Investment Evaluation Summary (IES)

Project Details:

Project Name:	BFM - Replace EDOs with alternative device (ie: boric acid fuses or dropout reclosers)
Project ID:	01518
Business Segment:	Distribution
Thread:	Overhead
CAPEX/OPEX:	CAPEX
Service Classification:	Standard Control
Scope Type:	B
Work Category Code:	SIFIC
Work Category Description:	Fire mitigation projects - Conductor
Preferred Option Description:	Replace HV EDO fuses in the HBLCA with boric acid fuses or dropout reclosers.
Preferred Option Estimate (Dollars $2016/2017):	$7,500,000

	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29
Unit ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00
Estimate ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total ($)	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000

Governance:

Works Initiator:	David Eccles	Date:	05/11/2018
Team Leader Endorsed:	Darryl Munro	Date:	14/11/2018
Leader Endorsed:	Nicole Eastoe	Date:	22/11/2018
General Manager Approved:	Wayne Tucker	Date:	22/11/2018

Related Documents:

Description	URL
Bushfire Risk Mitigation Plan	http://reclink/R303735
Overhead Conductors and Hardware Asset Management Plan	http://reclink/R260427
Polemounted Transformers - Distribution	http://reclink/R260428
BFM EDO Replacement NPV	http://reclink/R1199690
TasNetworks Corporate Plan - Planning period: 2017-18	http://reclink/R745475
TasNetworks Transformation Roadmap 2025	https://www.tasnetworks.com.au/customer-engagement/submissions/
TasNetworks Risk Management Framework	http://Reclink/R238142
Overhead Switchgear Asset Management Plan	http://reclink/R181933
Menorandum of Advice	http://reclink/

Section 1 (Gated Investment Step 1)

1. Overview

1.1 Background

TasNetworks' overhead high voltage fuses occur most commonly as expulsion drop out fuses (EDOs) and consist of a porcelain insulator with a hinged fibregalss tube held in place by a fusible link. When the expulsion drop out fuses experiences a fault current that exceeds the curve rating for the device, the fusible link melts, causing the fuse to drop open to isolate the equipment or section of network that it is protecting. EDO fuses are limited to operate in areas where the network fault current level is less than 8kA and are primarily located on distribution transformers and spur lines, with some located on isolating transformers on single wire earth return (SWER) lines.

In addition to EDO fuses installed on distribution transformers, TasNetworks has also installed over 7,000 EDO fuses on spur lines in the distribution system. Spur lines are single, three phase or SWER lines off the main feeder trunk. The main purpose of these fuses is to prevent feeder trunk outages in the event of a fault on a spur line.

Where EDO fuse operations and failures have caused fires, they have been included within fire start data as either EDO fuse element or EDO fuse tube failure. EDO fuse element and EDO fuse tube failure account for a combined total of approximately eleven per cent of fires caused by distribution assets (approximately three fires per annum).

All distribution transformers have a set of fuses installed (one fuse device on each phase) for protection against over-current faults; which may include temporary or permanent faults. The most commonly used fuse devices in the network are expulsion drop out fuses as shown in the figure below. EDOs are made up of a fuse holder, fuse element and mount. The fuse holder consists of a hinged fibreglass tube, the lower casting and tube top with a pull ring. The mount has a porcelain insulator, top and bottom terminals, bottom hinge and top contacts. The hinged fibre tube is held in place by a fusible link.

EDO fuse

When the EDO fuse experiences a fault current that exceeds the curve rating for the device, the fusible link melts, causing the fuse holder to drop down and interrupt supply, protecting the network asset.

Although EDO fuses are an economic solution for asset and network protection, the operation of an EDO has the potential risk of starting a bushfire. In the event of an overcurrent fault, the fuse holder drops out interrupting supply and hot molten particles are expelled from the fuse tube. Depending on the conditions, these molten particles have the potential to fall to the ground below and ignite a fire, which under some circumstances could spread into a severe bushfire.

