Business Case

Diverse Communications and Duplicate Protection in the Sub-Transmission Network

Part of the Energy Queensland Group

Executive Summary

Energy Queensland's protection assets are vital to ensure the safe, reliable operation of the electricity grid in Queensland. Comprehensive protection schemes are required to ensure all faults are automatically cleared with minimal fault duration and minimal network isolation. Protection must not trip when there is no fault present, or when another device could clear the fault with less network isolated.

The drivers associated with this program are largely due to non-compliance with the National Electricity Rules (NER), which requires protection that can operate within prescribed clearing times with one element out of service, and the risk of uncleared or slow clearing faults causing damage to high voltage equipment. This document recommends the optimal capital investment necessary for implementation of new protection schemes to address system risks posed by lack of duplicate communications for protection on nine 100kV+ transmission lines and lack of duplicate protection on 14 100kV+ transformers.

Three options were considered but rejected; a counterfactual, 'do nothing' option, an option to install a backup protection scheme, and an option to implement a risk-based augmentation program. All three were rejected due to the associated risks being unacceptably high, and the likelihood they would lead to non-compliance with the NER.

One option to address lack of duplication in protection and communications has been evaluated in this business case, as there are no alternate options to resolve the protection deficiencies in the sub-transmission network due to the compliance requirements of the NER.

Option 1 – Rectification of known transmission line and transformer protection deficiencies within the 2020-25 regulatory period

Energy Queensland 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 regulatory obligations with respect to protection service requirements under the NER are a strong driver, due to the need to rectify known protection deficiencies on 14 100kv+ transformers in the EQL network.

Option 1 is the only way to comply with the NER protection requirements. The option has a Net Present Value of $0.87M. The proposed work will provide the following benefits:

- Ensure EQL is compliant with its obligations under the NER
- Reduce the risk of faults damaging high voltage equipment
- Reduce the risk of extended faults tripping off generators due to system instability
- Improves reliability by potentially reducing amount of network isolated during a fault

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	$0	$1.1M

Note the original Regulatory Proposal bundled Diverse Communications protection schemes with those for SEF and DER, and as such there is not an applicable original direct cost for this business case from the Regulatory Proposal submissions.

Contents

1. Introduction

Protection systems ensure the safe and reliable functioning of the power network during power system abnormalities. The primary function of the protection system is to detect and disconnect faults (for example, a power line on the ground) from the power system.

Reliable operation of protection schemes is vital to eliminating risks such as electrocution, damage to equipment and maintaining system stability. Failure of a protection scheme to operate correctly results in unsafe conditions until manual intervention or back up arrangements are invoked.

1.1 Purpose of document

This document recommends the optimal capital investment necessary for implementation of new protection schemes to address system risks posed by lack of duplicate communications for protection and lack of duplication protection on transformers at sub-transmission voltages.

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 Energy Queensland (EQL) 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.

1.2 Scope of document

This document lays out the requirement for installation and duplication of high-speed protection schemes and communications for transformers and power lines that are greater than or equal to 100kV. This document examines the needs of both Energex and Ergon Energy (Ergon), however the only work identified for compliance is in the Ergon network.

1.3 Identified Need

Energy Queensland 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 regulatory obligations with respect to protection service requirements under the NER are a strong driver, due to the need to rectify known protection deficiencies on 14 100kv+ transformers in the EQL network.

This program is required to ensure Energy Queensland can meet current and future business requirements and will support meeting our obligations for legislated compliance, by ensuring ongoing and reliable operation of protection schemes.

In many cases, the schemes implemented in the past no longer meet the current requirements of the National Electricity Rules (NER), which requires duplicated communications assisted protection schemes to meet prescribed clearing times for voltages greater than 100kV.

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 protection schemes contribute 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	Ensure protection clearing times are sufficiently fast to reduce the energy released under fault conditions, reducing the likelihood of; catastrophic failure of equipment, ignition of a fire, and collateral damage including airborne debris. Ensure a fault is cleared within the NER prescribed clearing times with failure of any single element in a protection scheme, including communications failure.
Meet customer and stakeholder expectations	Quickly and reliably remove faults from the network, protecting customer and stakeholder equipment and ensuring network stability is not adversely impacted.
Manage risk, performance standards and asset investments to deliver balanced commercial outcomes	Reliable protection schemes can reduce the amount of network, and therefore number of customers, isolated from the power system during a fault. Comply with NER requirements to avoid being issued with a Notice to Improve or fines.
Develop Asset Management capability & align practices to the global standard (ISO55000)	Timely development of infrastructure, including appropriate protection schemes and using suitable asset standards aligns with the practices in ISO55000.
Modernise the network and facilitate access to innovative energy technologies	Modern performance standards and industry practice requires duplicate protection schemes, including communications.

