Business Case
Communications Power Systems

Executive Summary

The Communications Power Systems Program relates to battery banks and generators which provide backup power supply to the Ergon Energy communications network. This ensures that key services such as protection signalling, Supervisory Control and Data Acquisition (SCADA), and field voice services continue to operate as required during instances of network outage or major weather events.

Within the Ergon Energy network battery banks and generators subject to degradation and failure due to ageing must be addressed as part of standard asset management practices. Alongside standard age and condition-based replacement, there is a known manufacturing defect impacting a specific brand of battery banks, resulting in degradation and in-service failure which is difficult to detect through typical field inspections. Additionally, corrosion issues are impacting the performance of a significant population of generators. Neither of these asset defects can be addressed through repair, requiring full asset replacement when issues are identified.

A counterfactual, ‘Do nothing’ option was considered but rejected as part of this business case, due to the known and intolerable safety risks for staff and the network that would result if the communications network were left without power. Three network options have been evaluated as part of this business case:

Option 1 – An accelerated replacement program, under which all assets at the end of their useful life are replaced as soon as possible. Further, all battery banks in the specific problem brand will be replaced regardless of condition.

Option 2 – A risk-based rolling replacement program, under which replacement of both aged and problem assets will be conducted based on monitored condition and the opportunity to bundle replacement with other works.

Option 3 – A risk-based rolling replacement program, with maximum risk, under which only assets at the most critical locations are replaced proactively. The remaining assets will be replaced reactively upon failure.

Ergon Energy aims to minimise expenditure in order to keep pressure off customer prices, however understands that this must be balanced against critical network performance objectives. These include network risk mitigation (e.g. safety, bushfire), regulatory obligations (e.g. safety), customer reliability and security and preparing the network for the ongoing adoption of new technology by customers (e.g. solar PV. In this case safety is a strong driver, based on the need to support communication systems to ensure the network can be operated safely, particularly in instances of network outage or major weather events.

To this end, Option 2 was selected as the preferred option, as it presents the most economically efficient investment (its -$6.1M NPV result was the least negative of the three options) and prudent management of risks. The direct cost of the program across the 2020-25 regulatory period is $4.1M, with an additional $2.1M in outer years.

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
$4.1M	N/A	$4.1M

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1. Introduction

The Communications Power Systems program addresses the condition of backup power supply assets that allow critical telecommunications assets within the Ergon Energy network to continue operation in the event of a power outage. This initiative seeks to address issues impacting the reliability of generators and battery banks across the Ergon Energy network, to limit the in-service failure of these assets and thereby reduce the risks of extended customer outage and safety risks to personnel working within the network.

1.1 Purpose of document

This document recommends the optimal capital investment necessary for the Communications Power System 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.

1.2 Scope of document

The scope of this program covers the class of assets known as Communications Power Systems, specifically:

- Generators;
- Battery banks;
- Uninterruptible Power Supplies (UPS); and,
- Solar photovoltaic power systems.

This document should be considered in conjunction with the Energy Queensland (EQL) Asset Management Plan (AMP) – Telecommunications, and the Intelligent Grid Technology Plan. 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 case safety is a strong driver, based on the need to support communication systems to ensure the network can be operated safely, particularly in instances of network outage or major weather events.

Telecommunications assets are installed at substations, dedicated telecommunications sites, control and data centres, depots, and offices across the Ergon Energy network, and are required to support protection signalling, Supervisory Control and Data Acquisition (SCADA), operational telephony, security, alarming, and ancillary services.

Communications power systems provide backup power to telecommunications assets, and their correct operation is required to ensure that the network remains operational after power outages or major weather events. Failure to maintain power to the telecommunication network can result in the loss of services that are provisioned for safety and the support of basic services for the efficient completion of operational and supervisory activities for the power network. In-service failures of communications power systems can therefore significantly impact Ergon Energy until repairs are carried out, potentially resulting in the following:

- **Loss of protection circuits between substations,** leading to delays to fault clearance times, potentially resulting in significant damage to equipment and increasing risk to personnel;
- **Loss of SCADA systems and remote control of the network**, with potential customer outage or compliance impacts; and,
- **Loss of communications and site security monitoring**, increasing safety risks to substation or field staff and plant equipment.

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 Communication Power Systems 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 delivers increased reliability of communication services at substations field sites, which will reduce risk to staff, contractors and the community.
Meet customer and stakeholder expectations	Continued asset serviceability supports network reliability and promotes delivery of a standard quality electrical energy service. This program ensures that outage durations and severity (number of customers who lose supply) are not adversely impacted by ensuring SCADA and protection services are maintained at current performance levels.
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.
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

EQL has an asset management objective to ensure a safe and reliable network for the community. Programs associated with these asset classes, therefore, aim to reduce in service failures to levels which deliver a safety risk outcome which is considered So Far as Is Reasonably Practicable (SFAIRP) and as a minimum maintains current performance standards.

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. This program seeks to improve the reliability of communications power systems assets which directly influence the reliability of protection and control systems, thereby contributing to EQL's compliance with corporate objectives and Distribution Authority regulations.

1.6 Compliance obligations

Table 2 shows the relevant compliance obligations for this proposal.

