Supporting document 5.13

Bushfire mitigation program strategy and justification

2020-2025 Regulatory Proposal

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SA Power Networks

Bushfire mitigation program strategy and justification

Contents

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Executive Summary

Overview

Faults on our network can start fires. Although our fire start performance is good compared to other utilities, we still start fires during the bushfire season in High Bushfire Risk Areas (HBFRAs). The effect of fires in HBFRAs can be catastrophic for both our customers and the wider SA community. And with the forecast increase in extreme fire weather events and longer fire seasons[1], we need to manage this risk and adapt to new circumstances.

We have a comprehensive Bushfire Risk Management System, which each year includes undertaking numerous activities (eg line patrols, asset inspections and vegetation management) to reduce the likelihood that our network will start a major bushfire.

To enhance these existing operational practices, in the current period we commenced a bushfire mitigation capital program that is aimed at reducing this likelihood further. This bushfire mitigation program includes two elements:

- installing fast operating switches with remote control, which allows us to clear network faults much quicker, reducing the likelihood of a network fault resulting in a fire start; and
- replacing some outdated surge arrestor technologies whose open design makes them prone to starting fires due to contact from birds and air-borne debris.

We have invested (and forecast to invest) $16 million in these programs in the current 2015–2020 period. We propose to continue this program over the next period and have forecast capital expenditure of $13.0 million in the 2020–2025 period to continue to reduce bushfire risks in the HBFRA.

Importantly, in the current period we have made two significant developments that we believe will further improve the implementation of our bushfire mitigation program in the next regulatory period:

- **Ultra-fast fault clearance protection strategy** – We have developed a new protection strategy that should allow us to achieve very fast fault clearing during extreme bushfire conditions. Our analysis suggests that this strategy will significantly reduce the probability that a network fault will result in a fire starting[2]. Our program should allow us to implement this strategy on high risk feeders in HBFRAs.
- **Bushfire risk and cost-benefit analysis environment** – We have undertaken significant analysis, using experts such as the CSIRO, to develop a model that allows us to quantify the bushfire risk due to our network. This model also allows us to perform formal cost-benefit analysis on proposed program elements. We have used this model to assess the economic benefits (in terms of reduced bushfire risk) of possible program elements, and importantly, ensure that the proposed program for the next regulatory period will provide a positive net benefit to the SA community (ie the benefits will exceed the costs in present value terms).

Our modelling results indicate significant community benefits will accrue from the bushfire mitigation program proposed for the next period. Specifically, the results indicate that the $13.0 million capital investment over the next regulatory period will reduce bushfire risk by approximately 16%. We estimate that this risk reduction is valued in the order of $2.7 million per annum or $48 million over the life of the

[1] https://www.csiro.au/en/Showcase/state-of-the-climate

[2] Note, the probability of a fire starting increases with the time that the electrical current caused by the fault flows through combustible material.

assets. Consequently, the program will provide a significant net benefit to the community of approximately $1.7 million per annum or $35 million over the life of the assets.

Our new bushfire risk and cost-benefit analysis model

In its decision on our previous regulatory proposal, the AER criticised the analysis of our bushfire mitigation program. Specifically, the AER considered that we had not sufficiently quantified the bushfire risk and undertaken a structured cost benefit analysis. We have accepted and embraced these criticisms and set about developing a model that addresses them. We now consider that we have developed a model for quantifying our bushfire risk and undertaking cost-benefit analysis, which places us at, or at least very near to, the frontier of this work within Australian DNSPs.

In this model, bushfire risk is calculated based on the quantification of:

- **likelihood** – both in terms of our network starting a fire, and then this fire becoming a major bushfire; and

- **consequence** – both in terms of the physical fire footprint and the economic cost of land and property damage and public harm.

Furthermore, to ensure we have a detailed and accurate estimate of risk, we calculate likelihood and consequence across a range of bushfire weather conditions (36 in total) and a large number of fire start locations (29,765 locations in total representing 500m increments along the feeders in the HBFRA covered by this program)

Key features of the development of the model that ensures its robustness are:

- we have engaged expert advice on modelling – most notably CSIRO has undertaken extensive bushfire simulation, weather analysis, and fire suppression analysis to form inputs to our model;

- we have consulted with stakeholders that have SA bushfire expertise during the development – most notably we have held a number of workshops with SA Department of Environment and Water (DEW) and the Country Fire Service (CFS); and

- we have calibrated many aspects of the model with our historical data and SA bushfire events – most notably, we have used our own recent fire start history to develop fire start rates associated with our lines.

