Investment Evaluation Summary (IES)

Project Details:

Project Name:	BFM - Replace aged/deteriorated Galvanised Iron (GI) Conductor
Project ID:	01510
Business Segment:	Distribution
Thread:	Overhead
CAPEX/OPEX:	CAPEX
Service Classification:	Standard Control
Scope Type:	A
Work Category Code:	REMGI
Work Category Description:	Replace HV GI conductor
Preferred Option Description:	Review and replace defective and substandard Galvanised Iron (GI) Conductor based on condition.
Preferred Option Estimate (Dollars $2016/2017):	$9,577,574

	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29
Unit ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume	36.00	36.00	36.00	14.40	14.40	14.40	14.40	14.40	14.40	14.40
Estimate ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total ($)	$2,520,000	$2,520,000	$2,520,000	$1,008,787	$1,008,787	$1,008,787	$1,008,787	$1,008,787	$1,008,787	$1,008,787

Governance:

Works Initiator:	Michael Cooper	Date:	29/05/2017
Team Leader Endorsed:	Darryl Munro	Date:	01/06/2017
Leader Endorsed:	Nicole Eastoe	Date:	01/11/2017
General Manager Approved:	Wayne Tucker	Date:	01/11/2017

Related Documents:

Description	URL
Risk Mitigation Plan	http://reclink/R303735
Overhead Conductors and Hardware Asset Management Plan	http://reclink/R260427
Overhead Conductor Replacement Programs Prioritisation Guideline	http://reclink/R603335
National Electricity Rules (NER)	http://www.aemc.gov.au/Energy-Rules/National-electricity-rules/Current-Rules
TasNetworks Business Plan 2017-18	http://reclink/R0000779008
TasNetworks Transformation Roadmap 2025	http://Reclink/R0000764285
TasNetworks Corporate Plan - Planning period: 2017-18	http://reclink/R0000745475
TasNetworks Risk Management Framework	http://Reclink/R0000238142
BFM REMGI NPV	http://reclink/R732641

Section 1 (Gated Investment Step 1)

1. Overview

1.1 Background

TasNetworks bushfire mitigation programs (as approved by Board in March 2016) are aimed to mitigate the top ten high level causes of distribution asset related fires. These programs account for approximately ninety percent of all asset related fire causes. Timeframes for each of these programs vary depending upon factors such as risk, volumes and investment requirements.

Where conductor failures have caused fires, they have been included within fire start data as either conductor failure or connection failure (resulting in conductor failure). As shown within Table 1 below, conductor and connection failure account for a combined total of thirteen percent of fires caused by distribution assets.

Table 1: Causes of fires started by distribution network assets

Fire Cause	Number of Ground Fire Starts						% of Total
	2012/13	2013/14	2014/15	2015/16	2016/17	TOTAL	
Vegetation outside clearance	5	6	12	10	11	**44**	31.9
Conductor clashing	4	2	2	2	0	**10**	7.2
Conductor failure	4	1	1	3	1	**10**	7.2
EDO fuse element	0	3	4	2	1	**10**	7.2
Vandalism/accidental damage	1	2	4	1	3	**11**	8.0
Insulator broken/damaged	2	1	0	1	6	**10**	7.2
Connector failure	4	1	1	2	0	**8**	5.8
Birds/animals	2	0	1	3	2	**8**	5.8
Tie broken	0	0	1	4	2	**7**	5.1
Vegetation inside clearance	0	1	3	0	0	**4**	2.9
Lightning	0	1	0	1	1	**3**	2.2
Cable termination failure	0	0	0	3	0	**3**	2.2
EDO fuse tube	0	0	1	1	0	**2**	1.4
Turret (cable fault)	0	0	1	1	0	**2**	1.4
U/G cable failure	2	0	0	0	0	**2**	1.4
Switch-gear failure (LV)	1	0	0	0	1	**2**	1.4
Windborne material	0	0	0	0	1	**1**	0.7
Pole failure	0	0	0	0	1	**1**	0.7
TOTALS	**25**	**18**	**31**	**34**	**30**	**138**	**100**