Table 2: Compliance obligations related to this proposal

Legislation, Regulation, Code or Licence Condition	Obligations	Relevance to this investment
QLD Electrical Safety Act 2002 **QLD Electrical safety Regulation 2013**	We have a duty of care, ensuring so far as is reasonably practicable, the health and safety of our staff and other parties as follows: • Pursuant to the Electrical Safety Act 2002, as a person in control of a business or undertaking (PCBU), EQL has an obligation to ensure that its works are electrically safe and are operated in a way that is electrically safe.1 This duty also extends to ensuring the electrical safety of all persons and property likely to be affected by the electrical work.[2]	This proposal addresses conditional issues impacting the performance of communications power systems, which are essential for the correct operation of telecommunications networks in cases of network outage. These networks are necessary to ensure staff and asset safety, that network outages are not unnecessarily extended by delays to repair works.
Distribution Authority for Ergon Energy issued under section 195 of *Electricity Act 1994* (Queensland)	Under its Distribution Authority: • The distribution entity must plan and develop its supply network in accordance with good electricity industry practice, having regard to the value that end users of electricity place on the quality and reliability of electricity services. • The distribution entity will ensure, to the extent reasonably practicable, that it achieves its safety net targets as specified.	This proposal addresses conditional issues impacting the performance of communications power systems, which are essential for the correct operation of telecommunications networks in cases of network outage. These networks are necessary to meet safety net targets and MSS, by ensuring that network outages are not

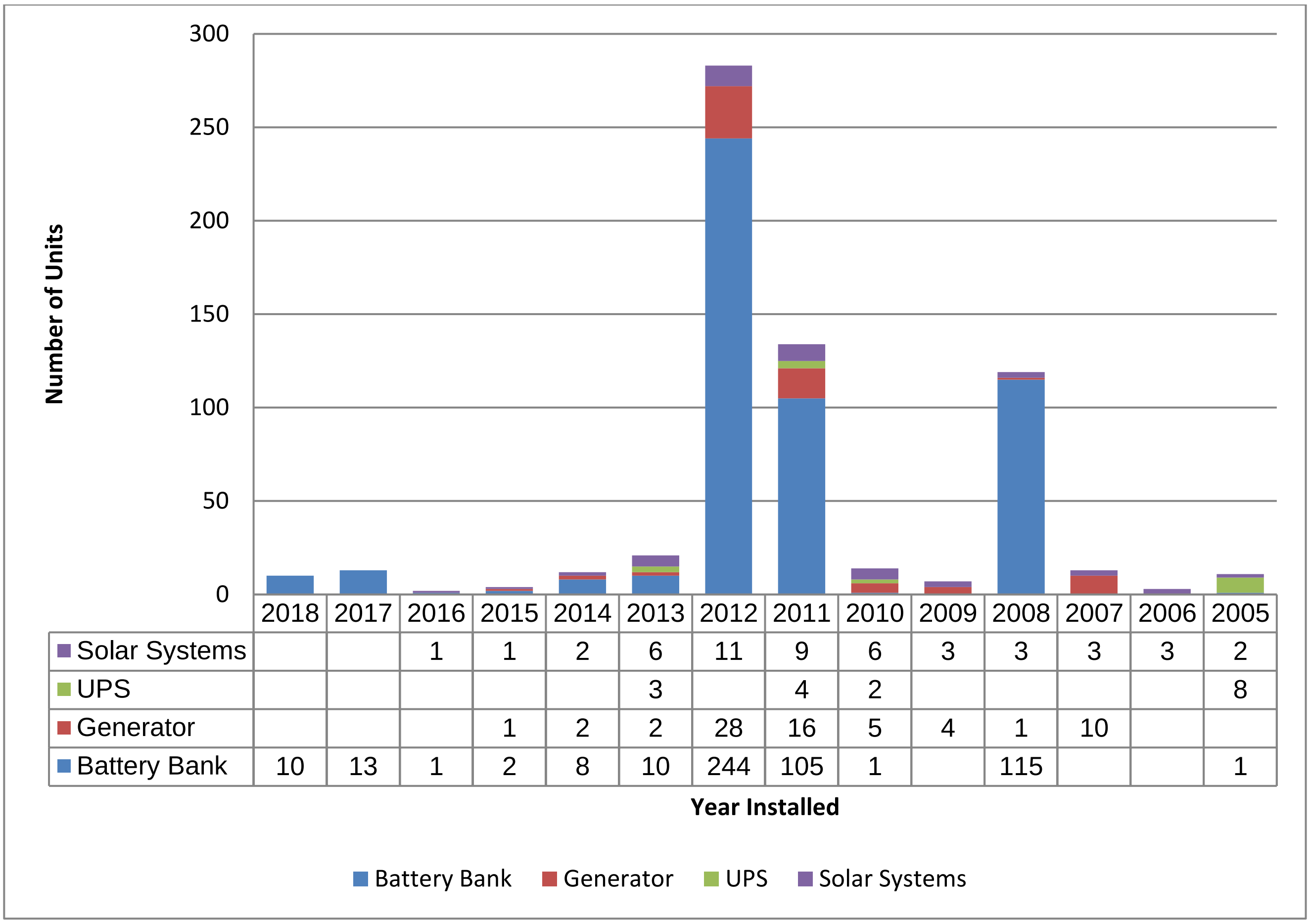
[1] Section 29, *Electrical Safety Act 2002*
[2] Section 30 *Electrical Safety Act 2002*

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)	unnecessarily extended by delays to repair works.
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	This proposal addresses conditional issues impacting the performance of communications power systems which are essential for provision of protection systems and fault clearance in cases of network outage.

