Investment Evaluation Summary (IES)

Project Details:

Project Name:	Transmission Line Protection Renewal Program
Project ID:	01248
Business Segment:	Transmission
Thread:	Transmission P&C
CAPEX/OPEX:	CAPEX
Service Classification:	Prescribed
Scope Type:	A
Work Category Code:	RENPC
Work Category Description:	Protection & Control
Preferred Option Description:	Planned replacement of transmission line protection schemes to reduce maintenance costs and mitigate safety, reliability and compliance risks to acceptable levels.
Preferred Option Estimate (Dollars $2016/2017):	$11,330,425

	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29
Unit ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume	0.16	0.16	0.16	0.16	0.16	0.25	0.25	0.25	0.25	0.30
Estimate ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total ($)	$2,266,085	$2,266,085	$2,266,085	$2,266,085	$2,266,085	$3,540,758	$3,540,758	$3,540,758	$3,540,758	$4,248,910

Governance:

Works Initiator:	Anthony Januba	Date:	3/11/2018
Team Leader Endorsed:	Robert Smith	Date:	08/11/2018
Leader Endorsed:	Nicole Eastoe	Date:	20/11/2018
General Manager Approved:	Wayne Tucker	Date:	22/11/2018

Related Documents:

Description	URL
Preferred Option Estimate	http://reclink/R681169
Asset Management Plan	http://reclink/R478117
Net Present Value	http://reclink/R711532
TasNetworks Risk Management Framework	http://reclink/R238142
National Electricity Rules (NER) Current rules	http://www.aemc.gov.au/Energy-Rules/National-electricity-rules/Current-Rules
TasNetworks 2017-18 to 2021-22 Corporate Plan	http://reclink/R745475
TasNetworks Roadmap - 2025	https://www.tasnetworks.com.au/customer-engagement/submissions/
TasNetworks Business Plan 2017-18	http://businesszone.tnad.tasnetworks.com.au/strategies-and-plans/Planning/TasNetworks%20Business%20Plan%202017-18.pdf
Zero Harm policy	https://www.tasnetworks.com.au/about-us/policies/zero-harm/

Section 1 (Gated Investment Step 1)

1. Overview

1.1 Background

TasNetworks owns and operates 110 kV and 220 kV transmission lines. Transmission line protection schemes are required to detect and isolate all types of electrical faults that can occur on a transmission line. A healthy protection scheme is able to clear a fault in minimal time to minimise damage to conductors, other primary plant, maintain stability of the power system by disconnecting only the faulted transmission line and alleviate the risk of bushfire start by rapidly disconnecting live Extra High Voltage (EHV) equipment. Additionally, modern transmission line protection schemes provide a fault location directly to the control room to assist in the fast rectification of a failed transmission line. To achieve this, it is imperative that protection schemes are maintained to optimal condition.

The condition of the transmission line protection equipment is assessed by using the failure rate for each specific model, availability of manufacturer support, quantity and health of spares, and inherent design issues.

Protection equipment manufacturers offer a model for an undetermined period of time because as technology develops, new models are created and the older models become obsolete. For a period of time after the cessation of an existing model, the manufacturer provides support through repair services and firmware development. However the manufacturer has to concentrate efforts on the newer models so once full product support ceases, network asset managers have to plan the replacement of obsolete models before spares deplete and further firmware issues begin to develop.

The rate of failure and level of manufacturer support will determine the time that spares are available to continue normal operational maintenance processes.

If a protection scheme fails, it must be returned to service in an acceptable timeframe as stipulated in the Australian Energy Market Operator (AEMO) Power System Security Guidelines. Additionally, during this time, under clause 4.8.2(a) of the National Electricity Rules (NER), AEMO may direct that the equipment protected or operated by the relevant protection system be taken out of operation which may contravene any network support agreement.

TasNetworks aims to maintain the performance of the transmission network in alignment with customer expectations derrived via feedback. This is assisted through the satisfactory performance of protection schemes.