An additional issue with the operation of an EDO fuse is its ability to become stuck, which is known as a 'Hang Up'. This results from corrosion of the parts or moisture ingress into the fibreglass caused by exposure to the elements. The danger of this situation is if the fuse element melts due to a fault or overload, the element may stick to the inside of the tube, causing the fuse holder to remain hung up and not release. If supply is not interrupted, electrical tracking can then occur, resulting in the generation of heat and, in some cases, ignition of the fiberglass fuse tube creating the potential of starting a fire at ground level (see figure below). TasNetworks has experienced both of these modes of failure.

Failed EDO fuse tube

1.2 Investment Need

The objective of the program is to reduce fires caused by the operation (or maloperation) of EDO fuses and as a result, reduce the risks to employees, customers and the general public. The EDO operations (and maloperations) that resulted in fire starts have been recorded as:

- burnt out fuses (fuse tube or holder had signs of fire damage);
- fuse hang ups (fuses became stuck causing sparking or burning of the fuse);
- grass fires (operation from an EDO fuse caused a small grass fire); and
- various other incidents including burnt off loops, connectors, and links associated with the EDO fuse installation.

As outlined within the Bushfire Risk Mitigation Plan, the operation of EDO fuses in the High Bushfire Loss Consequence Area (HBLCA) poses amongst the highest risk to TasNetworks. 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. The HBLCA aligns with contemporary best practice principles, and utilises the Phoenix Rapid – Fire Model (Phoenix). The Phoenix Model enables the application of the 80 per cent fire loss consequence model as detailed within the 2009 Powerline Bushfire Safety Taskforce Final Report. Phoenix is widely recognised as the best available tool to assess fire loss consequence. Details on the HBLCA are detailed in the Buhfire risk mitigation plan as referenced (http://reclink/R303735).

Following submission of TasNetworks draft determination to the Australian Energy Regulator (AER), the AER and its consultants have indicated in their review of TasNetworks' proposed capital expenditure for the 2019-24 regulatory control period, the as low as reasonably practicable approach (ALARP) process “is not one of balancing the costs and benefits of measures but, rather, of adopting measures except where they are ruled out because they involve grossly disproportionate expenses”.

Since TasNetworks earlier draft determination, we have undertaken quantitative risk cost assessment, to ensure that the risk cost is commensurate with the capital expenditure outlined.

TasNetworks assesses that availability and suitability of ways to eliminate or minimise the risk from EDO fuses. After assessing the extent of the risk and the available ways of eliminating or minimising the risk TasNetworks uses the quantitative risk methodology as outlined in Section 6. This methodology enables TasNetworks to establish the cost associated with available ways of eliminating or minimising the risk, against the risk cost. This enables TasNetworks to determine if the response is proportionate with the risk. TasNetworks, specifically in relation to the bushfire risks associated with the EDO fuses, also assesses whether other precautions are reasonable. This ensures that TasNetworks identifies all practicable precautions, especially as it relates to industry practices. TasNetworks must also consider the specific environmental conditions relevant to TasNetworks. Given the findings and recommendations made public in various interstate reports relating to major electricity caused bushfires, TasNetworks has been made aware of the risks and the ways of minimising the risks. Tasmania has a history of catastrophic bushfires, and is assessed as having areas of very high to extreme bushfire risk. There are also multiple climate change research papers which outline that the bushfire risk into the future continues to increase. Expert information relating to the risk of bushfire within Tasmania, climate change projects, and practices of other industry participants are provided within the referenced Bushfire Risk Mitigation Plan (http://reclink /R303735) and expert findings within this Investment Evaluation Summary.

TasNetworks is legally bound to mitigate the risk of bushfire to ensure it meets industry benchmark or best practice. The AER have expressed an opinion that TasNetworks is not legally mandated to undertake mitigation of bushfire. However, TasNetworks has sought independent legal advice from John T (Jack) Rush Q.C. (http://reclink/) relating to the draft decision of the AER as it outlines concerns against the proposed capital expenditure forecast of TasNetworks for the period 2019 to 2024 relating to bushfire mitigation and the need to undertake work even though we are not mandated through legislation. The independent advice has advised that even though TasNetworks is not mandated by legislation to undertake this mitigation work, it would not relieve TasNetworks of our obligations to undertake this work for EDO fuses. This is because we are legally bound to mitigate the risk of bushfire to ensure it meets industry benchmark or best practice.