1.7 Limitation of existing assets

Within the Ergon Energy network there are nearly 650 different communications power systems assets, installed across dedicated telecommunications sites, substations and other locations. The remoteness and criticality of Ergon Energy sites determines the nature of necessary backup power assets for their communications infrastructure, with some sites having multiple backup generation and battery power sources available at all times.

A number of life-limiting factors including load characteristics, thermal cycling, environmental exposure, and general ageing influence the performance and condition of these assets, particularly batteries and battery banks, which can experience significant performance loss as they age. Figure 1 outlines the age distribution of communications power systems assets within the Ergon Energy network, by year of installation.



	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005
Solar Systems			1	1	2	6	11	9	6	3	3	3	3	2
UPS						3		4	2					8
Generator				1	2	2	28	16	5	4	1	10		
Battery Bank	10	13	1	2	8	10	244	105	1		115			1

Figure 1: Age Distribution of Communications Power Systems Assets (AMP Telecommunications)

A significant program of replacement was undertaken in the Ergon network from 2010 to 2014 as part of the development of an internal telecommunication infrastructure platform to deliver enhanced monitoring and control of the distribution network. The assets that were installed through this program are now reaching the end of their useful life, experiencing degradation or in-service failure.

Of particular interest in this program are generators and battery banks, many of which will reach the end of their useful life (typically no more than six years) during the next regulatory period. Alongside typical age-based degradation, significant defects have been identified within a specific brand of battery banks, which make up the majority of the battery population, and generators.

Battery Bank Manufacturing Defect

Manufacturing issues have been identified to be affecting a specific brand of in-service battery banks, resulting in accelerated rates of failure which cannot be addressed through maintenance or refurbishment. Defects affecting the battery banks, which are found at around 49% of all sites with battery banks across the Ergon Energy network, were first identified in 2015/16. Investigations have determined the high rate of failure due to a manufacturing issue. The following information outlines the issue in detail:

- A total of 375 battery banks contain the affected batteries.
- Effected batteries account for 65% of battery banks in-service.
- Battery banks are actively monitored and produce alarms when critical states are reached, resulting in call-outs which increases network operational costs.
- The batteries have fundamental issues which cannot be rectified; the only course of action is to have them replaced.

Table 3 outlines the measured failure rates of the affected battery banks over the past three years.

Table 3: Measured Failure Rates of Defective Battery Banks

Battery Banks	2016/17	2017/18	2018/19
Failure rate (%)	10.1%	16.53%	14.91%

Generator Corrosion

The condition of generators across the Ergon Energy network has declined recently due to corrosion issues that cannot be adequately controlled by feasible site maintenance, due to the inaccessible location of the corrosion. This has resulted in three generators out of a total population of 69 being replaced completely since 2017, resulting in a failure rate of 2.17% p.a. Refurbishment of these generators proved uneconomic due to the extensive labour and expensive parts that were needed.

The number of complete generator replacements is expected to rise significantly, as a high number of generators currently being used are the same make and model, are of a similar age profile (most were installed over a five-year period) and have a similar condition which has been identified from maintenance reports.

Summary

Defects impacting both generators and battery banks are resulting in higher rates of failure than expected and cannot be readily addressed by existing asset management approaches. Field inspections are only completed every six months and the tests completed typically only identify failures that will occur in the short term (e.g. within the next month). These defects therefore threaten Ergon Energy's ability to comply with its legislative requirements and business standards for customer outage and safety. As the nature of identified asset defects means that the affected assets cannot be repaired or refurbished, a program of replacement is required to proactively address the risk of in-service failure.

2 Counterfactual Analysis

2.1 Purpose of asset

Communication Power Systems assets (including battery banks and generators) are typically the secondary source for power at communication sites, playing a more significant role at rural and remote areas with limited telecommunication networks. Communications power systems provide backup power to telecommunications assets, and their correct operation is required to ensure that the network remains operational after power outages or major weather events.

2.2 Business-as-usual service costs

There is a population base of over 500 battery banks and 69 generators across 328 sites within the Ergon Energy network. The majority of sites are located in rural and remote areas which can be difficult to access after major weather events.

Age and condition are the major drivers for the replacement of communication power systems assets by Ergon Energy. Once an asset is nearing its end of life, it is typically monitored extensively by field staff, and planned for replacement within a three-month period based on condition. Once asset condition deteriorates to a level below that required to successfully meet it functional requirements, the risk of failure, or maloperation increases to the point where continued operation of the equipment presents an intolerable risk to the business, it is replaced.

2.3 Key assumptions

Failure to maintain power to the telecommunication network can result in the loss of services that are provisioned for safety and the support of basic services for the efficient completion of operational and supervisory activities for the power network.