At this stage, we have developed the model to cover the HBFRA that our networks traverse. This covers the Mount Lofty Ranges, the South East, and high-risk regions of the Mid North, Flinders, Lower Eyre Peninsula and Kangaroo Island. In total, 417 of our HV feeders are covered by our model, representing approximately 13,900 route kms of overhead line.

Developing the scope of our bushfire mitigation program

We have used our new bushfire CBA model to assess a range of investment options and confirm the extent that they will produce a net-benefit in terms of bushfire risk reduction. The options considered, and the findings, are summarised in the table below.

Option	Bushfire CBA model result
replacing the old arrestor technology	approximately 1,447 units
replacing overhead bare wire conductors with overhead covered conductors	negligible[3]
replacing bare wire overhead conductor with underground cable	negligible[3]
upgrading feeders to enable new ultra-fast clearance protection strategy[4]	177 feeders identified

Table 1 – Bushfire CBA model options considered and summary results

Implementing the ultra-fast fault clearance strategy on a specific feeder can require a range of activities, depending on the capabilities of the existing protection devices on that feeder. The model provides the upper limit on the cost to achieve a positive net benefit given the change in the probability of starting a fire, but it does not define the scope of work. Therefore, we undertook a detailed investigation of the existing capabilities of each feeder identified by the model to develop a scope of work for that feeder.

We then used the model results and this additional analysis to define the bushfire mitigation program that will be applied for the remainder of the current regulatory period and the next regulatory period. The program scope and costs are summarized in the table below.

Program scope	Remaining current period (2 years 2018/19-2019/20)		Next period (5 years 2020/21-2024/25)	
	units	cost ($ millions)	units	cost ($ millions)
Replacing arrestors	**417**	**$1.47**	**1,031**	**$3.64**
Ultra-fast clearance strategy	**71**	**$4.01**	**239**	**$9.41**
Existing feeder source device protection setting implementation	16	$0.24	119	$1.79
Existing midline recloser protection setting implementation	6	$0.09	23	$0.35
Existing midline recloser upgrade / replacement	34	$2.55	33	$2.48
New midline recloser	15	$1.13	64	$4.80
Total bushfire mitigation program		**$5.48**		**$13.04**

Table 2 Bushfire mitigation program summary

Our bushfire risk and the benefits of the proposed program

On average over the last 10 years[5], faults on our network have started 19 fires per bushfire season in the regions covered by our program. Fortunately, none of these fires have resulted in catastrophic bushfires. However, a small number of these fires has resulted in material levels of land and property damage.

Although our analysis indicates that most of our fire starts will be suppressed or will self-extinguish without any significant damage or harm, any of these fires has the possibility of becoming more significant. Our bushfire CBA model estimates that the *expected* annual bushfire risk in 2018 over the covered region was

[3] Note, currently the model has found a very small number of segments where the benefits of installing covered conductor or undergrounding appeared to exceed the cost. But on more detailed investigation of these specific results, we found that these were more likely to be anomalous results, and therefore, we have not included these in our program.
[4] The results presented here assume the ultra-fast strategy is applied during time when the fire danger rating is at or above extreme, which typically corresponds to FDL2 or higher conditions.
[5] From summer 2007/08 to summer 2016/17 inclusive.

$18.6 million[6]. Our model also provides information on the distribution of possible bushfire outcomes in any year. For example, over the region covered by our model:

- we'll start a **major** bushfire (ie $50 million or greater fire) on average once in every 10 years; and
- we'll start a **catastrophic** bushfire (ie $250 million or greater fire - Ash Wednesday scale fire) on average once in every 70 years.

Using our bushfire CBA model, we estimate that our bushfire mitigation program will reduce the expected annual bushfire risk by 26%, or $4.8 million. A reduction in bushfire risk of $2.1 million per annum will be achieved by the program planned for the remaining two years of the current period, and a further $2.7 million per annum reduction in risk will be achieved in the next period.

To provide further context to the benefits of this program, by the end of the next period:

- we should have achieved a modest reduction in the frequency of our network starting a **major** bushfire from one in 10 years to one in 13 years; and
- a **catastrophic** bushfire from one in 70 years to one in 100 years.