1.2 Investment Need

The identified protection relay models are no longer supported by their manufacturers and spares are expected to diminish below acceptable levels to perform safe and reliable maintenance practices. The risk to TasNetworks is an unexpected increase in operational costs, extended return to service times of failed assets, increased network outages and security of the network at higher risk. The highest risk is reduced reliability from rushed, poor quality installations under emergency conditions. Transmission lines may also be constrained as the temporary protection installed after a failure may not allow full primary asset utilisation.

1.3 Customer Needs or Impact

The impact to the connected customer from the poor performance of the transmission line protection is the potential for forced outages or reduction of generation due to an extended outage of a failed transmission line protection scheme or constraint by a temporary protection scheme. This scenario would be likely to occur once dedicated spares are depleted and the timeframe to return a failed protection scheme to service increases significantly. There is an increased safety risk if the protection scheme fails to operate as designed. There will also be an increase in network security issues.

TasNetworks has undertaken a range of activities to gather feedback, and to understand the issues and concerns that are important to our customers. We have a range of customers, from very large customers directly-connected to our transmission network to large and small customers connected through our distribution network. TasNetworks continues to undertake customer engagement as part of business as usual and through the voice of the customer program. This engagement seeks in depth feedback on specific issues relating to:

- TasNetworks' Business Vision 2025;
- TasNetworks Grid Vision scenarios, including key load, generation and interconnection scenarios;
- New technologies and the future network;
- Customers' preferences on service, price and reliability;
- Regulatory Framework including incentive schemes;
- Forecast expenditure programs; and
- Transmission Pricing Strategies and Methodologies.

Through the engagement, customers have identified that we are meeting most customers' needs from an overall reliability perspective, but for some their needs and expectations are changing especially in regards to safety, restoration of faults/emergencies and reliability of supply. Customers identified that TasNetworks needs to provide for their future needs including: affordability, environmentally sustainable, communicative, innovative, efficient and reliable services.

This project specifically addresses the requirements of our customers in the areas of safety, restoration of faults/emergencies and reliability of supply.

1.4 Regulatory Considerations

Once dedicated spares are depleted, additional time is required to effectively design, install, test and commission a new scheme and return the protection to service in an acceptable timeframe as stipulated in the Australian Energy Market Operator (AEMO) Power System Security Guidelines. Additionally, during this time, under clause 4.8.2(a) of the National Electricity Rules (NER), AEMO may direct that the equipment protected or operated by the relevant protection system be taken out of operation which may contravene any network support agreement.

Other obligations TasNetworks is required to meet is outlined in the NER section 4.8.2 (a)

If a *Registered Participant* becomes aware that any relevant *protection system* or *control system* is defective or unavailable for service, that *Registered Participant* must advise *AEMO*. If *AEMO* considers it to be a threat to *power system security*, *AEMO* may direct that the equipment protected or operated by the relevant *protection system* or *control system* be taken out of operation or operated as *AEMO* directs.

Other requirements under the National Electricity Rules, include but are not limited to the following sections:

- Section 4.11 Power System Security Support;
- Schedule S5.1.2.1 Credible contingency events clause (d); and
- Schedule S5.1.9 Protection systems and fault clearance times clause (d).

Capital expenditure obligations TasNetworks is required to meet are outlined in the NER 6A.6.7 Forecast capital expenditure of the NER

(a) A *Revenue Proposal* must include the total forecast capital expenditure for the relevant *regulatory control period* which the *Transmission Network Service Provider* considers is required in order to achieve each of the following (the *capital expenditure objectives*):

(2) comply with all applicable *regulatory obligations or requirements* associated with the provision of *prescribed transmission services*;

(3) to the extent that there is no applicable *regulatory obligation or requirement* in relation to:

(i) the quality, reliability or security of supply of *prescribed transmission services*; or

(ii) the reliability or security of the *transmission system* through the supply of *prescribed transmission services*,

to the relevant extent:

(iii) maintain the quality, reliability and security of supply of *prescribed transmission services*; and

(iv) maintain the reliability and security of the *transmission system* through the supply of *prescribed transmission services*; and

(4) maintain the safety of the *transmission system* through the supply of *prescribed transmission services*.