In a 'Do Nothing' counterfactual approach, instances of failure of generators or battery banks may leave sites without telecommunications services in the case of a power outage or other large network incident such as a major weather event. This has various potential impacts:

- **Loss of protection circuits between substations:** For periods when protection circuits are not operating there are risks of potentially catastrophic damage to plant or premature aging of plant and 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 backup power failure.
- **Loss of SCADA systems and remote control of the network:** This can have various business, legislative, customer, and safety impacts, and in cases of widespread network outage loss of backup power systems can extend the duration of outages by reducing control over remote start-up systems.
- **Loss of communications and site security monitoring:** This can introduce significant risks to staff and plant equipment. Loss of fixed voice communications due to lack of power introduces safety risks to field staff operating in areas with poor mobile reception and tends to increase the duration and risk of repair and restoration works. Loss of site security monitoring can expose site equipment to damage by vandalism.

As well as the potential safety, reliability, and security impacts which may occur as a result of in-service failure of backup power assets, a 'Do Nothing' approach does not represent prudent application of asset management principles. The counterfactual ignores known failure modes in both battery banks and generators, and the fact that replacing or repairing assets after in-service failure carries significant emergency cost increases.

2.4 Risk assessment

Table 4 outlines the semi-quantitative risk assessment of the continuation of business-as-usual management of communication power systems. This risk assessment represents an approximation of the aggregated risk across all sites with backup communications power systems. Risks may be much higher for sites which rely more heavily on backup power, such as those in remote areas. 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 4: Risk Assessment

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
SCADA – Failure of communication power systems results in loss of visibility of SCADA derived data which leads to a reduced capacity to remotely control ≥2 bulk supply substations supply area.	Business	4 *(Inability to remotely control ≥2 bulk supply substations supply area)*	4 *(Likely)*	**16** *(Moderate Risk)*	2019
Protection – An unstable or failed communication power system results in delayed relay operation and the fault is unable to be cleared within specified timeframes, resulting in significant damage to equipment and plant and an inability to control **≥2 bulk supply substations supply area**.	Business	4 *(Inability to remotely control ≥2 bulk supply substations supply area)*	3 *(Unlikely)*	**12** *(Moderate Risk)*	2019
Protection –An unstable or failed communication power system 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 / Incurable Fatal Illness)*	3 *(Unlikely)*	**15** *(Moderate Risk)*	2019
Protection – Failure of communication power systems results in impaired protection services leading to a breach of National Electricity Rules.	Legislated	4 *(Improvement notice issued by regulator)*	3 *(Unlikely)*	**12** *(Moderate Risk)*	2019
Corporate voice/data – Failure of corporate voice, data and internet communication due to failure of communications power systems results in inability to access corporate IT (Information Technology) systems and inability to remotely control or manage the network across multiple sites.	Business	4 *(Inability to remotely control ≥2 bulk supply substations supply area)*	3 *(Unlikely)*	**12** *(Moderate Risk)*	2019
Field Voice - Inability to communicate with field crews via substation phones. Control Centre unable to transmit switching sheets impacting restoration and planned works equating to >$100,000.	Business	2 *(Significant impact on any restoration or planned works equating to >$100,000)*	4 *(Likely)*	**8** *(Low Risk)*	2019

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

2.5 Retirement decision

Communications power system assets cannot be considered for retirement or de-rating, as they perform a critical role in the continued operation of communications assets in instances of network power outage or major weather events, which are crucial for enabling current service standards and compliance.

3 Options Analysis

This section outlines the options considered to address defects associated with in-service assets as part of the Communication Power Systems Program.

3.1 Options considered but rejected

One option was considered and rejected in this analysis:

- **Do Nothing:** This option was considered but rejected, as it ignores a known, non-correctable asset failure mode which if left untreated will result in widespread failure of backup power systems within the Ergon Energy network. Relying solely upon reactive maintenance to address these assets only once they fail in-service introduces additional costs due to the unplanned nature of works and is therefore an inefficient investment and increases the risk that the backup power systems will be unavailable in the event of a network outage or natural disaster, potentially impacting the business' ability to reach safety objectives and compliance goals.

3.2 Identified options

In order to address issues causing the high observed failure rates of battery banks and generator units, three network options have been developed for the replacement of these assets. These are:

- Option 1 – Accelerated Program;
- Option 2 – Risk Based Rolling Program; and,
- Option 3 – Risk Based Rolling Program with Maximum Risk.

3.2.1 Network Options

Option 1 – Accelerated Program

This option seeks to minimise risk of failure as much as possible, with the following asset treatments:

- **Aged battery banks and generators:** All units at the end of their useful life will be scheduled for replacement as soon as possible, potentially limiting the ability of work crews to bundle replacement works with other geographical programs.
- **Known defective battery banks and generators:** replace as soon as an alternative solution is available. This option reduces the risk of in-service asset failure due to the specific identified defects completely but is not considered particularly prudent as it unnecessarily brings forward expenditure, replaces assets that have not been identified as at risk, and is potentially less cost efficient as bundling of replacements based on geographical sites may not be complete.