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 the Distribution Authorities, EQL 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. EQL 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 EQL daily.

1.6 Compliance obligations

Table 2 shows the relevant compliance obligations for this proposal.

Table 2: Compliance obligations related to this proposal

Legislation, Regulation, Code or Licence Condition	Obligations	Relevance to this investment
QLD Electrical Safety Act 2002 **QLD Electrical Safety Regulation 2013**	We have a duty of care, ensuring so far as is reasonably practicable, the health and safety of our staff and other parties as follows: • Pursuant to the Electrical Safety Act 2002, as a person in control of a business or undertaking (PCBU), EQL has an obligation to ensure that its works are electrically safe and are operated in a way that is electrically safe.[1] This duty also extends to ensuring the electrical safety of all persons and property likely to be affected by the electrical work.[2]	Robust protection schemes on the high voltage network are necessary to meet EQL's obligation under the Electrical Safety Act 2002.
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)	Robust protection schemes ensure that faults are cleared within the requisite clearing times, reducing the risk of equipment damage, system instability, or excessive network isolated to clear a fault. This aids EQL in ensuring that safety net targets are achieved, and reliability of electricity services is maintained.
National Electricity Rules, 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: • Section S5.1.9 Protection systems and fault clearance times • Section S5.1a.8 Fault Clearance Times • Section S5.1.2 Credible Contingency Events	Duplicated high-speed protection and communications are required to comply with the NER.

1.7 Limitation of existing assets

Section S5.1a.8 of the NER stipulates prescriptive fault clearance times for both primary and backup protection at voltages above 100kV. Section S5.1.9(d) stipulates that all faults must be automatically disconnected by protection schemes with sufficient redundancy to operate with any single protection element, including protection communications, out of service.

EQL has identified 8 two-ended feeders and 1 three-ended feeder with voltages greater than 100kV in the Wide Bay region of the Ergon network which have fault clearing times and a lack of redundancy that does not comply with the NER. EQL has 14 known power transformers that operate at voltages greater than 100kV which have non-compliant backup protection clearing times.

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

2 Counterfactual Analysis

2.1 Purpose of asset

Energy Queensland's protection assets are vital to ensure the safe, reliable operation of the electricity grid in Queensland. Comprehensive protection schemes are required to ensure all faults are automatically cleared with minimal fault duration and minimal network isolation. Protection must not trip when there is no fault present, or when another device could clear the fault with less network isolated.

2.2 Business-as-usual service costs

2.3 Key assumptions

The following were assumed during the analysis for this business case:

- Existing deficiencies in clearing time or redundancy will not be addressed as part of other projects, for example, substation refurbishments or relay replacement due to age
- If the backup protection on a transformer is unable to clear a fault quickly enough, an upstream element may operate, which could result in the whole substation being de-energised. Bulk supply substations can supply significant demand.

The following is an example of the cost of business as usual. If the slow clearing fault is not cleared by upstream protection, then the transformer itself may be damaged. This could result in significant repair cost of up to ~$1M for replacement of a transformer.

- Barcaldine bulk supply substation's peak load is 21.7 MVA.
- Assuming a load factor of 0.8 and a power factor of 0.9, if the substation is de-energised for 2 hours and there are no available transfers then the total unserved energy will be 31.25MWh.
- Applying an aggregated weighted average Value of Customer Reliability (VCR) value for Queensland of $39.71 per kWh, as provided by the Australian Energy Market Operator (AEMO), the potential cost of unserved energy for this one event would be $1.2M.