(b) The forecast of required capital expenditure of a *Transmission Network Service Provider* that is included in a *Revenue Proposal* must:

(4) identify any forecast capital expenditure:

(i) that is for a *reliability augmentation*; or

(ii) that is for an option that has satisfied the *regulatory investment test for distribution* or *regulatory investment test for transmission* (as the case may be).

2. Project Objectives

The objective of this program is to maintain secure and reliable protection schemes in EHV substations to maintain the security and reliability of the transmission network.

Related Projects

Additional protection schemes or Supervisory Control and Data Aquisition (SCADA) system replacements may be planned at these substations through other protection scheme or SCADA system renewal programs. Co-ordination and project planning may be required to ensure the logical inclusion and timing considerations for these projects.

3. Strategic Alignment

3.1 Business Objectives

TasNetworks Corporate Plan 2017-18 sets out four high level strategic goals: to understand our customers and make them central to all we do; to enable our people to deliver value and keep safe; to care for our assets, delivering safe and reliable network services while transforming our business; and to operate our business to deliver sustainable shareholder outcomes. The renewal of the identified protection schemes aligns with these objectives by ensuring our assets are maintained to provide a safe and reliable network at least cost for our customers and shareholders.

This project is relevant to the following areas of the corporate plan:

• We understand our customers by making them central to all we do;

• We enable our people to deliver value; and

• We care for our assets, delivering safe and reliable network services while transforming our business

3.2 Business Initiatives

To achieve the strategic goals, the TasNetworks Corporate Plan 2017-18 has also identified eight strategic initiatives. The strategic initiative that aligns with the objectives of the transmission line protection renewal program is the Zero Harm program which means that operating our business safely is number one priority.

The TasNetworks Transformation Roadmap 2025 lists the following factors that relate to this program of work:

- Network and operations productivity: We'll improve how we deliver the field works program, continue to seek cost savings and use productivity targets to drive our business;
- Electricity and telecoms network capability: To meet your energy needs and ensure power system security, we'll invest in the network to make sure it stays in good condition, even while the system grows more complex; and
- Enabling and harnessing new technologies and services: By investing in technology and customer service, we'll be better able to host the technologies you're embracing.

4. Current Risk Evaluation

The qualitative risk evaluation summarised in section 4.1 below shows the untreated risk associated with a do nothing option. It equates to a worst case scenario of inherent risk associated with a particular asset. A lower level of likelihood and / or consequence may be applied as part of the sensitivity analysis when calculating the total risk cost as part of the quantitative options analysis.

The business risk associated with these assets has been evaluated as Low by using the TasNetworks Risk Management Framework.

The risk from a transmission line protection scheme failure is assessed in accordance with TasNetworks' Corporate Risk Management Framework.

Historically significant numbers of protection equipment have not been left in service for long enough to obtain accurate statistics to provide an acceptable end of life failure characteristic. For this reason, TasNetworks have adopted the industry accepted Weibull distribution characteristic to determine the future likelihood of failure.

The main consequence associated with operating transmission line protection assets to the useful end of life arises when manufacturer support has ceased and dedicated spares have fully depleted. For this situation, the rectification of a failed relay becomes an unplanned refurbishment involving the installation of a different model of relay in place of the failed relay. This work requires the redesign and recommissioning of the protection scheme and this will have to take place as emergency work. These unplanned costs are not included in normal operational or capital budgets and although this work is not overly expensive, the flow on effect on protection and control resources can have a more significant effect on the delivery of the normal program of work. This emergency work can also leave the transmission line protection scheme in a precarious state as most new relay installations require significant design work to be undertaken by experienced protection and control engineers and require significant planning and testing to ensure a high quality and reliable installation.

4.1 5x5 Risk Matrix

TasNetworks' business risks are analysed utilising the 5x5 corporate risk matrix, as outlined in TasNetworks Risk Management Framework.