Option 2 – Risk Based Rolling Program (Recommended)

This option presents an optimised replacement scenario in order to balance risk of asset failure with efficient investment principles.

- **Aged battery banks and generators:** All units near the end of their useful life will be monitored closely and planned for replacement in line with other geographically bundled programs.
- **Known defective battery banks and generators:** battery banks and generators with known defects will be replaced over the next regulatory period based on risk assessments that include condition assessment and criticality of the specific services, resulting in a more

prudent and efficient program of investment than in Option 1. The replacement of battery banks and generators where feasible will be bundled with other work at the specific site locations, to reduce associated labour and operating costs.

Option 3 – Risk Based Rolling Program with Maximum Risk

This option involves only proactively replacing known defective assets at the most critical locations, and allowing all other assets to be reactively replaced, minimising up-front cost and maximising in-service life of assets.

- **Aged battery banks and generators:** Aged assets will be allowed to run to failure to maximise in-service life and will only be reactively replaced when high failure risks or in-service failures are identified by scheduled preventive maintenance.
- **Known defective battery banks and generators:** Replace only those assets at core critical sites, where the impact of in-service failure would be much greater. There are 18 core critical sites, with a total of 36 battery banks and 18 generators at high-risk. Defective assets at less critical telecommunication sites will only be replaced reactively when high failure risks are identified by scheduled preventive maintenance.
- This option carries significant risk of outages as field inspections are only completed on a six-month basis, and the tests carried out typically only identify failures that will occur in the short term. As significant battery bank issues have been identified across all telecommunication sites, it is likely this approach will result in significantly higher replacement costs overall due to the comparatively higher cost of reactive emergency replacement works than that of a proactive planned approach.

3.2.2 Non-Network Options

There are no appropriate non-network solutions 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.

Capital Costs – Planned Works

Capital costs (CAPEX) associated with each option have been defined as the materials and labour costs required to replace battery banks or generators at each site.

- **Battery Bank Replacement:** The costs and resources required to replace battery banks are well established as these activities have been ongoing over the last four years. A unit cost of $10,464/unit for materials and $892/unit for labour has been considered for all battery banks, based on an average of unit rates for various battery sizes and types throughout the network.
- **Generator Replacement:** The costs and resources required to replace generators are well established as these activities have been ongoing over the last eight years. A unit cost of $39,059/unit for materials and $14,534/unit for labour has been considered for all generators.

Geographical bundling of works can lend significant cost savings to a program of work through reducing travel time to regional sites. It was found that if works at each of the 328 sites with affected battery banks were carried out individually, compared to in groups of two for sites within 100km of each other, the total estimated travel distance would be increased by 44%. For Option 2, which involves prioritisation and grouping of work programs by region as well as criticality, it therefore was conservatively assumed that a saving of only 30% could be achieved for labour costs for both battery and generator replacement. This saving was modelled by increasing the labour cost of Options 1 and 3 by 30% above the base rate compared to Option 2.

Capital Costs – Emergency Works

When considering emergency works in the case of an in-service failure, additional materials and labour costs must be considered.

An additional labour cost of $3,300 per site for initial callout and investigation work to determine the nature of repairs required is incurred for emergency works for either battery or generator replacement. This cost was added to the standard labour cost for either form of asset replacement, and was calculated as follows:

- Average labour cost for initial investigation works: Minimum $2,200, based on the cost for two staff operating over 6.5 hours (inclusive of penalty rates) at $100/hr.
- Average travel cost for rectification works: $1,200, based on the average distance of 184km between a communications site and its nearest regional depot within the network, an average travel speed of 60km/hr, and a rate of $100/hr for two staff.
- Average time at site for rectification works: $800, based on an average of four hours per staff member.

Due to the emergency nature of replacement works in the case of in-service failures, and potential issues with acquiring spares for like-for-like replacement works, a premium of 20% was also applied to all CAPEX expenses in the case of emergency replacement.

Program of Replacement

The program of planned unit replacement works for each option is outlined in Table 5.

Programs of replacement for known defective battery banks and generators have been produced based on the assumptions for each option outlined in Section 3.2.1, taking into account opportunities for geographical bundling, the age and condition of defective assets, and the criticality of sites when composing the program.

Likely volumes of replacement for aged assets over the study period have been estimated based on the asset age profile outlined in Figure 1. For batteries, there is an average in-service life of around six years, and for generators, in-service life is slightly longer and more variable, typically reaching between eight to ten years. Annual volumes of replacement over the study period have been estimated at five batteries and two generators per year. Treatment of aged assets for replacement for each option is as follows:

- For Option 1, assets will be replaced as soon as they reach the end of their useful life, potentially limiting the ability of field staff to bundle works with other geographical programs.
- For Option 2, assets will be targeted for upcoming replacement by reaching the end of their useful life, but their actual replacement date will be triggered by monitoring and inspections.
- For Option 3, assets will be monitored only through standard maintenance and inspection programs, and will therefore be replaced reactively, incurring additional cost.