The AER has outlined expenditure concerns for asset replacement plans proposed to mitigate bushfire risk caused by the failure of electrical infrastructure initially in an area determined, after significant consultation, as the HBLCA. The AER brings into question TasNetworks assessment concerning extreme bushfire events is based on the Phoenix Rapid – Fire Model (Phoenix). The Phoenix model is used elsewhere in Australia to assess bushfire risk and is broadly considered a contemporary model and recognised as the most suitable tool to assess fire loss consequence. The independent legal advice outlines that "...It is in my opinion incumbent on TasNetworks to adopt a prudent bushfire mitigation strategy that at the least meets the standards of electricity providers in other high impact zones – zones identified by Phoenix as very high to extreme risk of bushfire". And "In the circumstances I can only say it seems close to incomprehensible that AER would not consider TasNetworks capex program for bushfire mitigation as essential". (http://reclink/)

TasNetworks firmly believes that proposed bushfire mitigation programs to replace the EDO fuses is reasonable and will reduce the risk of bushfires starting from the network to a level that is ALARP for an investment that is not grossly disproportionate to the risk. And also meets our obligations to ensure that the approach takes reasonably practicable precautions.

The investment need outlined above will be approached by either reducing the amount of fuse operations in these areas by installing fuse saving technology (such as dropout reclosers as shown in the figure below), or installing fuse devices in these areas that reduce the likelihood of starting a fire from a fuse operation (such as enclosed boric acid fuses as shown in the figure below). EDO's to be replaced will be prioritised with those within the HBLCA are to be actioned first and lower risk sites will continue to be addressed post 2023-24.

Dropout Recloser

Boric Acid Fuse

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

The objective of the program is to reduce fires caused by the operation (or maloperation) of EDO fuses.

The operation of fuses in the high fire risk areas poses the highest risk to TasNetworks. The approach will reduce the amount of fuse operations in these areas by either installing recloser technology or installing boric acid fuse devices in these areas which reduces the likelihood of starting a fire from a fuse operation. This program prioitises work to start in the HBLCA followed by other high fire risk areas of the state.

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 replace current EDOs within the HBLCA there is a risk that an EDO operation or failure could lead to a severe bushfire.

TasNetworks currently rates the risk of bushfire ignition resulting from asset related incidents as ''high' according to TasNetworks' the 5 x 5 risk matrix.

The current bushfire risk rating of 'high' is influenced by both the likelihood and consequence ratings used in the risk matrix.

The relevant key risk criteria and underlying assumptions that result in the current assigned rating of 'high' under our risk management framework are the:

- risk likelihood rating is considered to be 'unlikely'. This assumes a risk probability of 1 to 19 per cent, or 'may occur but not anticipated' or 'could occur in years to decades'; and

- consequence rating is considered to be 'severe'. The worst case consequence of a bushfire caused by TasNetworks would cause permanent impairment or fatality, severe impairment to critical habitat and ecosystems and/or greater than $75 million financial cost.

TasNetworks' risk assessment relating to bushfires

AON's risk assessment

TasNetworks' corporate insurance broker (AON) has provided an assessment of TasNetworks' risks in relation to a bushfire resulting from distribution overhead assets within the High Bushfire Loss Consequence area (HBLCA).

This assessment has been completed taking into account TasNetworks' current level of risk and controls in place.

It is noted that AON's risk assessment aligns with TasNetworks' assessment.

Further information relating to AON's risk assessment and quantification is detailed within Section 6.*Options Analysis* and Section 6.5.1 *Quantitative risk analysis.*

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	Potential to start a severe bushfire. Description of consequence: Non material supply interruption to <1000 customers. Cost of consequence: Calculated unserved energy costs	Unlikely	Negligible	Low
Environment and Community	EDO operations pose a risk of igniting a severe bushfire which could lead to widespread damage to both the environment and community. Description of consequence: Extensive impairment to critical habitat and ecosystems or species.	Unlikely	Major	Medium
Financial	Potential to start a severe bushfire. Description of consequence: Property Loss > $75M	Unlikely	Severe	High
Network Performance	Potential to start a severe bushfire. Description of consequence: Widespread separation of network	Unlikely	Major	Medium
Regulatory Compliance	Potential to start a severe bushfire. Description of consequence: Sustained regulator Intervention	Unlikely	Moderate	Medium

