# Business Case
# Physical Linear Media

# Executive Summary

The Physical Linear Media Program is an ongoing program of work which addresses conditional issues with metallic pilot and fibre-optic cables that cause degradation of performance and in-service failure. These assets are the primary or secondary communication path for the communication network which includes the transmission of protection signalling, Supervisory Control and Data Acquisition (SCADA), and field voice services, services which are critical for the safe and efficient operation of Energy Queensland (EQL) networks.

Within the Ergon Energy network there is a small population of old metallic pilot cables which is experiencing significant degradation due to ageing and becoming obsolete with the roll-out of fibre optic compatible technologies. The majority of the network is made up of fibre optic cable which experiences 'fibre creep', which must be rectified by reconnecting cores within the fibre cable to restore services. These two issues threaten the performance and reliability of these assets, and left unaddressed will cause the assets to fail, resulting in communications outages.

The counterfactual, 'do nothing' option was considered but rejected. Failure to replace and rectify pilot cable and fibre creep would result in increasing instances of in-service failure, resulting in unacceptable risk to the communication network and increase the risk to staff, contractors and the community. The business would also possibly fail to reach the safety objective goals under this option. Two network options were evaluated as part of this business case:

**Option 1** – An accelerated program to replace all pilot cable and rectify fibre creep issues as soon as an alternative is possible.

**Option 2** – A risk-based rolling program, under which replacement and rectification of assets is based on risk assessments that include condition assessment and criticality of the specific services

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 both safety and reliability are strong drivers, based on the need to address known issues with physical linear media that will otherwise increase the rate of communications outages.

To this end, Option 2 is the preferred option as it has the least negative Net Present Value (NPV) result of the two options considered (-$3.6M compared to -$4.7M for Option 1), while still addressing the known issues with the network's physical linear media.

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 |
|---|---|---|
| $2.9M | N/A | $2.9M |

# Contents

# 1 Introduction

The Physical Linear Media Program addresses conditional issues with linear communications assets, specifically: metallic pilot cables which experience significant degradation due to ageing, and ‘fibre creep’ of fibre optic cables. Linear communication assets are the primary or secondary communication path for the communication network which includes the transmission of protection signalling, Supervisory Control and Data Acquisition (SCADA), and field voice services, services which are critical for the safe and efficient operation of Energy Queensland (EQL) networks.

This is an ongoing program which addresses the condition of assets over time, by replacing metallic pilot cable with fibre optic cable in the case of pilot cable failure, and rectifying fibre cable in the case of fibre creep. The program will be divided into multiple projects to address differing needs, priorities and completion timings.

## 1.1 Purpose of document

This document recommends the optimal capital investment necessary for the physical linear media program. 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 should be considered in conjunction with the EQL Asset Management Plan (AMP) – Communications Linear Assets, and the Intelligent Grid Technology Plan.

## 1.2 Scope of document

This document covers the Physical Linear Media program, which relates to the following assets:

- Metallic Pilot Cable; and,
- Fibre Optic Cable.

The Return to Service (RTS) project is excluded from the program and will operate in conjunction to mitigate risk of in-service failures.

## 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 both safety and reliability are strong drivers, based on the need to address known issues with physical linear media that will otherwise increase the rate of communications outages.

Metallic pilot and fibre optic cables are the primary or secondary communication paths for the communication network which includes the transmission of protection, SCADA, and field voice services. These assets experience conditional issues which can seriously degrade their performance, or even result in in-service asset failure and outage. The replacement and rectification of these assets is therefore required to ensure that the Ergon Energy network continues to operate in a safe and efficient manner. Failure to address these known conditional issues with appropriate asset management practices could result in the loss of critical services that are provisioned for safety and the support of basic services for the efficient completion of operational and supervisory activities.

Some of the potential consequences which can occur as a result of physical linear media failure include:

- Inadvertent tripping of feeder protection schemes when cables or cores fail;
- Increased risk of plant damage and larger than necessary outages;
- Reduction of security in the power network;
- Loss of contingency capability; and,
- Rendering alternate communication paths inoperable when required.

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

## 1.4 Energy Queensland Strategic Alignment

Table 1 details how the Physical Linear Media program contributes to Energy Queensland'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: Asset Function and Strategic Alignment**

| Objectives | Relationship of Initiative to Objectives |
|---|---|
| **Ensure network safety for staff contractors and the community** | Diligent and consistent maintenance and operations support asset performance and hence safety for all stakeholders. This program ensures network safety for staff, contractors, and the community who could be exposed to unacceptable levels of risk should primary protection services fail to operate due to cabling faults. |
| **Meet customer and stakeholder expectations** | Continued asset serviceability supports network reliability and promotes delivery of a standard quality electrical energy service. |
| **Manage risk, performance standards and asset investments to deliver balanced commercial outcomes** | Failure of this asset can result in increased public safety risk and disruption of the electricity network. Asset longevity assists in minimising capital and operational expenditure. This program supports maintenance of the current level of cost for other key network assets which incur plant stress, premature ageing, and damage when primary protections services fail to operate due to cabling faults. Additionally, this program is based on efficient investment principles, promoting replacement of assets at the end of their economic life as necessary to balance network risk, cost, and performance (service) outcomes. |
| **Develop Asset Management capability & align practices to the global standard (ISO55000)** | This approach is consistent with ISO55000 objectives and drives asset management capability by promoting a continuous improvement environment. |
| **Modernise the network and facilitate access to innovative energy technologies** | This approach promotes the replacement of assets at end of economic life as necessary to suit modern standards & requirements |