Table 5: Planned Replacement of Battery Banks and Generators Under Each Option

Units Replaced		2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	Total
Option 1: Accelerated Program Option 1								
Known defective assets	Battery Banks	375	-	-	-	-	-	**375**
	Generators	18	-	-	-	-	-	**18**
Standard aged assets	Battery Banks	5	5	5	5	5	5	**30**
	Generators	2	2	2	2	2	2	**12**
Option 2: Risk Based Rolling Program								
Known defective assets	Battery Banks	163	105	80	9	9	9	**375**
	Generators	2	2	4	3	3	4	**18**
Standard aged assets	Battery Banks	5	5	5	5	5	5	**30**
	Generators	2	2	2	2	2	2	**12**
Option 3: Risk Based Rolling Program with Maximum Risk								
Known defective assets	Battery Banks	36	-	-	-	-	-	**36**
	Generators	18	-	-	-	-	-	**18**
Standard aged assets	Battery Banks	-	-	-	-	-	-	**0***
	Generators	-	-	-	-	-	-	**0***

**NOTE: While there are no planned replacements of aged assets in Option 3, the same number of asset failures (5 batteries and 2 generators per year) is expected.*

Key assumptions across all options include:

- Power system assets do not experience an accelerated failure rate over the program lifetime.
- Asset condition assessed from site maintenance is based on the same criteria and acceptable standard across all field groups.
- The replacement assets meet the expected life forecasted.
- Current ventilation standards for power systems are achieved in the course of replacement works and no further work is required.
- No delay or extended delivery times for the program greater than three months.

Rate of Failure

In order to quantify the rate of unit failure for each option due to the identified manufacturing defects, and the associated cost of emergency works, an estimated failure rate as a proportion of the recorded failure rates:

- The 2018/19 failure rate for battery banks (14.91%) was assumed to be the maximum annual failure rate for each option.
- Three generators failed due to corrosion between 2017 and 2019 out of a total affected population of 69, resulting in an annual failure rate of 2.17%.

Assumptions made around asset failure in-service during the study period were as follows:

- **Option 1:** No in-service failures assumed, as all defective assets replaced in the first year of the study, and aged assets scheduled for replacement as soon as they reach their end of life age.

- **Option 2:** The risk-based rolling approach to asset replacement is expected to prevent the majority of failures. However, as some at-risk assets will remain in-service, and field inspections are only carried out on a six-monthly basis with tests only able to identify imminent failure, it is conservatively assumed that 20% of failures still occur during the study period.
- **Option 3:** All assets assumed to run to either failure or near-failure, requiring reactive replacement and incurring emergency costs in each case.

Results

Using the assumptions outlined previously, the Present Value (PV) and 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), are outlined in Table 6.

Table 6: Net present value of options

Option	CAPEX PV ($M)	NPV ($M)
Option 1 – Accelerated Program	(7.99)	(7.99)
Option 2 – Risk Based Rolling Program	(6.14)	(6.14)
Option 3 – Risk Based Rolling Program with Maximum Risk	(7.65)	(7.65)

3.4 Scenario Analysis

3.4.1 Sensitivities

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

- Cost increase for Options 1 and 3 compared to Option 2, based on the limited potential for geographical bundling in these options. The base value for savings used was 30%, with sensitivities of 20% and 10% considered.
- Rate of generator and battery bank failures. A sensitivity of +/- 20% on each failure rate was considered.
- Emergency CAPEX premium cost. Sensitivities of 10% and 0% were compared to the base rate of 20% assumed.

The results of sensitivity analysis are shown in Table 7, 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 all sensitivities considered.

Option 1 was the most sensitive to savings associated with geographical bundling. When a saving of only 10% for Option 2 compared to Options 1 and 3 was applied, the NPV of Option 1 was reduced by around $1.2M. The NPV of Option 3 was also reduced by around $300,000. However, both options were more expensive than Option 2 by at least $600,000. Additionally, given that the potential saving from geographical bundling calculated was 44%, a situation in which a saving of only 10% can be incurred compared to the more accelerated programs is unlikely.

Option 3 was the most sensitive to reduction of the emergency CAPEX premium rate. When there was no difference between planned and emergency CAPEX base rates (the 0% sensitivity case), the NPV of Option 3 was reduced by over $700,000, as the majority of replacements carried out in Option 3 are under emergency conditions. Under this sensitivity, Option 2 was still the least-cost option by around $800,000.

Table 7: Sensitivity analysis

NPV ($M)	Base NPV	CAPEX rate increase for Options 1 and 3 compared to Option 2 (Base rate 30%)		Sensitivity on Failure Rates		Emergency CAPEX Premium (Base rate 20%)	
		20%	10%	-20%	+20%	10%	0%
Option 1	(7.99)	(7.38)	(6.76)	(7.99)	(7.99)	(7.99)	(7.99)
Option 2	(6.14)	(6.14)	(6.14)	(6.09)	(6.19)	(6.13)	(6.12)
Option 3	(7.65)	(7.51)	(7.37)	(7.30)	(7.90)	(7.28)	(6.92)

3.4.2 Value of regret analysis

In terms of selecting a decision pathway of 'least regret', Option 2 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 risk of continuing to operate assets with known irreparable manufacturing defects, phasing these out to avoid in-service failure. The key potential regret in this case is loss of some critical communications infrastructure in the event of a major weather event resulting in major loss of supply or safety risks through protection failures. The proposed option manages this key risk through a planned risk-based program of replacements and provides the lowest value of regret.