Substandard overhead conductor installed in the past is the cause of a number of mechanical conductor failures, which may result in bushfires and safety risks, as well as interruption of supply. Copper and Galvanised Iron Conductor have been identified as the conductor types that are most prone to failure and have been selected for replacement programs. Two main programs have been developed in previous years to replace substandard overhead conductor:

1. Replace Substandard Overhead Copper Conductor (REMCU); and
2. Replace Substandard Overhead Galvanised Iron (GI) Conductor (REMGI) (This Project).

The number of bare wire overhead conductor breakages (from WASP Outage Data) is shown in Table 2, Figure 1 shows the current estimated age profile of HV overhead conductor within the network.

Table 2: Failure Statistics for "Bare Wire Conductor Failures"

Cond Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
AA	1	1	3	7	8	10	13	11	9	3	12	9	12	8	63
AAA	2	0	2	2	4	1	6	10	9	8	3	5	10	13	36
ACSR	0	0	0	1	2	0	4	6	2	1	4	3	4	1	15
Cu	0	0	4	2	1	5	7	7	8	4	5	1	11	13	34
GI	7	3	1	7	11	7	20	13	15	4	14	9	17	28	84
ALL (known)	10	4	10	19	26	23	50	47	43	20	38	27	54	63	232
All TOTAL	38	40	48	48	46	44	67	53	43	20	38	27	54	63	428

Figure 1: Estimated age profile for all HV conductor in the network.

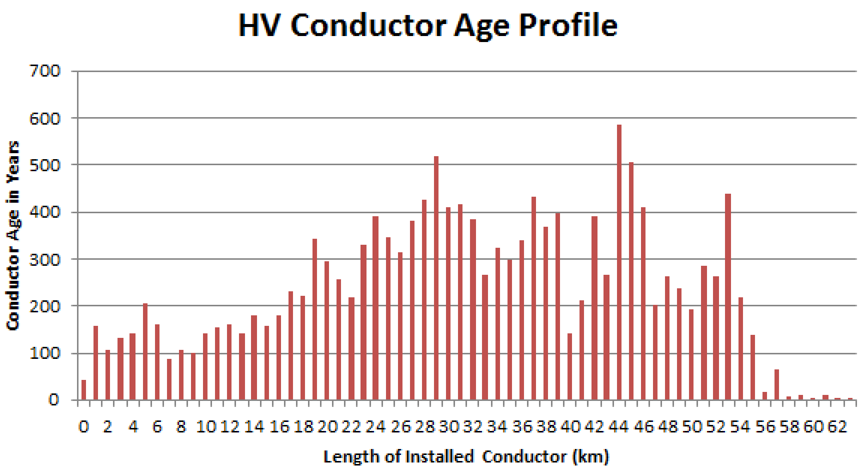

Table 3: HV overhead conductors and cables installed in TasNetworks' distribution system (as at July 2017)

Conductor Type	Total Length (km)	Percentage of Population
AA	6147	31.7%
AAA	2783	16.79%
ABC	18.5	0.11%
ACSR	732	4.42%
Cu	1111	6.7%
GI	5775	34.86%
Grand Total	16567	100.00%

The replacement programs for copper and GI conductor have, prior to 2012, been replaced as part of Replace HV Feeders (Safety) (REHSA). To better manage and monitor business costs and field works associated with this replacement program, two new work categories were created at the beginning of the 2012-2017 regulatory period to manage cost associated with copper and galvanised iron conductors, namely REMCU and REMGI respectively. To date 89KM of copper and 38kms of GI have been replaced. Table 4 shows the circuit length replaced in 2013 and 2014.

Table 4: HV overhead conductor replacements per year for copper and GI replacements 2013 – 2014.