## 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 D.

Under its Distribution Authority, Ergon Energy is expected to operate with an 'economic' customer value-based approach to reliability, with "Safety Net measures" for extreme circumstances. Safety Net measures are intended to mitigate against the risk of low probability vs 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 Safety Net and MSS performance information are publicly reported annually in the Distribution Annual Planning Reports (DAPR). MSS performance is monitored and reported within Ergon Energy daily.

## 1.6 Compliance obligations

The table below 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**<br><br>**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:<br>• 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 supports the safe operation of the Ergon Energy network by taking a proactive approach to address known failure modes of the primary communication assets that provide protection, SCADA, and field voice services, all of which are critical to ensuring the safe operation of equipment and the safety of staff in the network. |
| **Distribution Authority for Ergon Energy issued under section 195 of *Electricity Act 1994* (Queensland)** | Under its Distribution Authority:<br>• 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.<br>• The distribution entity will ensure, to the extent reasonably practicable, that it achieves its safety net targets as specified. | This proposal supports economically efficient investment, promoting replacement of assets at the end of their economic life as necessary to balance network risk, cost, and performance (service) outcomes.<br><br>This proposal also promotes safety net and reliability standards, by reducing the rate |

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

| Legislation, Regulation, Code or Licence Condition | Obligations | Relevance to this investment |
|---|---|---|
| | • The distribution entity must use all reasonable endeavours to ensure that it does not exceed in a financial year the Minimum Service Standards (MSS) | of in-service failure of key communications assets. |
| **National Electricity Rules (NER), Chapter 5** | Schedule S5.1 of the National Electricity Rules, Chapter 5 provides a range of obligations on Network Services Providers relating to Network Performance Requirements. These include:<br>• Section S5.1.9 Protection systems and fault clearance times<br>• Section S5.1a.8 Fault Clearance Times<br>• Section S5.1.2 Credible Contingency Events | This proposal reduces the likelihood of in-service failure of communications assets, thereby reducing the risk that protection systems will be unavailable. |

## 1.7 Limitation of existing assets

Metallic pilot and fibre optic cables have material-specific failure modes which cause significant risk to the Ergon Energy network.

### Metallic Pilot Cable

There is only a very limited population of metallic pilot cable remaining in the Ergon Energy network, following a significant program of replacement with fibre optic cables started in 2003 and completed in the period 2008-14.

Due to age-related factors such as degradation of insulation and corrosion, metallic pilot cable performance is naturally degrading. This reduction in performance is increasing the difficulty of maintaining services over the network and increasing the risk to Ergon Energy's ability to remain compliant with NER legislative requirements. Repair of existing cabling upon failure is impractical due to all "pairs" having failed with no remaining spare, hence the need to replace entire cable lengths to ensure services are adequately returned to operation.

Metallic pilot cable is becoming an obsolete technology due to the uptake of fibre optic cable and fibre compatible equipment across the network. Equipment within the Ergon Energy network which is still reliant upon metallic cable is limited, and eventually, suppliers will begin to discontinue equipment compatible with metallic pilot cables as demand falls. In many cases when services stop operating due to age-related degradation, no alternative cabling is available to swap services to.

Ergon Energy must focus on improving and expanding the fibre cable network where possible and only retaining the outdated metallic pilot cable where it is not economic to move to the newer fibre cable.

### Fibre Cable

Fibre cable performance is being degraded through an increased occurrence of fibre creep. Fibre creep is the gradual elongation of individual fibre cores within a cable, which occurs when the fibre optic support cable does not provide the flexibility and extra "length" as designed to protect the optic fibres from stress or breakage. Fibre creep left untreated renders the cable cores inoperable due to breakage. The exact cause of this issue is unknown, and EQL databases indicate that it occurs very infrequently in the Energex network, and is therefore suspected to be a cable design problem specific to Ergon Energy installations. Fibre creep across the network is resulting in failures well before the expected life of the cable which need to be addressed as they arise.

In some cases, no pre-failure signs are present to detect fibre creep, and the fibre core can fail without warning. Fibre creep may be identified by routine inspection and by sudden degradation of the performance of the systems using the cabling. When fibre creep is identified it is rectified by re-terminating the impacted cores. Failure to rectify the cable that is affected with fibre creep significantly increases the potential of an asset failure and significant signal degradation.