2.4 Risk assessment

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
Failure of protection and no or inadequate backup protection results in failure to quickly clear a 100kV+ transformer fault resulting in **significant equipment damage requiring replacement**.	Business	4 *(>$1,000,000)*	2 *(Very unlikely)*	**8** *(Low)*	2019
Unstable or failed communications path with no duplicate results in delayed relay operation and the fault is unable to be cleared within specified timeframes resulting in **a single fatality**.	Safety	5 *(Single fatality)*	2 *(Very unlikely)*	**10** *(Low)*	2019

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
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 *(Energex/Ergon identified issue requiring regulator to be notified. Improvement notice issued)*	3 *(Unlikely)*	**12** *(Moderate)*	2019

2.5 Retirement or de-rating decision

Retiring lines or transformers without adequate protection or duplicate communications is not a reasonable option to rectify the non-compliance issues. De-rating does not address the issue and has not been considered.

3 Options Analysis

3.1 Options considered but rejected

Installation of a Backup Protection Scheme

Instead of duplicating communications, an option to install a backup protection scheme that does not rely on communications was considered, provided this backup scheme can meet the prescribed backup clearing times determined by NER clause S5.1.9(e).

In practice, it is impossible to meet these clearing times without communications assisted high-speed protection without negatively impacting reliability. Without communications assistance, high-speed protection must be limited in the faults it can detect and clear to prevent excessive network isolation.

This option was rejected due to not meeting the compliance requirements and increased safety and equipment risk due to longer fault clearance time.

Risk-Based Augmentation Program

A risk-based augmentation program with the following scope was considered:

- Identify 100kV+ feeders with non-compliant protection/communication and classify by importance to the network. This may include:
    - Feeders that supply high customer density locations
    - Feeders that connect critical generators to the National Electricity Market (NEM)
    - Feeders in areas with historically more common faults
- Prioritise augmentation of identified feeders in this regulatory period
- Complete augmentation of non-compliant feeders in the next regulatory period

However, this option was rejected due to the 10-year time frame to resolve the safety and compliance risks, which is unacceptable.

3.2 Identified options

3.2.1 Network options

Option 1 – Rectification within the 2020-25 regulatory period

There are no alternate options to resolve the protection deficiencies in the sub-transmission network due to the compliance requirements of the NER. Duplicate protection, including communications, must be present on power networks at voltages greater than 100kV. It is unsafe and non-compliant to delay resolving the identified issues over multiple regulatory periods. This option involves:

Diverse Communications

- Augmenting diverse communication services and duplicating high-speed protection on eight two-ended and one three-ended 100kV+ feeders with single communications paths for protection, or protection clearing times that exceed the NER requirements, to ensure the required protection clearing times and redundancy requirements of the NER are met.

Non-compliant transformer protection

- Installing or upgrading back-up protection capable of meeting the NER protection clearance times for voltages greater than 100kV on the known 14 transformers with inadequate existing schemes.

3.2.2 Non-network options

There are no non-network options available to rectify the compliance issues identified.

3.3 Economic analysis of identified options

3.3.1 Cost versus benefit assessment of each option

The Net Present Value (NPV) of the available option has been determined by discounting costs over the program lifetime from FY2019/20 to FY2034/35 at the Regulated Real Pre-Tax Weighted Average Cost of Capital (WACC) rate of 2.62%, using the EQL standard NPV analysis tool. The results are provided in Table 4.

Capital Costs

The expected annual capital cost is $220,000 in each year from 2020/21 – 2024/25, for a total of $1.1 million in direct costs across the regulatory period.

Results

The NPV of the available option is -$0.87M over the next regulatory period. The risks for the risk-based augmentation and 'Do Nothing' options have been deemed unacceptable.

Table 4: NPV of Options

Option Number	Option Name	NPV	Direct Cost ($18/19 Dollars)
1	Comprehensive Augmentation	-$0.87M	$1.1M

3.4 Scenario Analysis

3.4.1 Sensitivities

Sensitivity analysis was carried out on CAPEX costs for this case, with sensitivities of +/- 20% were tested on the annual CAPEX rate of $220,000 per year for the program. Table 5 outlines the results of the analysis.

Table 5: Sensitivity Analysis Results

Options	Base NPV ($M)	CAPEX rate sensitivity	
		+20%	-20%
Option 1	$0.87	$1.05	$0.70

3.4.2 Value of regret analysis

In terms of selecting a decision pathway of 'least regret', Option 1 presents the only available economically efficient approach to investment to rectify Ergon's non-compliance with the NER for high voltage networks.