Relevant strategic business risk factors that apply are as follows:

Risk Category	Risk	Likelihood	Consequence	Risk Rating
Network Performance	Under clause 4.8.2(a) of the NER, AEMO may direct that the equipment protected or operated by the relevant protection system be taken out of operation which may contravene any network support agreement. Extended outages of transmission lines could result from the extended time required for an unplanned refurbishment, or transmission lines may be constrained due to the temporary protection settings required by emergency relay replacement. These outages or constraints have a direct impact on network perfomance and STPIS payments.	Rare	Minor	Low
Regulatory Compliance	Under clause 4.8.2(a) of the NER, AEMO may direct that the equipment protected or operated by the relevant protection system be taken out of operation which may contravene any network support agreement. Extended outages of	Rare	Minor	Low

	transmission lines could result from the extended time required for an unplanned refurbishment, or transmission lines may be constrained due to the temporary protection settings required by emergency relay replacement. As per the AER's Compliance and Enforcement Statement of Approach, fines may be applied should TasNetworks be found non-compliant with the requirements of their operating licence.			
Reputation	If TasNetworks run protection assets to failure and as a consequence incur regulatory compliance fines, the media are very likely to report on these breaches of operating requirements.	Rare	Minor	Low
Safety and People	Once dedicated spares have fully depleted and manufacturer support has ceased, the rectification of a failed relay becomes an unplanned refurbishment by installing a different model of relay in place of the failed relay. For transmission line protection, this requires replacement of the entire scheme which involves redesign and re-commissioning of the scheme as an emergency. These unplanned works can have an effect on the delivery of the planned program of work and will result in an increase in resourcing and costs.	Rare	Severe	Medium

Section 2 (Gated Investment Step 2)

5. Preferred Option:

The preferred solution is to renew the identified transmission line protection schemes to maintain secure and reliable protection schemes in EHV substations to maintain security and reliability of the transmission network.

5.1 Scope

2019-2024

Replace transmission line protection schemes at Burnie, Bridgewater, Chapel Street, Derby, George Town, Hadspen (10), Lindisfarne (3), Mowbray, Norwood (4), Palmerston (3), Risdon (4), Scottsdale (2), Sheffield (2), Starwood and Trevallyn (3) substations.

2024-2029

Replace transmission line protection schemes at Burnie (3), Chapel Street (2), Devonport (2), Gordon (2), Port Latta (2), Palmerston, Sheffield (5), Smithton (2), Temco (2), Waddamana (4) and Wesley Vale (2) substations.

5.2 Expected outcomes and benefits

The expected outcomes from the preferred solution will be lower operational maintenance costs, maintained reliability of protection schemes and reliable operation of the transmission network.

5.3 Regulatory Test

A RIT-T may be required as specified by the NER RIT-T obligations.

6. Options Analysis

Completion of options analysis has been undertaken using a modified Net Present Value (NPV) tool, to include Risk Cost. Risk Cost represents the expected annual cost of risk events ($ million) associated with the failure of asset. The business as usual case (BAU) base case definition applied in the options analysis is aligned to AER repex planning guideline. The NPV outcomes for all options considered, is relative to the BAU base case. The NPV tool has also been modified to include a Basis of Preparation. This enables increased transparency of the methodology and analysis undertaken, outlining methodology, key inputs, key assumptions. The Risk Cost methodology is represented as below:

Annual Asset Risk Cost = Probability of Asset Failure (PoF) x Asset units (No) x Likelihood of Consequence of Failure (LoC) x Cost of Consequence (CoC).

The analysis of all options is aligned with the Australian Energy Regulators application note for asset replacement planning, to ensure alignment of our approach. The risk cost categories, likelihood and consequence ratings are aligned with TasNetworks Corporate Risk Framework. The categories can also be mapped to the AER's repex planning guideline.

AON, TasNetworks corporate insurer provided Cost of Consequence (CoC) and Likelihood of Consequence (LoC) data. We have also analysed our assets and sought additional benchmarked data to develop Likelihood of Failure, Likelihood of Consequence and Cost of Consequence when it can be obtained.

The summary of costs outlined in section 6.3 below indicates the planned capital expenditure for repex over the 2019-24 period.

Protection schemes are required under section 4.6 of the NER to be maintained to a reliable standard. Protection schemes are generally applied by standard and best engineering practices to ensure highly reliable operation. Hence there are no other options for maintaining reliable protection schemes other than replacement with modern, standard protection equipment and associated designs. Through asset failure and condition prediction, and economic analysis, the option for renewal becomes the most economic capital investment.