# 2 Counterfactual Analysis

## 2.1 Purpose of asset

Linear communication assets are the primary or secondary communication path for the Ergon Energy communication network. These assets are responsible for the transmission of protection signalling, SCADA, and field voice services, all critical services for the safe and efficient operation of the network.

## 2.2 Business-as-usual service costs

There are only a limited number of operational metallic pilot cables (around 25 cables of total length of 42km). There is no available data on asset condition, age, or other factors for the limited number of pilot cables currently in service; however, anecdotal evidence from field staff is that the cabling is in a very poor state.

The network contains approximately 1,610km of fibre cable. The majority of pilot and fibre cables are located in urban areas and are susceptible to major weather events.

## 2.3 Key assumptions

Metallic and fibre pilot cables are subject to significant failure modes as they age. These ageing effects limit the correct functioning and capacity of the cables and can also cause sudden failure of the entire cable. Additionally, metallic cables are becoming obsolete as equipment relying on fibre cabling is rolled out across the network.

In a ‘Do Nothing’ counterfactual approach, these instances of degradation or imminent failure might not be identified by routine maintenance, causing cables to fail in-service. This has various potential impacts:

- **Tripping of Feeder Protection Scheme When Cables / Cores Fail:** In some limited cases such as DC (Direct Current) direct inter-tripping and some feeder differential schemes, when cables/cores fail the protection may mal-operate, causing tripping of feeders and resulting in loss of supply. This has potential customer impacts.
- **Increased Risk of Plant Damage and Larger than Necessary Outages:** For periods when protection circuits are not operating there are potential risks to of damage or premature ageing to plant equipment due to longer periods before backup protection systems clear faults. There are also increased outage impacts should a fault occur during the period of communication issues. While the duration of protection circuits not operating is normally a short period during repairs, in some cases such as a silent failure, it can be an indeterminate period.
- **Security in the Power Network May be Reduced:** If a protection circuit is lost on a 33KV, 110KV, or 132KV feeder (and on certain important 11kV feeders) it may be necessary to de-energise the feeder. This results in an abnormal network configuration and loss of N-1 security until such time as the circuits can be returned, increasing the risk of otherwise un-necessary outages.
- **Loss of Contingency Capability:** When issues occur, various indirect consequences can increase the risk to the organisation. For example, the failure of a pilot cable can result in the inability to utilise contingency feeders due to loss of SCADA control.
- **Alternate Paths Inoperable when Required:** In many cases Ergon Energy relies on alternative paths for the cable to allow services to be rerouted when a fault occurs.

Increasingly these alternative paths cannot be relied on to allow services to be re-routed due to the presence of degraded pilot cables.

As well as the potential safety, reliability, and security impacts which may occur as a result of in-service degradation or failure of linear communication assets, a Do-Nothing approach does not represent prudent application of asset management principles. The counterfactual ignores known failure modes in both cable types (discussed in Section 1.7) and the increasing obsolescence of metallic pilot cables, and the fact that replacing or repairing assets after in-service failure carries significant emergency cost increases

## 2.4 Risk assessment

Table 3 outlines the risk assessment for the counterfactual 'Do Nothing' scenario with no proactive program in place to address linear media conditional issues. This risk assessment is in accordance with the EQL Network Risk Framework and the Risk Tolerability table from the framework is shown in Appendix E.

**Table 3: Counterfactual risk assessment**

| Risk Scenario | Risk Type | Consequence (C) | Likelihood (L) | Risk Score | Risk Year |
|---|---|---|---|---|---|
| Protection – Failure to duplicate communication paths for protection services results in a breach of National Electricity Rules and an **improvement notice issued by the regulator**. | Legislated | 4<br>*(Improvement notice issued by regulator)* | 3<br>*(Unlikely)* | **12**<br>*(Moderate risk)* | 2019 |
| Protection – An unstable or failed communications path results in delayed relay operation and the fault is unable to be cleared within specified timeframes, resulting in **catastrophic damage to equipment and plant and an inability to control ≥2 bulk supply substations supply area**. | Business | 4<br>*(Inability to remotely control ≥2 bulk supply substations supply area)* | 3<br>*(Unlikely)* | **12**<br>*(Moderate Risk)* | 2019 |
| Protection – A single fatality occurs when an unstable or failed communications path results in delayed relay operation and the **fault is unable to be cleared within specified timeframes**. | Safety | 5<br>*(Single Fatality / Incurable Fatal Illness)* | 3<br>*(Unlikely)* | **15**<br>*(Moderate risk)* | 2019 |
| SCADA – Failure of linear media connection results in loss of visibility of SCADA derived data which leads to a **reduced capacity to remotely control sections of the Ergon Energy network**. | Business | 3<br>*(Inability to remotely control an Ergon substation)* | 4<br>*(Likely)* | **12**<br>*(Moderate risk)* | 2019 |
| Corporate voice/data – Failure of corporate voice, data and internet communication results in inability to access corporate IT (Information Technology) systems and **inability to remotely control or manage the network across multiple sites.** | Business | 3<br>*(Inability to remotely control an Ergon substation)* | 3<br>*(Unlikely)* | **9**<br>*(Low risk)* | 2019 |