3.5 Qualitative comparison of identified options

3.5.1 Advantages and disadvantages of each option

Table 6 details the advantages and disadvantages of each option considered. While there could be an issue of slow clearance of >100kV faults due to inadequate protection communications, resulting in network instability and significant potential consequences, option 1 brings the protection signalling in line with NER requirements and avoids this key risk.

Table 6: Qualitative Assessment of Options

Options	Advantages	Disadvantages
Diverse Communications Option 1 – Comprehensive augmentation	• Brings remainder of 100kV+ protection into compliance with the NER • Reduces risk of faults damaging high voltage equipment • Reduces risk of extended faults tripping off generators due to system instability • Improves reliability by potentially reducing amount of network isolated during fault	• Brings costs for replacement forward into single time-period • In the event of a slow clearance of a >100kV fault due to inadequate protection communications, could result in network instability with significant potential consequences. However, this proposed option brings the protection signalling in line with NER requirements and avoids this key risk.
Non-compliant transformer protection Option 1	• Improves Ergon Energy's compliance with the NER • Reduces risk of faults damaging high voltage equipment	• Protection equipment cost

3.5.2 Alignment with network development plan

The Distribution Annual Planning Report (DAPR) 2018-2023 outlines Ergon Energy's goals, one of which is to have high levels of safety, reliability and product excellence. Additionally, the network has a high probability of and exposure to significant environmental scenarios like cyclones, storms, bushfires and flooding, all of which increase the risk of a network fault occurring.

Ensuring that protection can operate correctly by installing duplicate communications and rectifying non-compliant transformer protection clearing times increases safety and reliability of the network.

Works will be cross-referenced and joined with other planned works, including the proposed backup reach program, to ensure risks are being addressed and sites are not unnecessarily revisited by overlapping projects.

3.5.3 Alignment with future technology strategy

This program of work does not contribute directly to Energy Queensland's transition to an Intelligent Grid, in line with the Future Grid Roadmap and Intelligent Grid Technology Plan. However, it does support Energy Queensland in maintaining affordability of the distribution network while also maintaining safety, security and reliability of the energy system, a key goal of the Roadmap. The proposed works accommodate new assets which are designed to modern standards, increasing the reliability and safety of the asset group. Additionally, augmenting protection schemes to ensure compliance with the NER increases the safety and reliability of the network, providing a well-prepared platform to support future developments including wide-spread sustainable generators.

3.5.4 Risk Assessment Following Implementation of Proposed Option

Table 7: Risk assessment showing risks mitigated following Implementation

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Failure of protection and no or inadequate backup protection results in failure to quickly clear a 100kV+ transformer fault resulting in **significant equipment damage requiring replacement**.	Business	*(Original)* *4* *(>$1,000,000)* (Mitigated) 4 *(As above)*	 *2* *(Very unlikely)* 1 *(Almost no likelihood to occur)*	 ***8*** ***(Low)*** **4** ***(Very Low)***	2019
Unstable or failed communications path with no duplicate results in delayed relay operation and the fault is unable to be cleared within specified timeframes resulting in **a single fatality**.	Safety	*(Original)* *5* *(Single fatality)* (Mitigated) 5 *(As above)*	 *2* *(Very unlikely)* 1 *(Almost no likelihood to occur)*	 ***10*** ***(Moderate)*** **4** ***(Very Low)***	2019
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	*(Original)* *4* *(Energex/Ergon identified issue requiring regulator to be notified. Improvement notice issued)* (Mitigated) 4 *(As above)*	 *3* *(Unlikely)* 1 *(Almost no likelihood to occur)*	 ***12*** ***(Moderate)*** **4** ***(Very Low)***	2019

4 Recommendation

4.1 Preferred option

The preferred option is to augment the protection and communication schemes on both the identified lines lacking diverse communications and transformers with inadequate backup protection in the 2020-25 regulatory period for a cost of $1.1M over the 2020-2025 regulatory period. The following is required:

- Eight two-ended protection signalling schemes and one three-ended protection signalling scheme are required on 100kV+ lines
- 14 duplicate transformer protection schemes

4.2 Scope of preferred option

Individual lines and transformers will have varying scope dependent on system configuration and existing equipment available. Augmentation will be undertaken as required on a site-by-site basis to ensure that:

- Lines at voltages >100kV have diverse communications and duplicated high-speed protection to ensure the clearing times mandated by the NER are achieved even with any one protection or communication element out of service during a fault.
- Transformers at voltages >100kV have adequate backup protection to ensure the NER clearing times are achieved with primary protection failure.