Reputation	The organisation reputation would be harmed if a severe bushfire was ignited from an asset. Description of consequence: Non sustained state press coverage.	Unlikely	Moderate	Medium
Safety and People	Current EDOs emit molten material and hot gasses during operation, this is hazardous to any member of the public or staff in the close vicinity, alternatively it could result in the loss of life from a bushfire. Potential to start a severe bushfire. Description of consequence: Fatality or permanent impairment.	Unlikely	Severe	High

Section 2 (Gated Investment Step 2)

5. Preferred Option:

Replace current EDOs with boric acid fuse devices or dropout reclosers located within the HBLCA and posing a direct risk of igniting a fire from operation.

5.1 Scope

Replace existing EDOs on spur lines or distribution transformers with alternative devices (ie: boric acid fuses or dropout reclosers).

This is a continuation of an existing program that focuses on EDO fuses in the HBLCA.

5.2 Expected outcomes and benefits

The benefits to TasNetworks from implementation of the preferred option will be:

- mitigate risk of starting a bushfire from an EDO operation in HBLCA;
- reduced safety risk to employees, customers and the general public; and
- reduce the risk of causing severe environmental and community damage.

5.3 Regulatory Test

A Regulatory Investment Test is not required for this program.

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) * Asset units (No) * Likelihood of Consequence of Failure (LoC) * 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.

6.1 Option Summary

Option description	
Option 0	Do nothing. Continue using conventional EDO fuses.
Option 1 (preferred)	Replace HV EDO fuses in the HBLCA with boric acid fuses or dropout reclosers.
Option 2	5 year deferral of replacement of all HV EDO fuses in the HBLCA with boric acid fuses or dropout reclosers.

6.2 Summary of Drivers

Option	
Option 0	The main driver for Option 0 is to avoid capital expenditure during the 2019-24 period.
Option 1 (preferred)	The main driver for Option 1 is to mitigate the risks (particularly bushfire risks) presented by EDO fuses in the distribution network through a program that is targeted and prioritised according to the risk that they present. This option adequately addresses TasNetworks' risks as identified within Section 4.1 (5x5 Risk Matrix) in this IES.
Option 2	Similar to Option 0, the main driver for Option 2 is to avoid capital expenditure during the 2019-24 period by deferring expenditure until post 2024.

6.3 Summary of Costs

Option	Total Cost ($)
Option 0	$0
Option 1 (preferred)	$7,500,000
Option 2	$0

6.4 Summary of Risk

Option 0 - Do Nothing:

Option 0 involves no programmed installation of EDO fuse replacements as a bushfire mitigation measure.

Emergency replacement will only be carried out when required and will involve increased operating and maintenance costs.

This option does not address the fire start risks presented in locations where EDO fuses are present, nor does it mitigate the risks in relation to:

- Customer;
- Environment & Community;
- Financial;
- Network Performance;
- Compliance;
- Reputation; and
- Safety.

This option is not aligned with the objectives and risk mitigation requirements identified in this IES.

This option does have the benefit of capital expenditure deferral but is not aligned with the strategies within TasNetworks' Bushfire Risk Mitigation Plan or the relevant distribution Asset Management Plans, developed to enable TasNetworks to maintain a safe and reliable network in a prudent and efficient manner.

Option 1 - Replace HV EDO fuses in the HBLCA with Boric Acid fuses or dropout reclosers. (Preferred Option):

Option 1 is the preferred option that aims to mitigate the risks presented by EDO fuses in the distribution network through a program that is targeted and prioritised according to the risk that they present.

This option adequately addresses TasNetworks' risks as identified within Section 4.1 (5x5 Risk Matrix) in this IES and is the most positive NPV option economically including risk cost.

Option 1 is aligned with the Bushfire Risk Mitigation Plan, the relevant distribution Asset Management Plans, and strategic performance objectives set by the business.

Option 2 - Defer option 1 for 5 years:

Similar to Option 0, Option 2 involves no programmed installation of EDO fuse replacements as a bushfire mitigation measure during the 2019-24 period.