As noted above, we have also used our new bushfire CBA model to confirm that all elements of the proposed program will have positive net benefits (ie the benefits will exceed the costs in present value terms).

We estimate that the total net benefit due to the program will be $3.4 million per annum. This net benefit is equivalent to approximately $66 million over the average 25-year life of the assets[7]. Approximately half of the life-time net benefit will be achieved by the program elements planned for the remaining two years of the current period, and the other half of these net benefits will be achieved through the program elements planned for the next regulatory period.

Regulatory treatment

We have included $13.04 million in our capital expenditure forecast in our regulatory proposal to the AER to allow for the component of our bushfire mitigation program that we have planned for the next regulatory period (2020/21 to 2024/25).

We believe that the AER can have confidence that this forecast is in accordance with the National Electricity Rules (NER), given the methodology we have applied, which represents a significant improvement in the approach we applied in our previous proposal.

We consider that the program's forecast capital expenditure is in accordance with the NER capex objectives as it is required to continue to comply with regulatory obligations and maintain the safety of our distribution system:

- we have a duty to take "reasonable steps" to ensure that the distribution system is safe and safely operated (Section 60(1) of the Electricity Act) and to maintain and operate the distribution system in accordance with good electricity industry practice (NER Clause 5.2.1(a)). These duties require us to have regard to objectively determined standards of safety;

[6] Note, this is the *expected* bushfire risk, which can be considered the long-term average, allowing for the probability distribution of outcomes ie some years will a have a lower outcome and some with a higher outcome.
[7] Note, we have used a lower life here than we may achieve from the assets to ensure we are not overstating the likely net benefit.

- given the thorough analysis, including cost-benefit analysis we have applied to determine appropriate actions to reduce the bushfire risk, we consider that we have demonstrated that the proposed program can be considered to reflect the "reasonable steps" we will need to take to continue to comply with these obligations and maintain the safety of our distribution system into the future; and

- furthermore, we believe that the need for us to continue to look for cost-effective methods to reduce bushfire risk is important given reports that extreme bushfire conditions are more likely in the future[8].

We also consider that the program's forecast is in accordance with the NER capex criteria as it reflects the efficient cost that a prudent operator would require to achieve the NER capex objectives, most notably:

- we have applied a robust approach to develop our bushfire CBA model and its input parameters, eg the use of experts, such as the CSIRO, to develop key bushfire risk inputs, and the use of our historical fire start data and SA historical bushfire data to calibrate and verify various model inputs;

- we have applied formal cost-benefit analysis to the program to ensure that only elements with a positive net-benefit are included; and

- we have used recent historical unit costs to develop the program cost estimate, which we consider can be assumed to reflect efficient costs for our circumstances given our good benchmark performance compared to other DNSPs.

We also consider that we have customer support for this program. We began the mitigation program in the current period and have spoken to our customers through the recent engagement process about continuing the program. Our customers and stakeholders indicated support for the program provided that the benefits to the community exceeded the costs. We consider that we have demonstrated here that this is the case.

With regard to trade-offs with other elements of our regulatory proposal, we are not including any adjustments to other incentive mechanisms because of this program. However, we have allowed for this program in our replacement capex forecast. The following are important in understanding this treatment:

- Reliability (STPIS) impact – The program elements that allow for our new ultra-fast fault clearance strategy includes investments in new midline reclosers, which could potentially improve supply reliability[9]. However, on the days when we implement the ultra-fast fault clearance, we expect reliability to worsen as the ultra-fast protection settings are more sensitive and hence spurious trips may result. We have undertaken analysis of these reliability benefits and dis-benefits and have found that the dis-benefits could outweigh the benefits.

  That said, we are not proposing a negative step change in the STPIS targets to allow for this program. Instead, we consider that further optimisation of the implementation of the new ultra-fast clearance strategy should result in a better balance of these factors, such that affected customers do not see a significant difference in reliability performance over the whole year.

- Opex (EBSS) impact – It could be argued that the reduced number of fires and arrestor faults achieved by this program will have some benefits in reduced operating expenditure. However, given the small number of fires in any year, we would expect this reduction to be immaterial.

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[8] https://www.csiro.au/en/Showcase/state-of-the-climate

[9] Note, the planned changes to protection settings and the planned replacement of slower devices should not improve reliability as these will not change the normal operation of these devices.