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

## 2.5 Retirement or de-rating decision

Physical linear media assets play a critical role in transmission of SCADA and protection signalling throughout the Ergon Energy network, and therefore cannot be retired. While this program recognises that metallic pilot cables are becoming obsolete as newer equipment suitable only to fibre cable connection is rolled out across the network and thus effectively dictates the retirement of metallic cabling in favour of fibre cable, the role of physical linear media within the network is crucial, and these assets cannot be retired.

# 3 Options Analysis

## 3.1 Options considered but rejected

One option was considered but rejected:

- **Do Nothing:** This option has been rejected, as failure to replace and rectify pilot cable and fibre creep would result in increasing instances of in-service failure, resulting in unacceptable risk to the communication network and increase the risk to staff, contractors and the community. The business will possibly fail to reach the safety objective goals under this option. This option also fails to acknowledge the increasing obsolescence of metallic pilot cable, and the need to transition away from this technology and thus is a poor asset management approach.

## 3.2 Identified options

Two options were identified and considered as part of this analysis:

- Option 1 – Accelerated Program; and,
- Option 2 – Risk Based Rolling Program.

### 3.2.1 Network Options

#### Option One – Accelerated Program

Replace all pilot cable and rectify fibre creep issues as soon as an alternative is possible. This proposal is not considered prudent as it unnecessarily brings forward expenditure and is potentially less cost efficient as geographical bundling of replacements by sites may not be complete.

#### Option Two – Risk Based Rolling Program (Recommended)

Continue to focus on cost efficient and prudent replacement and rectification of assets based on risk assessments that include condition assessment and criticality of the specific services. The replacement and rectification of pilot cable and fibre creep where feasible will be bundled with other work at the specific site locations.

### 3.2.2 Non-network options

There are no viable non-network options in this case.

## 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 over the program lifetime from FY2019/20 to FY2038/39, using the EQL standard NPV analysis tool. The tool incorporates any residual value for assets at the end of the program lifetime into the NPV analysis. The following costs and benefits have been considered for each option.

### Rate of Failure

In order to quantify the rate of unit failure for each option and associated cost of emergency works, an estimated failure rate was calculated for both metallic and fibre cables based on asset data from the wider EQL network.

Unfortunately, there is no data on asset age, condition or failure rate for the remaining metallic pilot cable population within the Ergon Energy network. Data on Energex pilot cable asset condition, shown in Figure 1, demonstrates that pilot cables tend to degrade as they age, however, the Energex pilot cable population is much larger and more diverse than Ergon Energy, and therefore comparison between the two is unreliable.

Due to the high degree of uncertainty associated with pilot cables in Ergon Energy networks, consideration of pilot cable failure outside of the planned replacement programs in Options 1 and 2 has been excluded from this study.

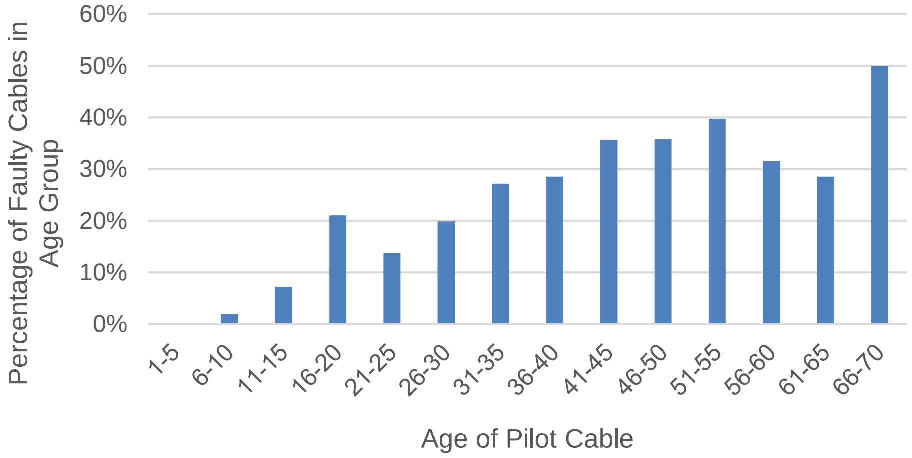


**Figure 1: Faulty metallic pilot cables within Energex (EQL AMP – Communications Linear Assets)**

Data on fibre creep associated failures from cables in the Ergon Energy network, as shown in Figure 2, has been used in this analysis to establish a failure rate due to fibre creep. By taking into account both ‘Macro Bend’ and ‘Fibre Break’ failure types, an annual average rate of failure was determined at a value of 2.6 failures per year as a result of fibre creep.

