Option 3 - Remediation of known defects over the 10-year period	• Provides a safety and customer risk reduction benefit • Deliverable within resource constraints* • Removes known defects from the network • Reduces delivery, compliance and financial risks associated with known defects	• Slower delivery results in longer non-compliance • Slower delivery results in longer known defects and associated risks existing in the network

*It should be noted that Ergon Energy has taken steps to proactively increase its field resources to enable the timely and efficient delivery of this and other related distribution programs.

3.5.2 Alignment with network development plan

This program is consistent with the requirements of the Distribution Annual Planning Report (DAPR) and aligns with the Asset Management Objectives outlined. 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 has utilised technology solutions to deliver a safer outcome for the public. The 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, and represents prudent asset management and investment decision-making to support optimal customer outcomes and value across short, medium and long-term horizons.

3.5.4 Risk Assessment Following Implementation of Proposed Option

The quantified risk assessment results are shown in Figure 4 to

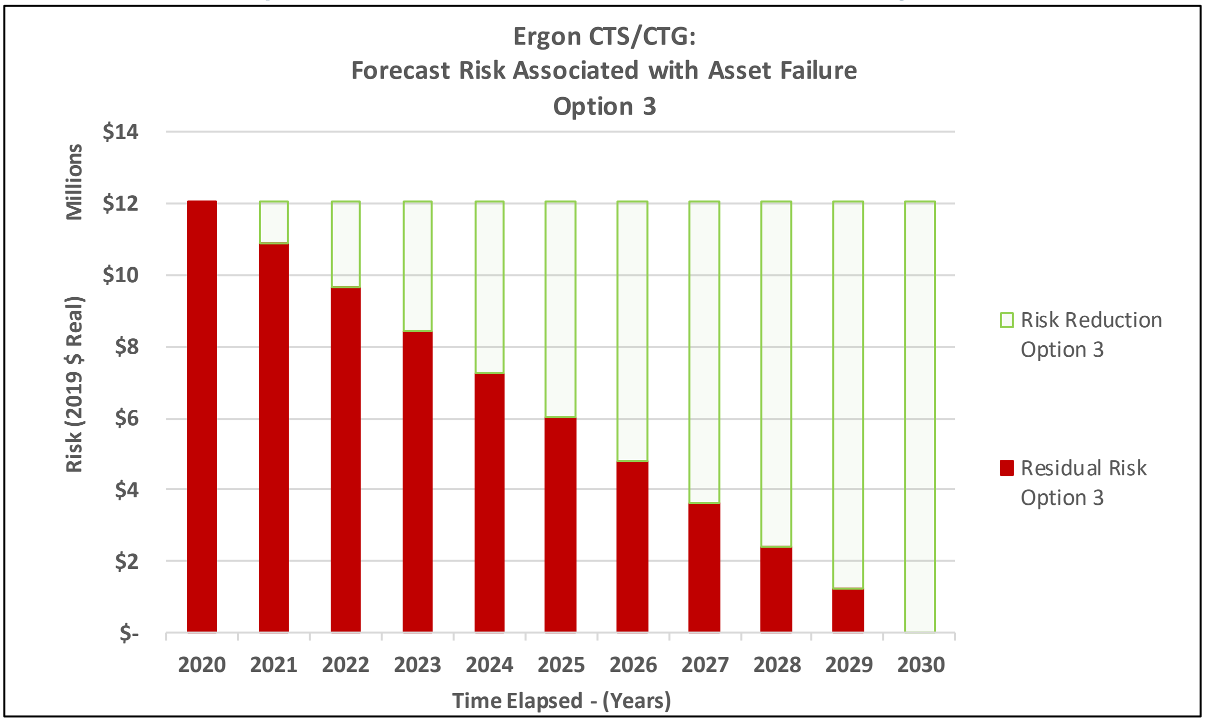


Figure 6. The semi-quantitative risk assessment results are shown in Table 8: Risk assessment showing risks mitigated following Implementation