Deferral of the program for many sites (Option 3) has a much higher potential value of regret.

While Option 1 was shown to have a slightly lower NPV under a scenario where savings due to geographical bundling are low, as this option brings forward all program activity to the first year of the program, it is a higher cost plan, that would be difficult to deliver, and is not the least-regret option.

3.5 Qualitative comparison of identified options

3.5.1 Advantages and disadvantages of each option

Table 8 details the advantages and disadvantages of each option considered.

Table 8: Assessment of options

Option	Advantages	Disadvantages
Option 1 – Accelerated Program	• Full replacement of all battery banks and generators as soon as possible will result in the most complete reduction of risk of asset failure	• Unnecessarily brings forward expenditure. • Unnecessary replacement of assets which are not categorised as at risk. • Potentially less cost efficient as bundling of replacements based on geographical sites may not be complete.
Option 2 – Risk Based Rolling Program	• Risk-based replacement framework targets efficient upgrading of assets based on condition assessment and criticality. • More cost-efficient program than Option 1, as assets that are still in an acceptable condition are not considered for replacement. • Additional cost efficiency gained through geographical bundling with other programs of work.	• Does not totally reduce risk of asset failure, as not all assets identified as at-risk due to the manufacturing issue are replaced.

Option	Advantages	Disadvantages
Option 3 – Risk Based Rolling Program with Maximum Risk	• Least-cost capital network option, only targeting 18 core critical sites out of a population of 690 sites.	• Significant risk of failure even with replacement of critical assets, as field inspections are only completed on a six-month basis and tend to identify short-term failure risk. • High cost from call-out maintenance works.

The following risk assessment has also been completed based on proposed Option 2 and the likely impact on the risks assessed in the Counterfactual analysis.

3.5.2 Alignment with network development plan

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

3.5.3 Alignment with future technology strategy

This program of work does not contribute directly to Energy Queensland's transition to an Intelligent Grid, in line with the Future Grid Roadmap and Intelligent Grid Technology Plan. However, it does support Energy Queensland in maintaining affordability of the distribution network while also maintaining safety, security and reliability of the energy system, a key goal of the Roadmap, and represents prudent asset management and investment decision-making to support optimal customer outcomes and value across short, medium and long-term horizons.

3.5.4 Risk Assessment Following Implementation of Proposed Option

Table 9 outlines the risk assessment for the Ergon Energy network post implementation of the preferred option, Option 2, as outlined in this program.

Table 9: Risk assessment showing risks mitigated following Implementation

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
<u>SCADA</u> – Failure of communication power systems results in loss of visibility of SCADA derived data which leads to a **reduced capacity to remotely control ≥2 bulk supply substations supply area**.	Business	(Current) 4 *(Inability to remotely control ≥2 bulk supply substations supply area)* (Mitigated) 4 *(As above)*	 4 *(Likely)* 3 *(Unlikely)*	 **16** *(Moderate Risk)* 12 *(Moderate Risk)*	2019
<u>Protection –</u> An unstable or failed communication power system results in delayed relay operation and the fault is unable to be cleared within specified timeframes, resulting in significant damage to equipment	Business	(Current) 4 *(Inability to remotely control ≥2 bulk supply substations supply area)*	 3 *(Unlikely)*	 **12** *(Moderate Risk)*	2019

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
and plant and an **inability to control ≥2 bulk supply substations supply area**.		(Mitigated) 4 *(As above)*	2 *(Very Unlikely)*	**8** *(Low Risk)*	
Protection –An unstable or failed communication power system results in delayed relay operation and the fault is unable to be cleared within specified timeframes, resulting in **a single fatality**.	Safety	(Current) 5 *(Single Fatality / Incurable Fatal Illness)* (Mitigated) 5 *(As above)*	3 *(Unlikely)* 2 *(Very Unlikely)*	**15** *(Moderate Risk)* 10 *(Low Risk)*	2019
Protection – Failure of communication power systems results in impaired protection services leading to a **breach of National Electricity Rules**.	Legislated	(Current) 4 *(Improvement notice issued)* (Mitigated) 4 *(As above)*	3 *(Unlikely)* 2 *(Very Unlikely)*	**12** *(Moderate Risk)* 8 *(Low Risk)*	2019
Corporate voice/data – Failure of corporate voice, data and internet communication due to failure of communications power systems results in inability to access corporate IT systems and **inability to remotely control or manage the network across multiple sites**.	Business	(Current) 4 *(Inability to remotely control ≥2 bulk supply substations supply area)* (Mitigated) 4 *(As above)*	3 *(Unlikely)* 2 *(Very Unlikely)*	**12** *(Moderate Risk)* 8 *(Low Risk)*	2019
Field Voice - Inability to communicate with field crews via substation phones. Control Centre unable to transmit switching sheets **impacting restoration and planned works equating to >$100,000.**	Business	(Current) 2 *(Significant impact on any restoration or planned works equating to >$100,000)* (Mitigated) 2 *(As above)*	4 *(Likely)* 3 *(Unlikely)*	**8** *(Low Risk)* 6 *(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 battery bank and generator condition 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 10.

