Investment Evaluation Summary (IES)

Project Details:

Project Name:	BFM - project replace aged/deteriorated Cu conductor
Project ID:	01509
Business Segment:	Distribution
Thread:	Overhead
CAPEX/OPEX:	CAPEX
Service Classification:	Standard Control
Scope Type:	A
Work Category Code:	REMCU
Work Category Description:	Replace HV copper conductor
Preferred Option Description:	Review and replace HV copper conductor based on condition and risk of fire start.
Preferred Option Estimate (Dollars $2016/2017):	$12,772,000

	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29
Unit ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume	48.00	48.00	48.00	19.20	19.20	19.20	19.20	19.20	19.20	19.20
Estimate ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total ($)	$3,360,000	$3,360,000	$3,360,000	$1,346,003	$1,346,003	$1,346,003	$1,346,003	$1,346,003	$1,346,003	$1,346,003

Governance:

Works Initiator:	Michael Cooper	Date:	29/05/2017
Team Leader Endorsed:	Darryl Munro	Date:	01/06/2017
Leader Endorsed:	Nicole Eastoe	Date:	24/11/2017
General Manager Approved:	Wayne Tucker	Date:	25/11/2017

Related Documents:

Description	URL
TasNetworks Business Plan 2017-18	http://reclink/R779008
TasNetworks Risk Management Framework	http://Reclink/R238142
National Electricity Rules (NER)	http://www.aemc.gov.au/Energy-Rules/National-electricity-rules/Current-Rules
Risk Mitigation Plan	http://reclink/R303735
Overhead Conductors and Hardware Asset Management Plan	http://reclink/R7260427
Conductor Failure Data 2010-2014	http://assetzone.tnad.tasnetworks.com.au/distribution/overhead-system-and-structures/Installation%20%20Maintenance%20Information /Conductor%20Replacement%20Strategy /Conductor_Failure_Update_2010-2014v2.xlsx
Conductor Inventory	http://assetzone.tnad.tasnetworks.com.au/distribution/overhead-system-and-structures/Installation%20%20Maintenance%20Information /DD17%20Data/REMGI_REMCU/Conductor_Inventory.xlsx
Overhead Conductor Replacement Programs Prioritisation Guideline	http://reclink/R603335
Conductor Age Profile Data	http://ttp://assetzone.tnad.tasnetworks.com.au/distribution/overhead-system-and-structures/Installation%20%20Maintenance%20Information /HV%20Overhead%20Conductor%20Estimated%20Install%20Date%20Data /Conductor_Age_Profile_Data_DD17_10JUN15.xlsx
TasNetworks Transformation Roadmap 2025	https://www.tasnetworks.com.au/customer-engagement/submissions/
TasNetworks Corporate Plan - Planning period: 2017-18	http://reclink/R745475
BFM REMCU NPV	http://reclink/R732644
Distribution Network Planning Manual	http://reclink/R833234

1. Overview

1.1 Background

TasNetworks bushfire mitigation programs are aimed to mitigate the top nine high level causes of distribution asset related fires. These programs account for approximately eighty five percent of all asset related fire causes. Timeframes for each of these programs vary depending upon factors such as risk, volumes and ability to deliver.

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 approximately thirteen per cent of fires caused by distribution assets. Substandard conductors can also be attributed to some cases of fires caused by conductor clashing.

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**

Overhead conductor installed in the past (to the standard of the day) is the cause of a number of mechanical conductor failures, which may result in risks to the community and environment through bushfires and safety risks, as well as interruption of supply. During their life these conductors are exposed to a wide range of events (including electrical, environmental, and mechanical) that cause reduction in tensile strength and scale (reduction in diameter). Conductors that meet pre-determined criteria of deterioration (as detailed within the Conductors and Hardware Distribution Asset Management Plan) are classified as being substandard. Typically, older installations of copper, aluminium and galvanised iron conductor are more likely to be identified as substandard and are the conductor types that are most prone to failure.