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
EQL identifies clearance defects in accordance with electrical safety regulations resulting in **regulator involvement and an enforcement notice being issued or complaint and summons being commenced.**	Legislative	*(Original)* 4 *(Legislative requirement and regulator involvement)* (Mitigated) 4 *(Single Fatality)*	6 *(Almost Certain)* 2 *(Very Unlikely)*	**24** ***(Very High)*** **8** ***(Low)***	2025
Due to inadequate clearance, a member of the public contacts an energised conductor resulting in **a single fatality** due to electric shock.	Safety	*(Original)* 5 *(Single Fatality)* (Mitigated)	3 *(Unlikely)*	**15** ***(Moderate)***	2025

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
		5 *(Single Fatality)*	1 *(Almost None)*	**5** ***(Very Low)***	
Due to inadequate clearance, a member of the public contacts an energised conductor resulting in **multiple serious injuries** due to electric shock.	Safety	*(Original)* 4 *(Multiple Serious Injuries)* (Mitigated) 4 *(Multiple Serious Injuries)*	 3 *(Unlikely)* 1 *(Almost None)*	 **12** ***(Moderate)*** **5** ***(Very Low)***	2025
Due to inadequate clearance, an object contacts an energised conductor resulting in a **loss of supply to customer premises for >3 hours** while repairs are made.	Customer	*(Original)* 2 *(Customer interruption >3hrs)* *(Mitigated)* 2 *(Customer interruption >3hrs)*	 3 *(Unlikely)* 1 *(Almost None)*	 **6** ***(Low)*** **2** ***(Very Low)***	2025
Due to inadequate clearance an object contacts an energised conductor resulting in a **fire causing property damage**.	Customer	*(Original)* 2 *(N/A)* (Mitigated) 2 *(N/A)*	 3 *(Unlikely)* 1 *(Almost None)*	 **6** ***(Low)*** **2** ***(Very Low)***	2025

Field Improvements – Development of Additional Conductor Sag Application

An important consideration in addressing the clearance defects is to ensure that all defects are adequately addressed in practice. For this purpose, a simple field application has been developed.

At present all new and refurbishment overhead line works pass through the design office where the design allows for a conductor temperature of 55ºC or 75ºC.

Emergency and unplanned re-conductoring work generally do not pass through the design office due to the short timeframe to perform the work.

A simple field application has been developed for use to calculate the additional conductor sag to compensate for ambient temperature to ensure statutory height compliance at 45ºC. This application is restricted for use in emergency or unplanned “like for like” re-conductoring work where designs are not available.

The field worker will be requested to enter the following information:

- Conductor voltage
- Location of conductor
- Span length
- Conductor Type
- Conductor Name

The application will display the:

1. The statutory clearance requirement based on the conductor voltage and location
2. The additional sag requirement due to ambient temperature difference
3. The required clearance requirement for that span

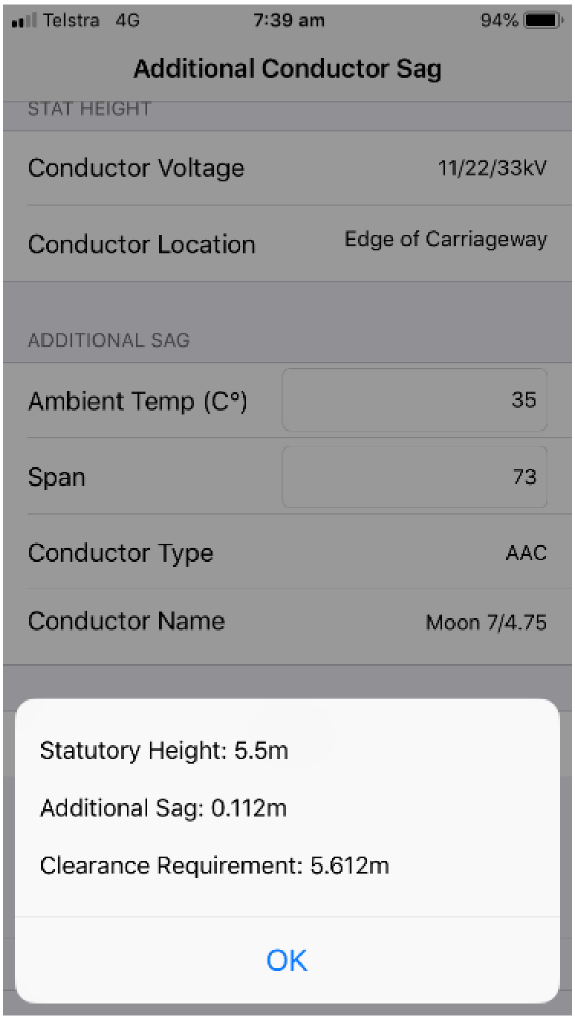


Figure 7: Screenshot of output from Conductor Sag Application

The application is currently being field tested and is anticipated to be rolled out within the next month to support the close out of defects in the field.