Emergency replacement will only be carried out when required and will involve increased operating and maintenance costs.

This option does not address the fire start risks presented in locations where EDO fuses are present, nor does it mitigate the risks in relation to:

- Customer;
- Environment & Community;
- Financial;
- Network Performance;
- Compliance;
- Reputation; and
- Safety.

This option is not aligned with the objectives and risk mitigation requirements identified in this IES.

This option does have the benefit of capital expenditure deferral but is not aligned with the strategies within TasNetworks' Bushfire Risk Mitigation Plan or the relevant distribution Asset Management Plans, developed to enable TasNetworks to maintain a safe and reliable network in a prudent and efficient manner.

6.5 Economic analysis

Option	Description	NPV
Option 0	Do nothing. Continue using conventional EDO fuses.	-$12,762,069
Option 1 (preferred)	Replace HV EDO fuses in the HBLCA with boric acid fuses or dropout reclosers.	$5,166,975
Option 2	5 year deferral of replacement of all HV EDO fuses in the HBLCA with boric acid fuses or dropout reclosers.	$5,130,234

6.5.1 Quantitative Risk Analysis

A quantitative risk analysis has been completed including the cost of risk as described in section 6 above. The most positive option has been selected as the preferred option.

TasNetworks corporate insurer risk quantification

TasNetworks' corporate insurance broker (AON) has provided quantification of TasNetworks' risks in relation to a bushfire resulting from distribution overhead assets within the HBLCA.

As outlined in section 6 above, TasNetworks has utilised this information to calcualte the risk cost that exist for EDO fuses. This assessment has been completed for various options, including a Business as Usual base case option. Which isthe point of comparison for all other options. The values used for the quantitative risk costs assessment are included in the Net Present Value relevant to this investment need, as refeerenced in the related documents section.

Quantification of the risk has been completed, using the Cost of Consequence (CoC) and Likelihood of Consequence (LoC) data as provided by TasNetworks corporate insurer for the relevant risk categories.

The percentage value shown as LoC relate to an annual event (e.g.: 0.010 = 1 in a 100 year event).

The annual CoC is determined by CoC multiplied by the LoC (e.g.: for property damage, the annual CoC = $75,000,000 X 0.010 = $750,000).

The average number of asset related annual fire starts has been calculated in order to quantify TasNetworks' bushfire risk. (i.e.: the average number of fire starts associated with TasNetworks' assets is 28.3 per annum).

The average number of fires associated with each bushfire mitigation program of work has been assessed to determine the percentage of annual risk in relation to the total sum of asset related bushfire risks. (e.g.: fires per annum associated with EDO operations = 3.0 equating to 10.6 per cent of total annual fire starts).

The percentage of annual risk for each bushfire mitigation program of work has been applied to determine the relative percentage of CoC for each risk category. (e.g.: for property damage, the annual CoC in relation to EDO operations = ($75,000,000 X 0.010) X 0.106 = $79,505 per annum).

6.5.2 Benchmarking

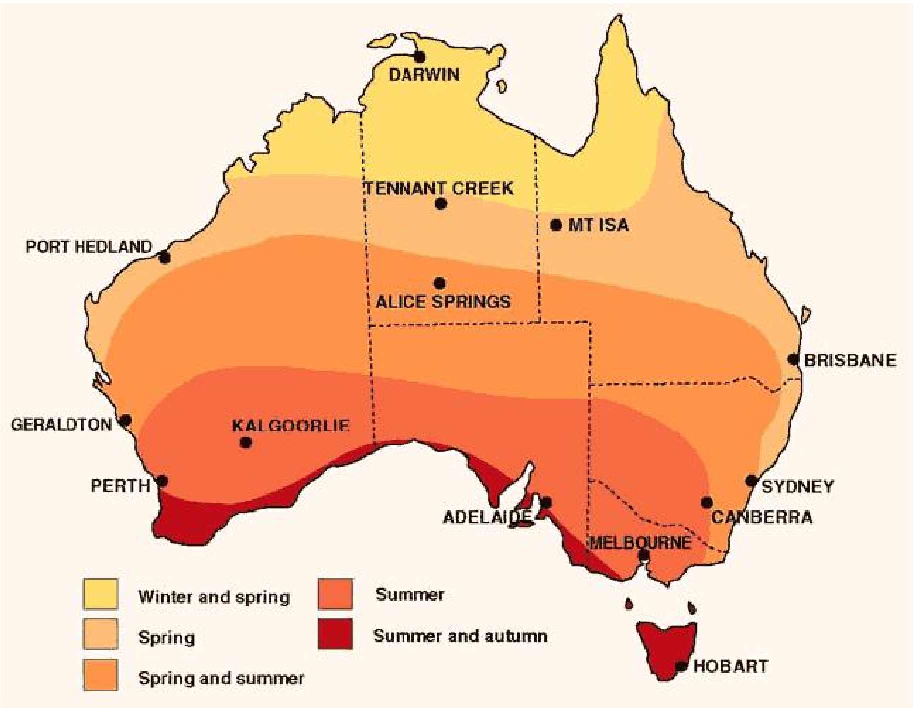
A survey was conducted around other utilities in Australia to understand the technology they are adopting and the issues surrounding this new technology. This feedback has assisted TasNetworks development of strategy that aligns with similar programs implemented by other utilities to mitigate bushfire risk due to EDO operations and failures.