6.1 Option Summary

Option description	
Option 0	Do nothing (Business As Usual base case): No capital investment. Continue planned operational maintenance. Existing risks remain.
Option 1	Unplanned replacement of the transmission line protection schemes with modern equivalents when failures occur and spares are fully depleted.
Option 2 (preferred)	Planned replacement of transmission line protection schemes to reduce maintenance costs and mitigate safety, reliability and compliance risks to acceptable levels.

6.2 Summary of Drivers

Option	
Option 0	Minimise capital costs by deferring the replacement of existing equipment. Advantages: • Defers capital expenditure. Disadvantages: • Does not address network performance risk; • Does not address regulatory or reputation risks; and • Does not address financial risk.
Option 1	Minimise ongoing operational costs by replacing failed protection schemes. Advantages: • Defers capital expenditure; and • Reduces operational costs. Disadvantages: • Cost is estimated to be 1.5 times that of planned replacements; • Does not address network performance risk; • Does not address regulatory and reputation risks; and • Does not address financial risk.
Option 2 (preferred)	Proactive replacement of protection relays to minimise maintenance due to the relay no longer being supported by the manufacturer, lackof spares or ongoing maintenance issues. Advantages: • Reduces operational costs; • Addresses network performance risk; • Addresses regulatroy and reputation risks; and • Addresses financial risk. Disadvantages: • Requires capial expenditure.

6.3 Summary of Costs

Option	Total Cost ($)
Option 0	$0
Option 1	$16,995,635
Option 2 (preferred)	$11,330,425

6.4 Summary of Risk

The target risk is low whereby normal maintenance processes can be undertaken to maintain reliable transmission line protection schemes for the Tasmanian transmission network.

6.5 Economic analysis

Option	Description	NPV
Option 0	Do nothing (Business As Usual base case): No capital investment. Continue planned operational maintenance. Existing risks remain.	$0
Option 1	Unplanned replacement of the transmission line protection schemes with modern equivalents when failures occur and spares are fully depleted.	-$1,666,975

Option 2 (preferred)	Planned replacement of transmission line protection schemes to reduce maintenance costs and mitigate safety, reliability and compliance risks to acceptable levels.	$2,902,721

6.5.1 Quantitative Risk Analysis

Quantitative risk has been used in the NPV analysis including the cost of risk as outlines in section 6. This provides an economic justification of the identified protection scheme replacements and formulates the preferred protection scheme replacement program.

6.5.2 Benchmarking

TasNetworks benchmarks against and shares work practices with Australian and International transmission utilities to ensure industry best practice is utilised when managing its assets. Committees and working groups TasNetworks participates in include: ENA, CIGRE and ITOMS.

The 2015 ITOMS benchmark report compares TasNetworks performance with respect to to other Australian National Energy Market (NEM) Transmission Network Service Providers (TNSPs). The results show TasNetworks has the highest unplanned outages and the second highest combined forced and fault outages per protection scheme. The report also indicated TasNetworks has the lowest performance per protection scheme and the highest Replacement / Refurbishment expenditure.

In 2015 the refurbishment / renewal program of work for protection replacements was in its early stages of addressing protection deficiencies, this explains the high expenditure versus low performace. An improvement in performace is expected as poor performing protection schemes are replaced with modern equivalents.

6.5.3 Expert findings

Not Considered

6.5.4 Assumptions

Due to the defined 15 year asset lifespan for static and microprocessor based protection and control equipment, combined with condition assessments derrived from failure reporting it is assumed that the protection schemes planned for renewal in the 2019-24 period will be obsolete, with failure rates exhibiting end of asset life and have minimal spares remaining.

It is assumed that the protection devices at both ends of a transmission line will be replaced at the same time to ensure the unitised protection remains in service after the refurbishment works are complete.

Unplanned renewal is 1.5 times more expensive than planned renewals, this estimate based on the following parameters:
1) work to be carried out as overtime or as a disruption to planned work;
2) repeat site visits;
3) initial solution is a temporary fix;
4) emergency design work; and
5) testing and commissioning as overtime or as a disruption to planned work activity.