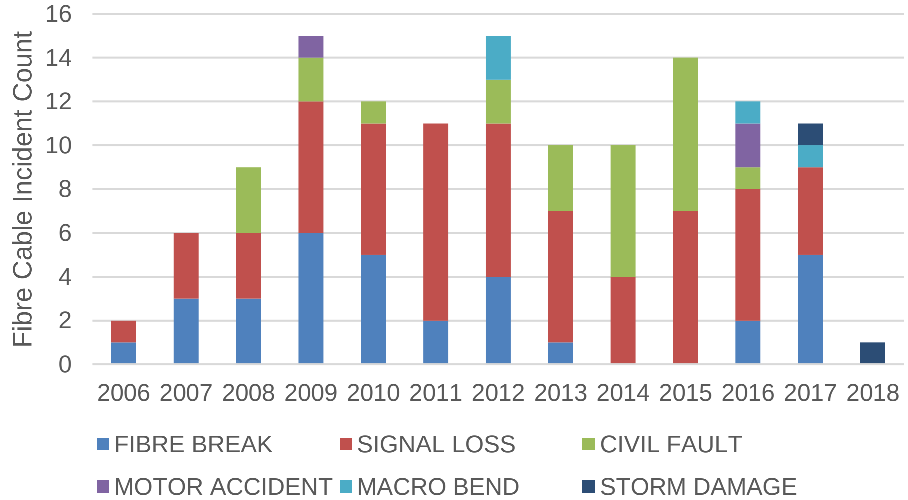


**Figure 2: Fibre cable faults within Ergon Energy (EQL AMP – Communications Linear Assets)**

In Options 1 and 2 where planned replacement of known at-risk assets takes place, no failure of fibre cable is considered during the period 2019/20 to 2024/25. The risk-based approach and condition assessments used to assess asset criticality in Option 2 are assumed to be sufficient to prevent in-service failure due to fibre creep during the program, as is the overhaul of all known at-risk assets in Year 1 for Option 1.

Given the nature of fibre creep failure, it is assumed that some baseload rate of failure might occur in each option past 2024/25 (without taking into account future programs of work).

### Capital Cost – Pilot Cable Replacement

The capital costs (CAPEX) associated with each option have been defined as the materials and labour costs required to replace metallic pilot cable with fibre optic cable in the case of pilot cable failure, or to rectify fibre cable in the case of fibre creep.

The CAPEX associated with pilot cable replacement is calculated as follows:

- **Unit Cost of Overhead Fibre:** The unit cost to replace fibre cable is calculated as $67,704/km, based on an estimated cost breakdown of $34,904/km for materials, and $32,800/km for labour. These values were sourced from EQL data on typical work programs.

Several factors can introduce additional costs or savings to capital works associated with communications linear assets replacement, such as:

- Geographical bundling of replacement works with other planned network operations can produce significant labour efficiencies for programs.
- Works carried out in urban areas tend to incur a much higher labour rate due to added project complexity associated with such issues as traffic management and time restrictions.
- Long-length cable replacements tend to produce significant savings from materials costs when compared to the 1km breakdown presented above.

The program developed for Option 2 accounts for both the likely delays and potential efficiencies in project operations, and has been used as a best-practice benchmark in this analysis. Options 1 which has accelerated programs of works and therefore likely will see higher costs due to inefficient bundling of works, has been assumed to incur a 20% higher CAPEX rate than Option 2.

### Capital Cost – Fibre Cable Rectification

In the case of fibre creep, it is rare that the fibre cable is entirely replaced. Instead, rectification works are typically carried out, reconnecting or re-splicing cores within the fibre cable to re-establish the lost services. The CAPEX associated with fibre cable rectification is calculated as follows:

- **Cost of Rectification:** Fibre rectification is a labour-intensive activity, typically costing around $35,707 per section for labour. No material cost has been considered for planned fibre rectification works.

As with pilot replacement works, the bundled nature of Option 2 works has been accounted for by applying a premium of 20% to costs in Option 1.

### Capital Cost – Fibre Cable Rectification, Emergency Works

In the case of emergency rectification works for fibre creep, field teams are typically required to implement a temporary solution to re-establish the lost services before carrying out the usual rectification works.

Implementing a temporary solution typically requires 8-12 hours work for two to four staff, at a rate of $100/hour, with penalty rates considered due to the emergency nature of works (at a rate of 1.5x for the first three hours, and 2x for each hour after). There is an additional materials and equipment expense of around $1,000 to $2,000 incurred. The total additional cost for this activity is therefore in the range of $3,900 and $11,000. Taking the average value for each of these additional costs, the total extra cost for temporary workaround works has been included in this study at $7,050 per event.