6.5.3 Expert findings

This project is one of TasNetworks' targeted bushfire mitigation programs of work. All of TasNetworks' bushfire mitigation projects are aimed at addressing the increasing risks as detailed within recent research and modelling (relevant to Tasmania) published by a range of climate and bushfire experts.

South-eastern Australia has the reputation of being one of the three most fire-prone areas in the world, along with southern California and southern France[1].

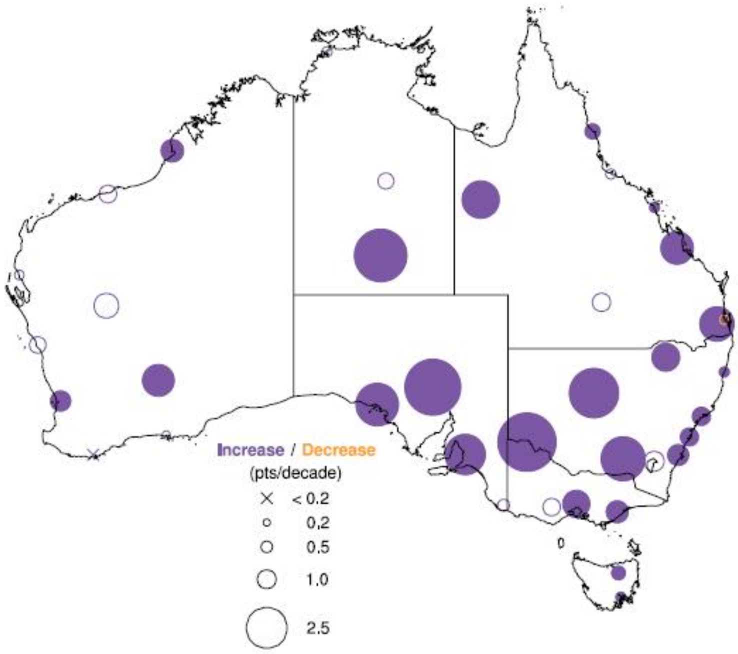
Figure 1: Seasonal pattern of fire danger. http://www.bom.gov.au/climate/c20thc/fire.shtml



Fire danger has increased in recent decades[2]. Observed fire weather in Australia from 1973–2010 is analysed for trends using the McArthur Forest Fire Danger Index (FFDI). Annual cumulative FFDI, which integrates daily fire weather across the year, increased significantly at 16 of 38 stations. Annual 90th percentile FFDI increased significantly at 24 stations over the same period. None of the stations examined recorded a significant decrease in FFDI.

The largest increases in seasonal FFDI occurred during spring and autumn, although with different spatial patterns, while summer recorded the fewest significant trends. These trends suggest increased fire weather conditions at many locations across Australia, due to both increased magnitude of FFDI and a lengthened fire season.

Figure 2: Map of trend in annual 90th percentile FFDI. Marker size is proportional to the magnitude of trend. Reference sizes are shown in the legend. Filled markers represent trends that are statistically significant.