Table 10: Planned Replacement of Battery Banks and Generators

Replacement Driver	Asset Type	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	Total
Known defective assets	Battery Banks	163	105	80	9	9	9	**375**
	Generators	2	2	4	3	3	4	**18**
Standard aged assets	Battery Banks	5	5	5	5	5	5	**30**
	Generators	2	2	2	2	2	2	**12**
Total	Battery Banks	168	110	85	14	14	14	**405**
	Generators	4	4	6	5	5	6	**30**

The annual CAPEX associated with Option 2 is outlined in Table 11 in real 2018/19 dollars. The total CAPEX spend planned for the six-year program is $6,207,054, and the CAPEX associated with the 2020/21 to 2024/25 regulatory period is $4,084,839. This represents a $177 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 11: 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	$208,026	$156,279	$163,041	$85,161	$85,161	$99,695	**$797,363**	**$589,337**
Material	$1,914,188	$1,307,276	$1,123,794	$341,791	$341,791	$380,850	**$5,409,691**	**$3,495,503**
Total	**$2,122,215**	**$1,463,555**	**$1,286,836**	**$426,952**	**$426,952**	**$480,545**	**$6,207,054**	**$4,084,839**

Appendix A. References

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

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

Energy Queensland, *Asset Management Plan, Telecommunications [7.043]*, (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
BESS	Battery Energy Storage System
CAPEX	Capital expenditure
CSIRO	Commonwealth Scientific and Industrial Research Organisation
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
DER	Distributed Energy Resource
DSO	Distribution System Operator
ENA	Energy Networks Association
ENTR	Electricity Network Transformation Roadmap
EQL	Energy Queensland
ESR	(Queensland) Electrical Safety Regulation (2013)
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
HV	High Voltage (35kV – 230kV AC)
IS	Isolated System
IT	Information Technology
KRA	Key Result Areas
LV	Low Voltage (50V – 1 000V AC)
MEGU	Micro Embedded Generating Units
MSS	Minimum Service Standards
MV	Medium Voltage (1kV – 35kV AC)
NEL	National Electricity Law

Abbreviation or acronym	Definition
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
QoS	Quality of Supply (to a customer)
RTS	Return to Service
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAMP	Strategic Asset Management Plan
SCADA	Supervisory Control and Data Acquisition
SFAIRP	So Far as Is Reasonably Practicable
WACC	Weighted Average Cost of Capital
ZS	Zone Substation

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

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

Table 12: 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	As indicated in *Table 2: Compliance obligations related to this proposal*, this proposal ensures that safety obligations, reliability obligations and protection requirements are met by providing an appropriate, economically efficient program of works to ensure that communications systems continue to operate in the event of local power failure. Without this program, these obligations would be at significant risk of being breached.
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	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) 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 during all routine and emergency events.
6.5.7 (c) (1) (i) 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. Specialised contractors are utilised as appropriate to ensure that costs are efficiently managed through market testing. Cost performance of the program will be monitored to ensure that cost efficiency is maintained. The unit costs that underpin our forecast have also been independently reviewed to ensure that they are efficient (Attachments 7.004 and 7.005 of our initial Regulatory Proposal).
6.5.7 (c) (1) (ii) The forecast capital expenditure reasonably reflects a realistic expectation of the demand forecast and cost inputs required to achieve the capital expenditure objectives	The prudency of this proposal is demonstrated through the options analysis conducted. 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 13: 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

<table>
<tr><th colspan="5">Network Risks - Risk Tolerability Criteria and Action Requirements</th><th></th></tr>
<tr><th>Risk Score</th><th>Risk Descriptor</th><th colspan="3">Risk Tolerability Criteria and Action Requirements</th><th></th></tr>
<tr><td>30 – 36</td><td colspan="4">Intolerable
(stop exposure immediately)</td><td></td></tr>
<tr><td>24 – 29</td><td>Very High Risk</td><td rowspan="5">*ALARP
Risk in this range managed to As Low As Reasonably Practicable</td><td>Executive Approval
(required for continued risk exposure at this level)</td><td>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</td><td rowspan="5">SFAIRP
Risks in this area to be mitigated So Far as is Reasonably Practicable</td></tr>
<tr><td>18 – 23</td><td>High Risk</td><td>Divisional Manager Approval
(required for continued risk exposure at this level)</td><td>Introduce new or changed risk treatments to reduce level of risk
Periodic review of the risk and effectiveness of the existing risk treatments</td></tr>
<tr><td>11 – 17</td><td>Moderate Risk</td><td rowspan="2">Group Manager / Process Owner Approval
(required for continued risk exposure at this level)</td><td rowspan="2">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</td></tr>
<tr><td>6 – 10</td><td>Low Risk</td></tr>
<tr><td>1 to 5</td><td>Very Low Risk</td><td>No direct approval required but evidence of ongoing monitoring and management is required</td><td>Periodic review of the risk and effectiveness of the existing risk treatments</td></tr>
</table>

Figure 2: 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)	$4.10
Business Case Value	
(M$2020)	$4.25