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Table 8: Risk assessment showing risks mitigated following Implementation

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
EQL identifies clearance defects in accordance with electrical safety regulations resulting in **regulator involvement and an**	Legislative	*(Original)* 4 *(Legislative requirement and regulator involvement)*	6 *(Almost Certain)*	**24** ***(Very High)***	2025

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
enforcement notice being issued or complaint and summons being commenced.		(Mitigated) 4 *(Single Fatality)*	 2 *(Very Unlikely)*	 **8** ***(Low)***	
Due to inadequate clearance, a member of the public contacts an energised conductor resulting in **a single fatality** due to electric shock.	Safety	*(Original)* 5 *(Single Fatality)* (Mitigated) 5 *(Single Fatality)*	 3 *(Unlikely)* 1 *(Almost None)*	 **15** ***(Moderate)*** **5** ***(Very Low)***	2025
Due to inadequate clearance, a member of the public contacts an energised conductor resulting in **multiple serious injuries** due to electric shock.	Safety	*(Original)* 4 *(Multiple Serious Injuries)* (Mitigated) 4 *(Multiple Serious Injuries)*	 3 *(Unlikely)* 1 *(Almost None)*	 **12** ***(Moderate)*** **5** ***(Very Low)***	2025
Due to inadequate clearance, an object contacts an energised conductor resulting in a **loss of supply to customer premises for >3 hours** while repairs are made.	Customer	*(Original)* 2 *(Customer interruption >3hrs)* *(Mitigated)* 2 *(Customer interruption >3hrs)*	 3 *(Unlikely)* 1 *(Almost None)*	 **6** ***(Low)*** **2** ***(Very Low)***	2025
Due to inadequate clearance an object contacts an energised conductor resulting in a **fire causing property damage**.	Customer	*(Original)* 2 *(N/A)* (Mitigated) 2 *(N/A)*	 3 *(Unlikely)* 1 *(Almost None)*	 **6** ***(Low)*** **2** ***(Very Low)***	2025

Field Improvements – Development of Additional Conductor Sag Application

An important consideration in addressing the clearance defects is to ensure that all defects are adequately addressed in practice. For this purpose, a simple field application has been developed.

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A simple field application has been developed for use to calculate the additional conductor sag to compensate for ambient temperature to ensure statutory height compliance at 45°C. This application is restricted for use in emergency or unplanned "like for like" re-conductoring work where designs are not available.

The field worker will be requested to enter the following information:

- Conductor voltage
- Location of conductor
- Span length
- Conductor Type
- Conductor Name

The application will display the:

4. The statutory clearance requirement based on the conductor voltage and location
5. The additional sag requirement due to ambient temperature difference
6. The required clearance requirement for that span