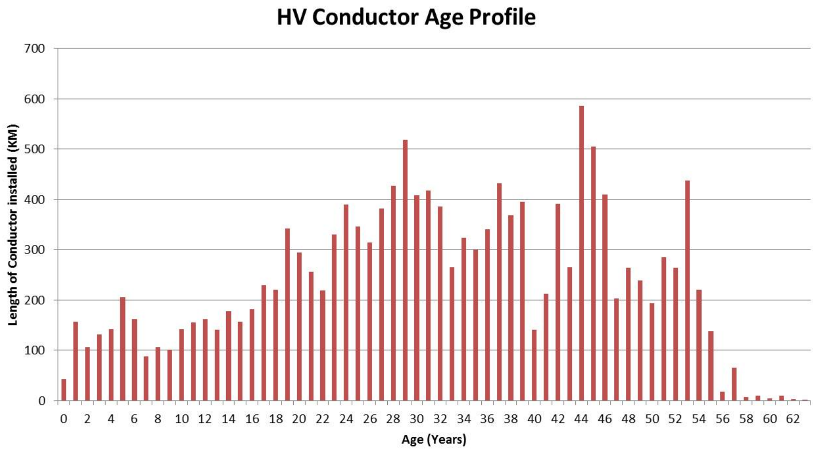
Given the large volumes of work associated with the state-wide conductor replacement programs and TasNetworks' ability to deliver such volumes, works have now been prioritised to ensure that the highest ranking risks are addressed first. Highest ranking risks include sites where aged conductor exists, is confirmed as being substandard, and is within the high bushfire loss consequence area (HBLCA). The HBLCA has been identified as an area where the losses associated with starting a major bushfire have the potential to cause greatest impact on communities and the environment in terms of loss of life and damage to infrastructure. This investment evaluation summary (IES) has been developed to address the risk associated with potential fire starts due to copper conductor failures within the HBLCA.

The makeup of all high voltage (HV) conductors in the distribution network and the number of bare wire overhead conductor breakages (from WASP Outage Data) is shown in Table 2, and Figure 1 shows the current estimated age profile of HV overhead conductor within the network. Table 2 is ordered in terms of most failures per 1000 KM for each conductor type with copper showing the highest failure rate.

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

Bare HV Conductors			Failures Per Year										Average	
Type	Total Length	Percentage of Network	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Per Year	Per 1000 KM of Conductor
Cu	1,111	6.7	1	5	7	7	8	4	5	1	11	13	6.2	5.58
ACSR	732	4.4	2	0	4	6	2	1	4	3	4	1	2.7	3.69
AAA	2,783	16.8	4	1	6	10	9	8	3	5	10	13	6.9	2.48
GI	5,775	34.9	11	7	20	13	15	4	14	9	17	28	13.8	2.39
AA	6,147	37.1	8	10	13	11	9	3	12	9	12	8	9.5	1.55
ABC	19	0.1	0	0	0	0	0	0	0	0	0	0	0.0	0.00
Total	16,567	100	26	23	50	47	43	20	38	27	54	63	39.1	2.36

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



The replacement programs for copper, aluminium and galvanised iron conductor have, prior to 2012, been replaced as part of Replace HV Feeders for Safety program (REHSA). To better manage and monitor business risks, costs and field works associated with these replacement programs, three new work categories were created at the beginning of the 2012-2017 Determination Period, namely REMCU (HV copper conductor replacement), REMAC (HV aluminium conductor replacement) and REMGI (HV galvanised steel conductor replacement) respectively. These programs continue in parallel to this IES in order to address the risks identifed outside of the HBLCA.

1.2 Investment Need

The majority of copper conductor was installed prior to 1964. Copper conductors range in size from 7/.044 to 19/.104.