Furthermore, any actual reduction because of these factors would be offset by increases necessary to maintain the higher number of reclosers and implement the ultra-fast clearance strategy.

- Replacement capex (and other augmentation programs) – The replacement of some reclosers in this program does overlap with a small number of replacements in the replacement program. To ensure we have not double counted replacements, we have undertaken a reconciliation exercise of the recloser works across all programs. Where there is an overlap with the replacement program, we have removed the replacements from the replacement program[10].

  It is also worth noting that this program is largely focused on different drivers of risk than the replacement program. The risks in this program are largely driven by "assisted" asset failures, due to weather and the associated environment that are predominantly unrelated to asset age. The risks addressed by the asset replacement programs are largely driven by "unassisted" failures and operational cost increases due to the age and condition of the assets. Therefore, the risk reduction achieved through this program cannot be traded with the replacement program, without increasing age-related risks above current prudent and efficient levels as the asset population continues to age over the next period.

Given the above, we consider that the AER can have confidence that the treatment in our regulatory proposal of this program is in accordance with the NER. Importantly, this forecast represents a reduced scope from the program that was included in our previous proposal associated with the current period, which was rejected by the AER. We have accepted the reasoning given by the AER for its rejection, and we believe that we have addressed all the AER's concerns in developing the program included here.

[10] Note, we do not have a replacement program specifically addressing the old arrestor technologies, and therefore, there should not be an overlap associated with this element of the bushfire mitigation program.

1. Purpose

In the current regulatory period, we commenced a bushfire mitigation capital program that is aimed at reducing the likelihood that our network will start a fire in bushfire risk areas during the bushfire season. This bushfire mitigation program includes two elements:

- installing fast operating switches with remote facilities – this allows us to clear network faults much quicker, so the faults are less likely to start fires
- replacing some outdated surge arrestor technologies, of which their open design made them prone to starting fires due to contact from birds and air-borne debris.

We have invested (and forecast to invest) $16 million in these programs in the current regulatory period (2015-2020). We propose to continue this program over the next period (2020–2025) and have forecast capital expenditure of $13.0 million in the next period to continue to reduce bushfire risks in the HBFRA.

The purpose of this document is to explain these capital elements of our proposed bushfire mitigation program, and importantly, demonstrate why we believe this program is justified and should be included as part of our capital expenditure forecast in our next regulatory proposal to the AER.

To achieve this, we have structured this document as follows:

- In Section 2 we provide background and introductory information to provide context to our program and its justification.

- In Section 3, we discuss two important developments that we have achieved since our last regulatory proposal, which we consider greatly improves the analysis, effectiveness and efficiency of our program, namely:

    - a new protection strategy that should significantly increase the speed of fault clearing during extreme bushfire conditions, reducing the likelihood of a fault resulting in a fire

    - a new bushfire risk and cost-benefit analysis environment, which has provided us with a much greater understanding and quantification of our bushfire risk and allowed us to provide formal cost-benefit analysis on our programs to confirm they will provide a net-benefit.

- To provide context to our bushfire risk, in Section 4 we provide information on our historical fire start performance in the bushfire risk areas addressed through this program. Importantly, in this section we demonstrate that, we *do* start fires in these areas, and we *do* start fires at times when the fire danger is very high.

- We present summary results from our new bushfire risk analysis in Section 5. Importantly, this section provides a quantification of our estimate of the average long-term economic cost associated with bushfires that our network could start in the regions covered by our program. This section shows the make-up of this risk, including our estimate of the frequency of major fires and their different sizes, the relationship of risk with fire danger rating, and the spatial make-up of risk in the various regions covered by our program.

- In Section 6 we discuss our bushfire mitigation program and how we have evaluated this program, including options we considered, the results of our cost-benefit analysis, and an overview of the benefits and net benefits that should be achieved by the program. Importantly, in this section we demonstrate how we have determined that all elements of this program should provide positive net benefits (ie the benefits in terms of bushfire risk reduction should outweigh the cost in present value terms).

- Finally, in Section 7, we discuss how we have treated this program in our regulatory proposal to the AER, including why we consider it appropriate that the forecast capital expenditure associated with this program over the next regulatory period should be included in our forecast capital expenditure in our regulatory proposal, and how this program relates to the implementation of other incentive mechanisms and other programs.

This document is supported by other documents we have prepared, including:

- Bushfire Mitigation Program Forecasting Methodology paper, which provides a more detailed explanation of our new bushfire risk analysis and cost-benefit model.