Work Category	Year of replacement (km)		Total Length Replaced (km)
	2013	2014	
REMCU	24	65	89
REMGI	13	25	38
Total Length replaced per year (km)	37	90	127

1.2 Investment Need

Galvanised Iron (GI) conductor was introduced as a standard conductor in the distribution network in the 1940s. TasNetworks ceased to install single strand No. 8 GI in the 1970s and the imperial 3/12 GI was replaced with the metric 3/2.75 GI around 1976, which is the present day TasNetworks standard for rural conductors.

The performance of GI is particularly poor in marine environments. When subjected to wind borne salt spray and sea fogs containing salt contaminants, salt crystals are deposited on conductors. A galvanic cell is formed which results in the oxidation of the zinc coating on the conductor, over a long period of time. Once the zinc coating is removed, the iron in the conductor begins to corrode, which results in a loss of mechanical strength and eventually conductor failure.

The drivers for this program are therefore maintaining network performance and managing business operating risks (safety). Substandard overhead conductor may result in broken wires; increasing the likelihood of an interruption to supply, catastrophic bushfire and fatality or impairment to a person's life.

There is 5775 km of GI conductor in the network, which makes up 36% of the total network, by length. Approximately 707km of this GI conductor is located within 2 km of the coastline.

Table 5 shows the number of galvanised iron conductor failures by year (from WASP outage data where the cause is 'Conductor Failure – Bare Wire – Broken') and shows a general increasing trend in failures.

Table 5: Galvanized iron conductor failure statistics by year

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of failures	7	20	13	15	4	14	9	17	28

Table 6 shows the results of geospatial analysis of conductor failures from 2000-2014. These results indicate that conductors closer to the coast are more susceptible to salt spray from the prevailing winds and is therefore more likely to fail through corrosion. It can also be seen that galvanised iron conductor represents an average of 36% of all failure.

Table 6: Conductor failure statistics by distance from coast (2010-2014)

	Distance to Coastline (km)				
Row Labels	0 - 5	5 - 10	10 - 20	20 - 30	>30
AA	57	11	4	13	24
AAA	30	14	6	3	24
ACSR	5	4	6	2	12
Cu	15	5	2	4	42
GI	53	31	12	18	43
Grand Total	160	65	30	40	145

This program is a continuation of an existing project approved and commenced in 2017/2018 as part of TasNetworks' Bushfire Mitigation Strategy. The program has been scheduled to cover all GI conductor within the High Bushfire Loss Consequence Area (HBLCA) within the 2019-2024 regulatory period, the focus will then move to non-HBLCA areas.

1.3 Customer Needs or Impact

TasNetworks continues to undertake consumer 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:

- how its prices impact on its services;
- current and future consumer energy use;
- outage experiences (frequency and duration) and expectations;
- communication expectations;

- STPIS expectations (reliability standards and incentive payments); and
- Increasing understanding of the electricity industry and TasNetworks.

Consumers have identified safety, restoration of faults/emergencies and supply reliability as the highest performing services offered by TasNetworks.

Consumers also identified that into the future they believe that affordability, green, communicative, innovative, efficient and reliable services must be provided by TasNetworks.

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

Customers will continue to be consulted through routine TasNetworks processes, including the Voice of the customer program, the Annual Planning Review and ongoing regular customer liaison meetings.

1.4 Regulatory Considerations

This project is required to achieve the following capital expenditure objectives as described by the National Electricity Rules section 6.5.7(a).

6.5.7 (a) Forecast capital expenditure:

(1) meet or manage the expected demand for *standard control services* over that period;

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

(ii) the reliability or security of the *distribution system* through the supply of *standard control services*,

to the relevant extent:

(iii) maintain the quality, reliability and security of supply of *standard control services*; and

(iv) maintain the reliability and security of the *distribution system* through the supply of *standard control services*; and

(4) maintain the safety of the *distribution system* through the supply of *standard control services*.

2. Project Objectives

To perform targeted replacement of GI conductor with new standard conductor, to address the safety and environmental risks presented by the potential failure of these conductors with focus on conductors located within the HBLCA. The replacement conductors shall be selected from TasNetworks' standard conductors as defined in the Distribution Network Planning Manual.