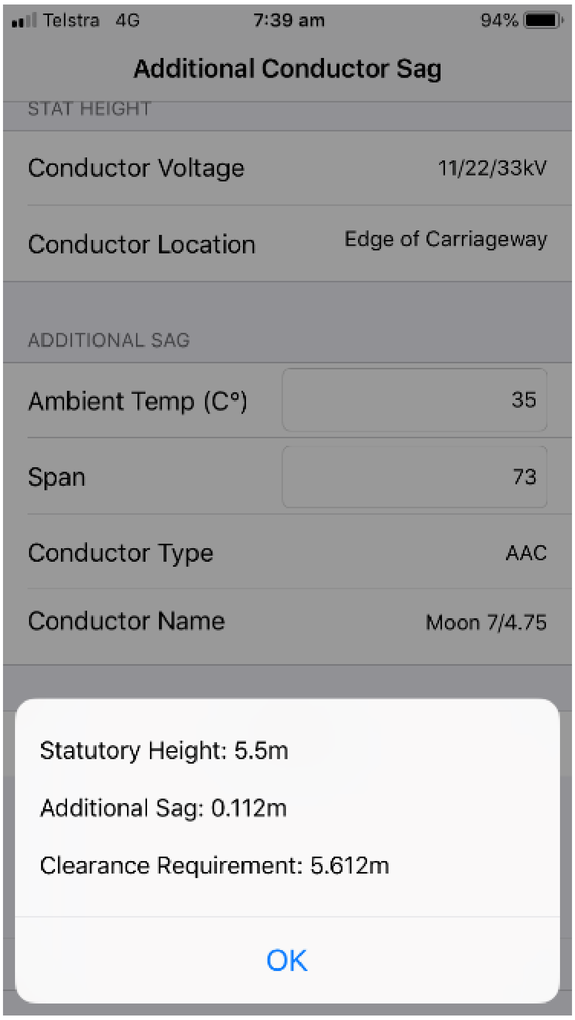

Figure 7: Screenshot of output from Conductor Sag Application

The application is currently being field tested and is anticipated to be rolled out within the next month to support the close out of defects in the field.

4 Recommendation

4.1 Preferred option

The proposed option is to remediate the known CTS/CTG defects. There are some 22,486 defects existing in the network to be addressed over the 2020-25 regulatory control period. The unit cost of defect remediation is estimated at $6,667 based on historical actual costs. The total expenditure is forecast at $150M over the 2020-25 regulatory control period with a flat phasing of $30M expenditure per year.

4.2 Scope of Preferred option

The scope of the preferred option is to remediate the known defects over the 2020-25 regulatory control period. This option would result in the resolution of 4497 defects per year over the 5-year period, at a unit cost of $6,667, with resultant annual expenditure of $30.0M and total expenditure of $150M over the AER 2020-25 regulatory control period.

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).*

AEMO, *Value of Customer Reliability Review, Final Report,* (September 2014).

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

Energy Queensland, *Asset Management Plan, Overhead Conductors [7.035]*, (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
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ALARP	As Low as Reasonably Practicable
AMP	Asset Management Plan
Augex	Augmentation Capital Expenditure
BAU	Business as Usual
CAPEX	Capital expenditure
CoC	Cost of Consequence
CTG	Clearance to Ground
CTS	Clearance to Structure
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
DNSP	Distribution Network Service Provider
EQL	Energy Queensland Ltd
IT	Information Technology
KRA	Key Result Areas
kV	Kilovolt
LiDAR	Light Detection and Ranging
LoC	Likelihood of Consequence
MSS	Minimum Service Standard
MVA	Megavolt Ampere
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

Abbreviation or acronym	Definition
OPEX	Operational Expenditure
PCBU	Person in Control of a Business or Undertaking
PoS	Probability of Severity
Previous regulatory control period or previous period	Regulatory control period 1 July 2010 to 30 June 2015
PV	Present Value
Repex	Replacement Capital Expenditure
RIN	Regulatory Information Notice
RIT-D	Regulatory Investment Test – Distribution
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
SFAIRP	So Far as Is Reasonably Practicable
VCR	Value of Customer Reliability
WACC	Weighted average cost of capital
ZS	Zone Substation

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 9: 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**	Pursuant to the Electrical Safety Act 2002, as a person in control of a business or undertaking (PCBU), Ergon Energy has an obligation to ensure that its works are electrically safe and are operated in a way that is electrically safe.[6] This duty also extends to ensuring the electrical safety of all persons and property likely to be affected by the electrical work.[7] This proposal addresses Ergon's key obligation in relation to ensuring that it works are electrically safe. Clearances of electricity infrastructure to external structures and to ground are key factors in managing electrical safety risks and are compliance obligations related to Queensland Electrical Safety Regulation 2013, Schedule 4.
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**	While the primary purpose of this program is the delivery of safe outcomes for customers, it does also address reliability issues associated with service failures.
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.**	Pursuant to the Electrical Safety Act 2002, as a person in control of a business or undertaking (PCBU), Ergon Energy has an obligation to ensure that its works are electrically safe and are operated in a way that is electrically safe.[8] This duty also extends to ensuring the electrical safety of all persons and property likely to be affected by the electrical work.[9] This proposal addresses Ergon's key obligation in relation to ensuring that it works are electrically safe. Clearances of electricity infrastructure to external structures and to ground are key factors in managing electrical safety risks and are compliance obligations related to Queensland Electrical Safety Regulation 2013, Schedule 4.
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 submission).