When conductors are subjected to fault currents, they are rapidly heated, which may result in annealing if the fault is not adequately cleared. Copper conductor is typically not fault rated, so the exposure of conductor to fault currents for extended duration results in annealing, which reduces the tensile strength of the conductor. This may be identified by the conductor taking on an orange and scaling appearance. The condition of the conductor can also be determined by the number of joints installed in a span (generally installed following conductor failure) from a visual inspection. The smaller 7 stranded conductor is particularly susceptible to this failure mode.

Substandard overhead conductor is resulting in broken wires throughout the distribution network, increasing the risks accociated with the community and environment, safety and interruption to supply. The key drivers for this program are therefore to protect community and the environment (particularly in the form of bushfire mitigation), maintain safety, network performance associated with failure of copper conductors and compliance with regulatory responsibilities.

Given the potential failure modes mentioned above, copper conductor also creates unsafe working enviornment for field staff and restrictions currently apply for specific work methods when working on some copper conductors due to its tendency to fail whist being manouvered. For example, HV live line techniques cannot be used when working on small gauge copper conductors (such as 7/.044 and 7/.064) due to the safety risks posed by potential conductor failure. As such, operational costs and supply reliability are negativey impacted when works are required on copper conductors.

Table 3 shows that there have been a significant number of copper conductor failures over the past few years (from WASP outage data where the cause is ‘Conductor Failure – Bare Wire – Broken’). The total number of failures per year is shown in Table 3 and illustrates the growing trend in conductor failures. This trend, if left unmitigated, also increases the risk of fires starts from the increased occurrances of conductor failure, which is a concern to TasNetworks given our risk appetite towards fire starts.

Table 3: Number of copper conductor failures by year

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of failures	5	7	7	8	4	5	1	11	13

An analysis of copper conductor age and condition indicates that 99.96 per cent of all installed copper conductor is greater than forty years old with the majority being in poor condition and will require replacement in the near future. Approximately seventeen per cent of installed copper conductor is installed within the HBLCA.

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 replace all copper conductor (that meets the criteria mentioned within 5.1 *Scope*) within the HBLCA within the 2019-2024 regulatory period, after which the focus will then move to non-HBLCA areas with the intention to reduce risk in the HBLCA as quick as possible, taking into account finite TasNetworks' resources before addressing the fire start risk across the remainder of the state. The approach being undertaken by TasNetworks is consistent with other distribution networks in response to significant bushfires in other states.

There is another replacement program (REMCU) run parallel to this program where the primary focus is safety and reliability of supply rather than bushfire risk reduction.

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:

(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 replace HV copper conductor with new standard conductor, to address the safety, community 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.

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 due to conductor failures.	Possible	Negligible	Low
Environment and Community	Conductor failures pose a significant risk of igniting a bushfire and causing significant damage to local environments and communities.	Likely	Major	High
Financial	Excessive payout of reliability incentive schemes (STPIS, GSL, NECF) from declining network reliability. Conductor 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 due to conductor failures.	Unlikely	Minor	Low
Regulatory Compliance	Increased number of unplanned outages due to conductor failures leads to systemic NCEF breaches.	Unlikely	Minor	Low
Reputation	Conductor asset failure results in catastrophic bushfire or injury with significant media coverage.	Unlikely	Severe	High
Safety and People	Conductor asset failure results in a fatality or permanently impairs a person's life.	Unlikely	Severe	High

Section 2 (Gated Investment Step 2)

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 HBLCA before moving to other parts of the state.

5.1 Scope

Replace HV copper conductor based on condition assessment to reduce the risk associated with substandard assets starting a bushfire with associated safety risk to public, environment and community. This program has focus on HBLCA followed by other locations across the state, with a primary focus on reduction of the risk of fire start. Volumes for HV copper conductor replacement driven by this program for Bushfire Mitigation (BFM) and parallel program for safety/network reliability (Non-BFM) are shown in Table 4 below.