3. Strategic Alignment

3.1 Business Objectives

Strategic and operational performance objectives relevant to this project are derived from TasNetworks 2017-18 Corporate Plan, approved by the Board in 2017. 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 networks services while transforming our business.

3.2 Business Initiatives

The business initiatives reflected in TasNetworks Transformation Roadmap 2025 publication (June 2017) for transition to the future that have synergy with this project are as follows:

- Voice of the customer: We anticipate and respond to your changing needs and market conditions.
- 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.
- Predictable and sustainable pricing: To deliver the lowest sustainable prices, we'll transition our pricing to better reflect the way you produce and use electricity.
- 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

If TasNetworks does not continue to monitor and replace the condition of overhead conductors there is a risk that a conductor failure could result in a severe bushfire or a serious injury sustained by a member of the public or staff.

The business risk associated with these assets has been evaluated as High by using the TasNetworks risk management framework.

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
Customer	Disruption to customer supply from declining network reliability.	Possible	Negligible	Low
Environment and Community	Conductor failures pose a significant risk of igniting a bushfire and causing significant damage to local environements and communities.	Unlikely	Severe	High
Financial	Excessive payout of reliability incentive schemes (STPIS, GSL, NCEF) from declining network reliability. Asset failure results in catastrophic bushfire. Insurance providers refuse to cover TasNetworks for future events.	Rare	Moderate	Low
Network Performance	Localised interruption of supply to customers.	Unlikely	Minor	Low
Regulatory Compliance	Increased number of unplanned outages leads to systemic NCEF breaches.	Unlikely	Minor	Low
Reputation	Asset failure results in catastrophic bushfire or injury with significant media coverage.	Unlikely	Major	Medium
Safety and People	Asset failure results in a fatality or permanently impairs a person's life.	Unlikely	Severe	High

5. Preferred Option:

The preferred option is to replace a targeted selection of substandard conductor which has been identified as the highest risk within the High Bushfire Loss Consequence Area (HBLCA).

5.1 Scope

For bushfire risk consequence mitigation, install replacement conductor to replace condition assessed aged GI overhead conductor to reduce the risk associated with unsafe assets, specifically safety to public, workers and bushfire starting which presents a safety and environment/community risk.

This program has focus on High Bushfire Loss Consequence Area locations.

The other item with focus on non-bushfire high risk other risk priorities for safety and reliability locations, for replacing GI conductors in priority wearout risk.

The scope here is to install replacement conductor to replace condition assessed aged GI overhead conductor to reduce the risk associated with bushfire higher risk areas for unsafe assets, specifically safety to public, workers and bushfire starting which presents a safety and environment/community risk.

Table of combined REMGI in BFM and general wearout safety risk

Units (KM)	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
BFM volumes (this program)	36	36	36	14	14	14	14	14
other volumes (non BFM)	13	13	13	13	13	13	13	13

Prioritisation of poor condition conductor: high-risk spans, in poor condition are included in the program of work to be replaced with a suitable replacement.

5.2 Expected outcomes and benefits

The expected outcome of this program is a reduction in the frequency of GI and Copper conductor failures. This will address the safety and environmental risks presented by the potential failure of these conductors.

5.3 Regulatory Test

A Regulatory Investment Test may be required for this program.

6. Options Analysis

6.1 Option Summary

Option description	
Option 0	Do nothing
Option 1 (preferred)	Review and replace defective and substandard Galvanised Iron (GI) Conductor based on condition.
Option 2	Replace Galvanised Iron (GI) Conductors after 50 years.

6.2 Summary of Drivers

Option	
Option 0	Advantages: • Lowest Expenditure option.