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).

Energex, *Distribution Annual Planning Report (2018-19 to 2022-23) [7.050]*, (21 December 2018).

Energy Queensland, *Asset Management Overview, Risk and Optimisation Strategy [7.025]*, (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
AMP	Asset Management Plan
Augex	Augmentation Capital Expenditure
BAU	Business as Usual
CAPEX	Capital expenditure
Current regulatory control period or current period	Regulatory control period 1 July 2015 to 30 June 2020
DAPR	Distribution Annual Planning Report
DC	Direct Current
DNSP	Distribution Network Service Provider
EQL	Energy Queensland Ltd
IT	Information Technology
KRA	Key Result Areas
kV	Kilovolt
MSS	Minimum Service Standard
MWh	Megawatt Hour
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
OPEX	Operational Expenditure
PCBU	Person in Control of a Business or Undertaking

Abbreviation or acronym	Definition
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
VCR	Value of Customer Reliability
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 8: 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**	Refer to Table 2 in section 1.6 of this report for the relevant regulatory and compliance obligations.
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**	Robust protection schemes are a key component in ensuring that EQL does not exceed minimum service standards for reliability, including; • System Average Interruption Duration Index (SAIDI) • System Average Interruption Frequency Index (SAIFI) By ensuring that the number of customers de-energised to isolate a fault is minimised, and that the duration of the de-energisation is minimised by ensuring a fault is cleared as quickly as possible to reduce damage caused by fault energy to the electrical system. Faults on the transmission network in particular must be cleared within strict periods of time to prevent the wider electrical network from becoming unstable, or to prevent unnecessary shedding of load or tripping of generators.
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.**	Protection schemes must operate quickly and reliably to isolate faulted sections of the network. Electricity faults, especially those involving a conductor on the ground, pose a significant safety risk to EQL staff and the public until they are de-energised. Protection devices are mechanical and digital and by nature these devices are at risk of failure. Due to this, it is necessary to ensure that any fault on the network can be detected and isolated by a minimum of two separate protection devices to maintain the safety of the electrical system.
6.5.7 (c) (1) (i) **The forecast capital expenditure reasonably reflects the efficient costs of achieving the capital expenditure objectives**	The Unit Cost Methodology and Estimation Approach sets out how the estimation system is used to develop project and program estimates based on specific material, labour and contract resources required to deliver a scope of work. The consistent use of the estimation system is essential in producing an efficient CAPEX forecast by enabling: • Option analysis to determine preferred solutions to network constraints • Strategic forecasting of material, labour and contract resources to ensure deliverability • Effective management of project costs throughout the program and project lifecycle, and • Effective performance monitoring to ensure the program of work is being delivered effectively. The unit costs that underpin our forecast have also been independently reviewed to ensure that they are efficient (Attachments 7.004 and 7.005 of our initial Regulatory Proposal).

Capital Expenditure Requirements	Rationale
6.5.7 (c) (1) (ii) **The forecast capital expenditure reasonably reflects the costs that a prudent operator would require to achieve the capital expenditure objectives**	The prudency of this proposal is demonstrated through the options analysis conducted and the quantification of risk and benefits of each option. The prudency of our CAPEX forecast is demonstrated through the application of our common frameworks put in place to effectively manage investment, risk, optimisation and governance of the Network Program of Work. An overview of these frameworks is set out in our Asset Management Overview, Risk and Optimisation Strategy (Attachment 7.026 of our initial Regulatory Proposal).

Appendix D Mapping of Asset Management Objectives to Corporate Plan

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

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

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

Table 9: 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 1: A Risk Tolerability Scale for evaluating Semi-Quantitative risk score

Appendix F Reconciliation Table

Reconciliation Table Conversion from $18/19 to $2020	
Business Case Value	
(M$18/19)	$1.10
Business Case Value	
(M$2020)	$1.14