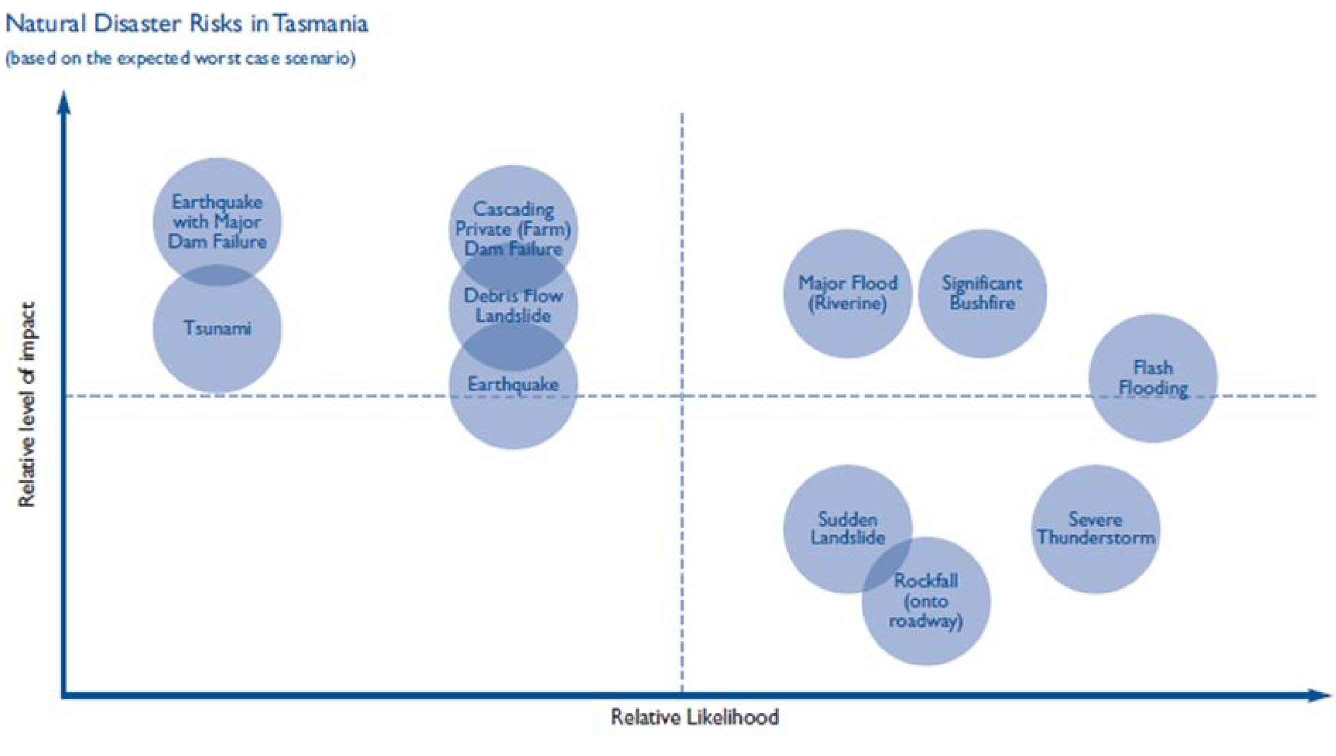
Fire danger is projected to increase further with greenhouse warming[3]. *The impact of climate change on the risk of forest and grassland fires in Australia* concludes that Australia will be significantly more exposed to forest and grassland fire risk in the future.

Bushfires already cause extensive damage and concern, and any increase in fire danger or shifts in the frequency, intensity or timing of fires, will have widespread consequences for human communities and natural systems[4]. Multi-model mean fire dangers indicate an accelerated increase if fire danger later this century via:

- a continuation of the trend of increasing springtime fire danger, a gradual increase in summer fire danger, but little change in autumn;
- an overall broadening of the fire season;
- an increase in the number of days at the highest range of fire danger at several representative locations around Tasmania, associated with synoptic patterns conducive to dangerous fire weather

The 2012 Tasmanian State Natural Disaster Risk Assessment (TSNDRA)[5] highlighted fire driven by changing weather and climate as one of the natural hazards most likely to cause significant damage and cost to Tasmania.