The cost of standard rectification works must also then be considered for each emergency event. The labour cost of rectification has been conservatively considered to be the same as that of planned works in Option 2 for each option.

### Operating Costs

Data on the operating cost of fibre optic cable compared to metallic pilot cable is unavailable, due to the limited population of metallic cable within the Ergon Energy network. Additionally, as the population of metallic pilot cables is insignificant compared to the much larger population of fibre cable, the switch from one material to another across the entire Ergon Energy network is unlikely to have a material impact on the analysis. Operating costs of different cable types have therefore not been considered in this analysis.

### Program of Replacement

The program of planned unit replacement works for each option is outlined in Table 4.

**Table 4: Planned Replacement Pilot Cable and Rectification of Fibre Cable Under Each Option**

| Option | Length Replaced | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | Total |
|---|---|---|---|---|---|---|---|---|
| **Option 1** | Metallic pilot cable (km) | 42 | - | - | - | - | - | **42** |
| | Fibre cable (sections) | 18 | - | - | - | - | - | **18** |
| **Option 2** | Metallic pilot cable (km) | 7 | 7 | 7 | 7 | 7 | 7 | **42** |
| | Fibre cable (sections) | 3 | 3 | 3 | 3 | 3 | 3 | **18** |

The program of replacement presented for Option 2 in Table 4 represents a small change from the program presented in the original proposal submitted to the AER in January 2019, with metallic pilot cable lengths in 2019/20 and 2020/21 increased to 7km from 6km in order to address the entire existing population of pilot cable.

Key assumptions constant across both options include:

- The linear assets do not experience an accelerated failure rate.
- Asset condition assessed from field Communication Technicians during site maintenance is based on the same criteria and acceptable standard across all field groups.
- The fibre creep rectification work is successful, and the issue does not return for the remaining life of the asset.
- The replacement fibre meets the expected life forecasted.
- The infrastructure that is utilised for pilot cable can be reused for fibre cable.
- No delay or extended delivery times greater than 3 months.

### Results

Using the assumptions outlined previously, the Present Value (PV) and Net Present Value (NPV) results of each option, discounted at the Regulated Real Pre-Tax Weighted Average Cost of Capital (WACC) rate of 2.62% (as specified in the EQL Standard NPV Tool) in 2018/19 dollars are outlined in Table 5.

Based on the NPV results presented in Table 5, Option 2 presents the most economically efficient option for investment.

**Table 5: Net present value of options**

| Option | CAPEX (PV $M) | NPV ($M) |
|---|---|---|
| **Option 1** | (4.73) | (4.73) |
| **Option 2** | (3.56) | (3.56) |

## 3.4 Scenario Analysis

### 3.4.1 Sensitivities

Sensitivity analysis was considered on several key variables in this analysis:

- CAPEX rate increase for Option 1 compared to Option 2. The base value used was 20%, with sensitivities of 0% and 10% considered.
- Rate of fibre creep occurrence. Sensitivities of +/-20% were considered on the base rate of 2.6 sections/year.

The results of sensitivity analysis are shown in Table 6, with NPV of each option presented at the regulated real pre-tax WACC rate of 2.62%. Option 2 is the most economically efficient option under each sensitivity considered, even when the same cost efficiencies associated with a planned and geographically bundled program are applied to the alternative options. Option 1 unnecessarily brings forward expenditure and would likely carry higher risk of in-service cable failure due to fibre creep in the later years of the program, without a planned program for monitoring and replacement in those years.

**Table 6: Sensitivity analysis**

| NPV ($M) | Base NPV | CAPEX rate increase for Option 1 (Base rate 20%) | | Fibre Creep Frequency | |
|---|---|---|---|---|---|
| | | 10% | 0% | 20% | -20% |
| **Option 1** | (4.73) | (4.38) | (4.03) | (4.84) | (4.62) |
| **Option 2** | (3.56) | (3.56) | (3.56) | (3.67) | (3.45) |

### 3.4.2 Value of regret analysis

Option 2 presents the least-regret option in this program, as it 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. It acknowledges the need to phase out increasingly obsolete pilot cable technology, but does so in a way that allows assets to remain in-service while they are still in an acceptable condition, thereby maximising asset useful life. The key regret issue identified in this case is a major communication failure resulting in significant loss of supply and possible safety consequences. The proposed option targets replacements of the key populations on a staged basis which is both economically efficient and also reduces the risk of the key regrets. Hence it provides the lowest value of regret for an economically efficient option.

## 3.5 Qualitative comparison of identified options

### 3.5.1 Advantages and disadvantages of each option

Table 7 details the advantages and disadvantages of each option considered.