REMCU Replacement of aged/deteriorated HV Copper Conductors

Year	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29
Volumes (KM)												
BFM (this program)	19	29	48	48	48	19	19	19	19	19	19	19
Non-BFM program	8.4	0	33	33	33	33	33	33	33	33	33	33
Total	27.4	29	61	61	61	52	52	52	52	52	52	52

Table 4: Replacement forecasts of HV copper conductors

5.2 Expected outcomes and benefits

The expected outcome of this program is a reduction in the risk to public safety, community and environment from fire starts resulting from failing HV copper conductors. This program will start with a focus on the HBLCA before moving to other parts of the state.

5.3 Regulatory Test

A Regulatory Investment Test will not be required for this program.

6. Options Analysis

6.1 Option Summary

Option description	
Option 0	Do nothing
Option 1 (preferred)	Review and replace HV copper conductor based on condition and risk of fire start.
Option 2	Replace HV copper conductors after 50 years.

6.2 Summary of Drivers

Option	
Option 0	Advantages: • Lowest capital expenditure option; and • 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 community and environment, public safety and bushfire ignition; • Network reliability will be reduced; and • Higher expenditure to replace conductors under emergency fault repair.
Option 1 (preferred)	Advantages: • The risk to community and environment is significantly reduced due to the risk of a bushfire from a failed conductor being reduced; • Emergency fault replacement jobs are reduced; • Network reliability is maintained; • TasNetworks has capability to deliver the program; and • The lifespan of current conductors is maximised.

	Disadvantages: • Not all conductor deterioration may be recognisable; and • Difficult to schedule / predict future program expenditure.
Option 2	Advantages: • The risk to community and environment is reduced due to the risk of a bushfire from a failed conductor being reduced; • Emergency fault replacement jobs are reduced; • Network reliability is maintained; and • Easy to schedule/ predict future program expenditure. Disadvantages: • Highest capital expenditure option; • Doesn't fully mitigate the risk of a conductor failing in service as conductors may still fail prior to 50 years; • TasNetowrks capability to deliver the program; and • Conductors will frequently be replaced with many years of functional life remaining.

6.3 Summary of Costs

Option	Total Cost ($)
Option 0	$0
Option 1 (preferred)	$12,772,000
Option 2	$30,580,380

6.4 Summary of Risk

Option 0 - Do nothing:

The associated risk to community and environment due to fire start from failed HV copper conductors under this option is unchanged and remains High in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The high risk to community and environment, public and staff safety from fire start due to HV copper 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 age and condition (Preferred Option):

By replacing overhead HV copper conductors once they are identified as substandard, the ongoing risk to community and environment due to fire start from failed copper conductors is considered Low in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The risks to community and environment from fire start due to HV copper conductor failure are low but cannot be removed entirely;
- The likelihood of unplanned outages occuring due to HV copper 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 to community and environment due to fire start from failed HV copper conductors under this option is remains High in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The risks to community and environment from fire start due to HV copper 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 HV copper conductor failure compared to Option 0 but a higher number of outages compared to Option 1;
- This is the highest expenditure option. This option may result in the premature replacement of some assets; and
- 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	$0
Option 1 (preferred)	Review and replace HV copper conductor based on condition and risk of fire start.	-$16,327,319
Option 2	Replace HV copper conductors after 50 years.	-$48,887,709

6.5.1 Quantitative Risk Analysis

Not Applicable.

6.5.2 Benchmarking

HV copper conductor replacement programs are consistent with strategies implemented by other Australian Distribution Network Service Providers to effectively manage the risk of fire starts associated with these assets.

6.5.3 Expert findings

Not Applicable.

6.5.4 Assumptions

- 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).

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 replacement programs (where the main driver is safety and reliability of supply) also exist focusing outside of the HBLCA (REMCU = line item 591, REMAC = line item 1719, REMGI = line item 594). These are not duplicate programs.

Material Specifications

Whilst new conductor technology is being investigated, the current strategy for HV copper conductor is to replace with Aluminium 19/3.25AAC conductor.

Program Development

The HBLCA unit volumes have been derived from condition assessment of total length of HV copper conductor installed in the network within the HBCLA 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.