Figure 3: Relative impact and likelihood of natural disasters in Tasmania



Relative Impact and Likelihood of Natural Disasters in Tasmania

The TSNDRA identifies that Bushfire and Flood remain Tasmania's most significant hazard risk types. The assessment found that Bushfires are generally more severe in the southeast part of the State.

Key finding of the TSNDRA includes the necessity to maintain focus on prevention in awareness and education programs:

This was a common issue expressed across hazard – that work was needed to further embed prevention and mitigation into hazard and risk education and communication programs. It was felt that there remained a focus on 'what to do in the event of a disaster' in current programs, when it was likely that community resilience could be improved better by focusing on preventative actions.

Climate Futures for Tasmania modelling[6] projections indicate the following changes by the end of the century:

• The type of strong weather system that brings the majority of the worst fire weather days to south–east Tasmania is projected to become more frequent.

• The total number of days per year categorised as 'Very High Fire Danger' is projected to increase by at least 120%. In the future, this is about a 10% per decade increase to 2100.

• Projected changes show strong regional and seasonal variations. Regions currently with the greatest risk of fire are projected to get worse most rapidly.

• The area of Tasmania under 'Total Fire Ban' conditions during summer due to fire weather is projected to increase by at least 75%. This is a 6% increase per decade.

• The average area of Tasmania in spring categorised as 'Very High Fire Danger' is projected to increase by at least 250%. This is a 20% increase per decade.

• There is no major change to the fire danger risk in autumn.

• The analysis suggests that all projections could be conservative estimates of future changes.

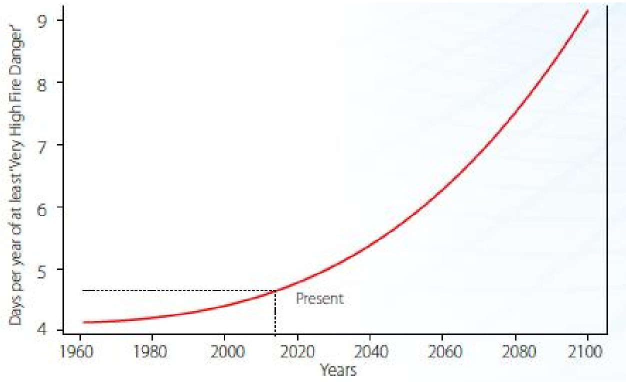
The Climate Futures for Tasmania study provides supporting evidence for stakeholders to prioritise and develop future bushfire strategies.

There is an increase in both average and extreme (99th percentile) Forest Fire Danger Index projected through the century. The rates of change vary across Tasmania and are different in each season. Most notably there is an increase in high fire danger days projected to occur in spring. There is also a projected increase in the frequency of the weather systems associated with many of the most severe fire weather events, and increases to other large–scale drivers of fire risk, as well as projected increases in soil dryness.

Taken together, all these factors provide a consistent story of increasing ire weather risks through the 21st century. This increase in risk factors will underlie the ongoing year–to–year and decade–to–decade variability of fire weather events in Tasmania.

Given the expected shorter return periods of bushfire events, emergency services may need to plan for more rapid repair of vital infrastructure and recovery of personnel to meet these increased risks.

Figure 4: Projected frequency of 'Very High Fire Danger' days from 1961 to 2100



Smoothed projection of the number of days per year categorised as at least 'Very High Fire Danger' from 1961 to 2100. Forest Fire Danger Index values will increase into the future, with the majority of the increase after 2050.

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[3] Pitman A, Narisma G, McAneney J. The impact of climate change on the risk of forest and grassland fires in Australia. 2007.

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[5] Department of Police and Emergency Management. 2012 Tasmanian State Natural Disaster Risk Assessment. 2012.

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6.5.4 Assumptions

Material Specifications

Boric acid fuses or dropout reclosers will account for the vast majority of replacement units. These units are currently a standard store stocked item.

Program Development

The HBLCA unit volumes have been derived from total units of HV EDO fuses 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.

NPV Assumptions

See basis of preparation within NPV spreadsheet for detailed assumptions regarding NPV inputs.