[6] Section 29, *Electrical Safety Act 2002*
[7] Section 30 *Electrical Safety Act 2002*
[8] Section 29, *Electrical Safety Act 2002*
[9] Section 30 *Electrical Safety Act 2002*

Capital Expenditure Requirements	Rationale
6.5.7 (c) (1) (ii) **The forecast capital expenditure reasonably reflects a realistic expectation of the demand forecast and cost inputs required to achieve the capital expenditure objective**	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 submission).

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

Figure 8: A Risk Tolerability Scale for evaluating Semi-Quantitative risk score

Appendix F. Quantitative Risk Assessment Details

Data Input			
		Description/Justification	**Source**
Asset Class	Ergon CTS/CTG	-	-
NPV Period (years)	20	-	-
Unit Rate ($)	6,667	Forecasted expenditure within the 2020-2025 regulatory period.	Input data provided by EQ

Defects and Replacements			
		Description/Justification	**Source**
Defects	22,486	Number of CTS/CTG defects to be replaced	Input data provided by EQ
Replacements - Counterfactual	-	Replace 0 CTS/CTG defects.	-
Replacements - Option 1	-	Replace all defects evenly over 5 years	
Replacements - Option 2	-	Replace all defects evenly over 7 years	-
Replacements - Option 3	-	Replace all defects evenly over 10 years	-

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	6,600	4	Cost of a fire scaled by a factor of 4.	

[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 ($/MWH)**	25,420	The value different types of customers place on having reliable electricity supplies under different conditions. Determined from survey results conducted by AEMO.	AEMO Value of Customer Reliability Fact Sheet
	Load (MVA)	1.61	Load lost per CTS/CTG issue. Calculated as a weighted average of load data for wooden poles.	Input data provided by EQL
	Hrs to restore	14	Time taken to get a CTS/CTG issue operating as usual. Based on typical travel and labour involved with CTS/CTG issues.	As agreed with EQL.
	Power Factor	0.85	The ratio which determines the real power used by EQL residential customers. Based on the typical uncompensated power factor for an EQL zone substation.	EQL 2018 DAPR – typical values
	Load Factor	0.2	A ratio of average load to peak load within a specific time. Acts as a measure of EQL's utilisation rate. Conservative value based on typical values for EQL residential load profiles.	As agreed with EQL.
	Percentage of Mix	88%	Percentage of EQL customers who are considered as residential loads. Based on the approximate mix of residential versus commercial customers in the EQL network as informed by customer type information.	As agreed with EQL.
Commercial	**VCR ($/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 CTS/CTG issue. 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 CTS/CTG issue operating as usual. Based on typical travel and labour involved with CTS/CTG issues.	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	300	Safety	5	0.01%	ICR – Approx. 1% of incidents are attributed to a single fatality. PoS - Calibrated to represent approx. 1 fatality every 30 years, conservative.	ICR - Assumed based on EQL and peer organisation industry experience. PoC – Input data provided by EQ
Major Injury	300	Safety	4	0.1%	ICR – Approx. 1% of incidents are attributed to a major injury fatality PoS - Calibrated to represent the historically expected 1 major injury every 3 years.	ICR - Assumed based on EQL and peer organisation industry experience. PoC – Input data provided by EQ
Fire	50	Fire	2	30%	ICR – Approx. 0.2% 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 CTS/CTG issues. PoS - 30% of incidents result in a fire. Based on the severity of the consequence being considered as moderate.	ICR - Assumed based on EQL and peer organisation industry experience. PoC - Assumed based on EQL and peer organisation industry experience.
Customer Outage	75	Customer	1	100%	ICR - Approx. 0.3% of incidents are attributed to outages PoS - 100% of incidents result in a customer outage Based on no redundancy within low to medium voltage (< 66kV) pole network.	ICR - Assumed based on EQL and peer organisation industry experience. PoC - Assumed based on EQL and peer organisation industry experience.
Total No. of Incidents	**22,486**	-	-	-	-	Input data provided by EQ

Appendix G. Reconciliation Table

Reconciliation Table Conversion from $18/19 to $2020	
Business Case Value	
(M$18/19)	$52.40
Business Case Value	
(M$2020)	$54.68

Appendix H. Overview of CTS/CTG Determination Processes

LiDAR Methodology

The EQL Group has been at the forefront of development and workflow implementation of Light Detection and Ranging (LiDAR) data acquisition and analysis to detect non-compliance with statutory clearances across the networks. LiDAR equipment is mounted on a light aircraft and measures distances by illuminating objects with pulsed laser light and measuring the reflected pulses with a sensor. Previously, the only way to manage electrical clearance issues across the network was via a regular system of inspections which relied on visual assessments of clearances by an individual person.