**Table 7: Assessment of options**

| Options | Advantages | Disadvantages |
|---|---|---|
| **Network Option 1 – Accelerated Program** | • Full replacement of all pilot cable as soon as possible will result in the most complete reduction of risk of pilot cable failure. | • Unnecessarily brings forward expenditure.<br>• Unnecessary replacement of assets which are not categorised as at risk.<br>• Potentially less cost efficient as bundling of replacements based on geographical sites may not be complete. |
| **Network Option 2 – Risk Based Rolling Program** | • Risk-based replacement framework targets efficient upgrading of assets based on condition assessment and criticality.<br>• More cost-efficient program than Option 1, as assets that are still in an acceptable condition are not considered for replacement.<br>• Additional cost efficiency gained through geographical bundling with other programs of work. | • Does not totally reduce risk of pilot cable failure within the study period, as not all of the pilot cable population is replaced immediately.<br>• The condition assessment and risk-based program will likely result in the most efficient reduction of failure risk for fibre creep issues, as field staff may be able to identify imminent failure through the planned assessment program. |

### 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 supports Energy Queensland's transition to a modern communications network, addressing the obsolescence and risks associated with physical linear media in a manner which balances risk and cost. This is in alignment with the Future Grid Roadmap and Intelligent Grid Technology Plan, which promote the use of modern technology in maintaining affordability of the distribution network while also maintaining safety, security and reliability of the energy system, and supporting optimal customer outcomes and value across short, medium and long-term horizons.

Additionally, customers have indicated they want prudent investments in technology to modernise the network, to enable them to interact with the network, manage their electricity costs and take advantage of new products and technology developments. A modern communication network is a critical part of the intelligent grid of the future that will enable this for customers.

### 3.5.4 Risk Assessment Following Implementation of Proposed Option

Table 8 outlines the risk assessment for the asset class following implementation of the Physical Linear Media program.

**Table 8: Risk assessment showing risks mitigated following Implementation**

| Risk Scenario | Risk Type | Consequence (C) | Likelihood (L) | Risk Score | Risk Year |
|---|---|---|---|---|---|
| Protection – Failure to duplicate communication paths for protection services results in a breach of National Electricity Rules and an **improvement notice issued by the regulator**. | Legislated | (Current)<br>*4*<br>*(Improvement notice issued by regulator)*<br>(Mitigated)<br>4<br>*(As above)* | *3*<br>*(Unlikely)*<br>2<br>*(Very Unlikely)* | **12**<br>*(Moderate Risk)*<br>**8**<br>*(Low risk)* | 2019 |
| Protection – An unstable or failed communications path results in delayed relay operation and the fault is unable to be cleared within specified timeframes, resulting in **catastrophic damage to equipment and plant and an inability to control ≥2 bulk supply substations supply area**. | Business | (Current)<br>*4*<br>*(Inability to remotely control >=2 bulk supply substations supply area)*<br>(Mitigated)<br>4<br>*(As above)* | *3*<br>*(Unlikely)*<br>2<br>*(Very Unlikely)* | **12**<br>*(Moderate Risk)*<br>**8**<br>*(Low risk)* | 2019 |
| Protection – A single fatality occurs when an unstable or failed communications path results in delayed relay operation and the **fault is unable to be cleared within specified timeframes**. | Safety | (Current)<br>*5*<br>*(Single Fatality / Incurable Fatal Illness)*<br>(Mitigated)<br>5<br>*(As above)* | *3*<br>*(Unlikely)*<br>2<br>*(Very unlikely)* | ***15***<br>*(Moderate Risk)*<br>**10**<br>*(Low risk)* | 2019 |
| SCADA – Failure of linear media connection results in loss of visibility of SCADA derived data which leads to a **reduced capacity to remotely control sections of the Ergon Energy network**. | Business | (Current)<br>*3*<br>*(Inability to remotely control an Ergon substation)*<br>(Mitigated)<br>3<br>*(As above)* | *4*<br>*(Likely)*<br>3<br>*(Unlikely)* | ***12***<br>*(Moderate Risk)*<br>**9**<br>*(Low risk)* | 2019 |
| Corporate voice/data – Failure of corporate voice, data and internet communication results in inability to access corporate IT (Information Technology) systems and **inability to remotely control or manage the network across multiple sites.** | Business | (Current)<br>*3*<br>*(Inability to remotely control an Ergon substation)*<br>(Mitigated)<br>3<br>*(As above)* | *3*<br>*(Unlikely)*<br>2<br>*(Very unlikely)* | ***9***<br>*(Low risk)*<br>**6**<br>*(Low risk)* | 2019 |

# 4 Recommendation

## 4.1 Preferred option

The preferred option in this program is Option 2, a Risk-Based Rolling Program to address pilot cable obsolescence and degradation and fibre creep at sites based on their criticality. The program presents significant cost efficiencies compared to other options by geographical bundling of works and does not unnecessarily bring forward capital cost.

## 4.2 Scope of preferred option

The scope of works planned for Option 2 is outlined in Table 9.