	• Longest lifespan of existing conductors is used. Disadvantages: • Does not meet TasNetworks' risk appetite or align with Zero Harm initiatives. • Conductors will fail in service risking public safety and bushfire ignition. • Network reliability will be reduced. • Higher expenditure to replace conductors under emergency fault repair.
Option 1 (preferred)	Advantages: • The risk of a conductor failing in service is significantly reduced. • Emergency fault replacement jobs are reduced. • Network reliability is maintained. • Sustainable expenditure. • The lifespan of current conductors is maximised. Disadvantages: • Not all conductor deterioration may be recognisable. • Difficult to schedule / predict future program expenditure.
Option 2	Advantages: • Significantly reduces the risk of a conductor failing in service. • Easy to schedule/ predict future program expenditure. Disadvantages: • Highest expenditure option. • Doesn't fully mitigate the risk of a conductor failing in service - Conductors may still fail prior to 50 years. • Conductors will frequently be replaced with many years of functional life still remaining.

6.3 Summary of Costs

Option	Total Cost ($)
Option 0	$0
Option 1 (preferred)	$9,577,574
Option 2	$24,033,765

6.4 Summary of Risk

Option 0 - Do Nothing:

The associated risk of this option is unchanged and remains High in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The high risk to public and staff safety from conductor failure;
- Reduced network reliability of customer supply due to increased incidents of unplanned outages due to conductor failure; and
- This option has the lowest upfront expenditure however high additional costs to the business are incurred in the form of regulatory and compliance breaches. As this option does not address the risk to public safety it is highly likely to involve further costs due to incidents and legal proceedings.

Option 1 - Replace Based on Condition (Preferred Option):

By replacing overhead conductors once they are identified as condmened, the ongoing risk is considered Low in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The risks to public safety from conductor failure are low but cannot be removed entirely;
- The likliness of unplanned outages occuring due to conductor failures are significantly reduced; and
- This is the lowest expenditure option that still addresses the risk to public safety.

Option 2 - Replace after 50 years:

The associated risk of this option is remains High in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The risks to public safety from conductor failure are lower than Option 0 but still does not adequately address public safety;

- There will be a lower incident of unplanned outages due to conductor failure compared to Option 0 but a higher number of outages compared to Option 1; and
- This is the highest expenditure option. This option necessitates the premature replacement of some assets. Additional costs to the business in the form of regulatory and compliance breaches are lower than for Option 0 but are likely to be higher than Option 1.

6.5 Economic analysis

Option	Description	NPV
Option 0	Do nothing	-$3,599,804
Option 1 (preferred)	Review and replace defective and substandard Galvanised Iron (GI) Conductor based on condition.	-$9,255,004
Option 2	Replace Galvanised Iron (GI) Conductors after 50 years.	-$20,374,044

6.5.1 Quantitative Risk Analysis

Not Applicable

6.5.2 Benchmarking

Condutor replacement programs within other Australian DNSPs are considered prudent and actioned as a buisness as usual activity, as 'run to failure' is not a viable alternative.

6.5.3 Expert findings

Not Applicable

6.5.4 Assumptions

- All conductor replacements would be for overhead high voltage rural lines – economic life of 60 years.
- Replacement volumes would be consistent for each of the ten years.
- The unit rate would be $58203 to replace 1 km of conductor (assumed to be 1km of 3 x 19/3.25AAC HV Replacement - 9 x 120m Spans).
- A condition audit process will be consistent over the ten year period.

Related Projects

Conductor replacement programs for Copper, Galvanised Steel and Aluminium are similar projects aimed at prevention of conductor failure for their specific design/construction characterisitics. Parallel conductor programs also exist that focus outside of the High Bushfire Loss Consequence Area (Copper = line item 591, Aluminium = line item 1719, Galvanised Iron = line item 594). These are not duplicate programs and are separated mainly for reporting purposes.

Material Specifications

Whilst new conductor technology is being investigated, the main strategy for Galvanised Steel is to replace like for like.

Program Development

The high bushfire loss consequence area unit volumes have been derived from total unit exposure to determine project volumes.

Annual volumes are a derivative of total program volumes divided by program timeframes.

Unit values have been determined using historical unit costs.

Unit costs are applied to annual program volumes to determine annual costs.