LiDAR technology is now able to provide an analysis of CTG and CTS distances across the entire EQL network in a shorter timeframe (cycle) than traditional capability permitted and has provided the EQL Group with knowledge of risks that were previously undetected. While the continued development and implementation of the LiDAR technology has delivered many safety benefits it has also presented some challenges for the EQL Group. For example, the enhancement of the LiDAR technology has led to a steep increase in the identification of defects which has then increased the volume of rectification work to be carried out across the Energex and Ergon networks.

As the sensitivity of technology improves the inevitable outcome is that more and more non-compliances are able to be detected by use of the technology. While this is a great outcome for safety across the network, it comes with the challenge of appropriately prioritising the non-compliances identified and hence has increased the investment required to rectify and address these defects

Inspection and Classification Process

The LiDAR technology provides automated analytics to determine clearance issues. The technology provides an output that details the measurement of clearances and includes relevant data including:

- Date and time of survey
- Geolocation of the pole
- Topographical reference level
- Height of attachment on each pole
- The span length (distance between the pole)
- The conductor length
- The clearance height from the ground
- Minimum clearance height and where it occurs

The system classifies defects based on risk criteria including clearance measurement, and location of defect eg. proximity to public infrastructure. The classification categories are Emergency Risk, High Risk, Medium Risk and Low Risk.

Following the provision of this data, some physical spot checking of the results occurs, with priority given to public, high-risk areas.

Temperature Adjustment

Many clearance issues will be worse under high ambient temperature conditions due to increased conductor sag. A methodology has been developed to identify further defects based on defined temperature conditions of 35^{o}C.

The LiDAR survey data does not provide all the inputs necessary to perform the sag calculations. The missing input values are derived based on engineering assumptions and practices. These derived values include:

- Ambient temperature - obtained by associating the time of the survey and the closest Bureau of Meteorology Site
- Conductor Type – Obtained by matching spans in Asset Database
- Conductor Tension – based on typical values for the span length and conductor type

For each surveyed span, the following calculation is done

1. The value of the clearance at the survey temperature is noted, $CL_{Ambient}$
2. The sag at the survey temperature using the actual and derived values, $S_{Ambient}$
3. the sag at the 35°C using the same the actual and derived values, S_{35}
4. The additional sag due to temperature is $\Delta S = (S_{35} - S_{Ambient})$
5. The clearance at 35°c is $CL35 = CL_{Ambient} - \Delta S$

A breach is determined when CL_{35} is less than the statutory height requirement

Defect Remediation

Clearance defects can be remediated using a range of options including:

- Conductor re-tensioning
- Pole Top structure re-build
- Pole replacement
- Additional poles
- Move structures that are encroaching on the lines

When defects have been identified, the clearance issues are examined in detail in the field and sometimes the remediation approach is the subject of engineering design processes. Once the optimal remediation approach has been determined then the work is issues for field remediation to occur.

Appendix I. Details of CTS/CTG Quantity Determination

The defect quantities have been derived from the following sequence of defect identification.

- In 2017, Ergon Energy conducted the Cycle 5 flight over its assets to determine defects. This cycle identified some 2,700 direct clearance defects and these were included in the Ergon Regulatory proposal in January 2019, at a value of $2.8M/year. These defects were spread across a range of repex categories.
- In May 2019, Ergon Energy conducted the Cycle 6 flight over its assets to determine defects. This cycle identified some 10,853 clearance defects.
- In September 2019, Ergon Energy completed analysis involving extrapolation of known clearances to account for peak temperature conditions, to ensure that lines retain required clearances at all times. This resulted in a further 15,000 defects predicted to occur during peak temperature conditions, which will require remediation.
- Ergon Energy expects to complete some 6,067 defects during 2019/20, which will leave 7,486 direct defects and 15,000 temperature related defects for remediation post 2019/20, i.e. 22,486 defects in total.