**Table 9: Planned Replacement and Rectification Works**

| | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | Total |
|---|---|---|---|---|---|---|---|
| **Metallic pilot cable replaced (km)** | 7 | 7 | 7 | 7 | 7 | 7 | **42** |
| **Fibre optic cable rectification (sections)** | 3 | 3 | 3 | 3 | 3 | 3 | **18** |

The annual CAPEX associated with Option 2 is outlined in Table 10, in real 2018/19 dollars. The total CAPEX spend planned for the six-year program is $3,486,307, and the CAPEX associated with the 2020/21 to 2024/25 regulatory period is $2,905,256. This represents a $1,047 increase in the cost associated with the next regulatory period from the cost presented in the original submission to the AER, due to rounding of annual costs.

**Table 10: Planned Annual CAPEX Spend Under Option 2 Program**

| | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | Program Total | Next Reg. Period Total |
|---|---|---|---|---|---|---|---|---|
| **Labour** | $336,721 | $336,721 | $336,721 | $336,721 | $336,721 | $336,721 | $2,020,329 | $1,683,607 |
| **Material** | $244,330 | $244,330 | $244,330 | $244,330 | $244,330 | $244,330 | $1,465,979 | $1,221,649 |
| **Total** | **$581,051** | **$581,051** | **$581,051** | **$581,051** | **$581,051** | **$581,051** | **$3,486,307** | **$2,905,256** |

# 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).*


AEMC, *Integrating Distributed Energy Resources for the Grid of the Future, Economic Regulatory Framework Review,* (26 September 2019).

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

Energy Queensland, *Asset Management Plan, Communications Linear Assets [7.029]*, (31 January 2019).

Energy Queensland, *Customer Quality of Supply Strategy [7.047],* (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, *Low Voltage Network Monitoring Strategy [7.080],* (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 |
| AMP | Asset Management Plan |
| 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 |
| EQL | Energy Queensland Ltd |
| IT | Information Technology |
| KRA | Key Result Areas |
| 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 |
| PV | Present Value |
| RTS | Return to Service |
| SAIDI | System Average Interruption Duration Index |
| SAIFI | System Average Interruption Frequency Index |
| SAMP | Strategic Asset Management Plan |

| Abbreviation or acronym | Definition |
|---|---|
| SCADA | Supervisory Control and Data Acquisition |
| 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 11: Alignment with NER**

| Capital Expenditure Requirements | Rationale |
|---|---|
| **6.5.7 (a) (2)**<br>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 | As indicated in Table 2, this proposal ensures that safety obligations, reliability obligations and protection requirements are met by providing an appropriate, economically efficient program of works to prevent in-service failure of physical linear media assets. Without this program, these obligations would be at significant risk of being breached. |
| **6.5.7 (a) (3)**<br>The forecast capital expenditure is required in order to:<br>(iii) maintain the **quality, reliability and security of supply** of supply of standard control services<br>(iv) maintain the **reliability and security of the distribution system** through the supply of standard control services | This program of work ensures the integrity of communications functions that support SCADA, protection, voice and data communications systems. They are critical in the provision of network reliability in support of MSS and safety net security and reliability targets. |
| **6.5.7 (a) (4)**<br>The forecast capital expenditure is required in order to maintain the **safety of the distribution system** through the supply of standard control services. | This program of work ensures the integrity of communications functions that support SCADA, protection, voice, and data communications systems. They are critical in ensuring safety through correct protection operation, and through the availability of voice and data communications. |
| **6.5.7 (c) (1) (i)**<br>The forecast capital expenditure reasonably reflects the **efficient costs** of achieving the capital expenditure objectives | The options considered in this proposal take into account the need for efficiency in delivery. The preferred option has utilised a delivery approach that provides for bundling of work in terms of both timing and geography to enable a lower cost delivery compared to other options. It generally avoids emergency replacements that incur higher costs by enabling efficient use of labour resources in the delivery of the work programs.<br>Specialised contractors are utilised as appropriate to ensure that costs are efficiently managed through market testing.<br>Cost performance of the program will be monitored to ensure that cost efficiency is maintained.<br>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)**<br>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.<br>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 12: 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**<br>***Operate safely as an efficient and effective organisation***<br>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**<br>***Be Community and customer focused***<br>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**<br>***Strengthen and grow from our core***<br>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**<br>***Operate safely as an efficient and effective organisation***<br>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**<br>***Create value through innovation***<br>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)<br>Introduce new or changed risk treatments to reduce level of risk<br>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<br>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<br>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 3: A Risk Tolerability Scale for evaluating Semi-Quantitative risk score**

# Appendix F. Reconciliation Table

| Reconciliation Table<br>Conversion from $18/19 to $2020 | |
|---|---|
| **Business Case Value** | |
| **(M$18/19)** | $2.90 |
| | |
| **Business Case Value** | |
| **(M$2020)** | $3.01 |