- Bushfire Risk Mitigation High Speed Protection Settings and Philosophy, which provides a more detailed explanation of this new strategy and the analysis we have performed that supports its introduction.

- The bushfire CBA model, which is an excel model that provides feeder-level results of our bushfire risk analysis, the cost-benefit analysis of our program and other options.

2. Introduction

How we manage our bushfire risk

Managing bushfire risk continues to be a significant focus of ours. As we will show in Section 4, our network can and does start fires in high bushfire risk areas during the bushfire season. We believe we have a comprehensive and mature Bushfire Risk Management System (BRMS) that is detailed in the Bushfire Risk Management Manual No 8. The manual details the methods we use for mitigating bushfire risk due to our network, including both annual programs and the operating practices we implement on high fire danger days.

The present management system has been in place since the late 1980s following the findings into the 1983 Ash Wednesday fires, and has been progressively improved since. The system was reviewed by Jacobs in 2012 and described as "generally mature, logical, defendable, appropriately documented and well managed."[11]

Importantly, each year we implement enhanced line patrol, inspections and vegetation management in bushfire risk areas to mitigate risks prior to the start of each bushfire season. There are legislative obligations associated with managing and monitoring these activities. We also have powers to switch off supply when bushfire conditions are extreme. However, switching off electricity supply to a community during extreme bushfire conditions has its own risks, including to the health of that community[12]. Therefore, we only switch off supply to a community when the fire danger rating and weather conditions suggest the likelihood is very high that our network supplying that community could start a major bushfire.

The capital programs proposed here should have enduring benefits that will enhance these existing activities. Most notably, they are aimed at economically reducing the risks associated with starting major bushfires.

Our safety obligations that underpin our bushfire mitigation program

We have a duty to take "reasonable steps" to ensure that the distribution system is safe and safely operated (Section 60(1) of the Electricity Act) and to maintain and operate the distribution system in accordance with good electricity industry practice (NER Clause 5.2.1(a)). These duties require us to have regard to objectively determined standards of safety.

Given our network starting a catastrophic bushfire is one of the most significant safety hazards associated with our network, it is important that we continuously monitor, assess and evaluate our approach to managing these risks to consider what constitutes "reasonable steps". Importantly, the environment is continually changing and adapting, both technologically and economically. Therefore, what may be viewed as reasonable steps at one time, may not be later.

Given our analysis and reasoning presented in this document, we consider that this bushfire mitigation program will allow us to prudently and efficiently continue to manage the bushfire risks due to our network, and importantly, continue to comply with our safety obligations.

Consumer support for our bushfire mitigation program

We consider that we have customer support for this program. We began the mitigation program in the current period and have spoken to our customers through the recent engagement process about

[11] SA Power Networks Bushfire Risk Management Strategies, Development of Strategic Options for Bushfire Risk Management, 18 December 2012

[12] Extreme fire risk weather stems from high temperatures. Switching off supply at times of elevated temperatures increases the risk of injuries and fatalities due to the increased heat stress. http://www.cawcr.gov.au/technical-reports/CTR_060.pdf

continuing the program. Our customers supported the program providing that the benefits to the community exceed the costs. We consider that we have demonstrated here that this is the case.

Our previous regulatory proposal and the AER's decision

In our last revenue proposal to the Australian Energy Regulator (ie 2015-20 Regulatory Control Period), we included a program of bushfire initiatives to mitigate the risks associated with our network assets starting significant bushfires. As part of the Australian Energy Regulator's (**AER**) deliberations on the proposal, it reviewed our justification for the program and determined that we had not adequately justified or demonstrated the need for this program.

A key reason for this view was that the AER considered that we had not demonstrated that the bushfire risks were sufficiently high. Most notably:

- the AER did not consider that we had demonstrated that the probability of us starting a major bushfire was sufficiently high;
- although we provided analysis demonstrating we could start catastrophic bushfires, the AER noted that the consequences were not always catastrophic; and
- the AER also noted that we have the authority to switch off supply, and so considered that this must reduce the risks associated with us starting major bushfires.

Importantly, the AER also considered that we should have provided cost-benefit analysis of our strategy to demonstrate the scale of the benefits.

This view was upheld by the Australian Competition Tribunal when we appealed the AER's determination.

We have accepted these concerns and consider that in developing our bushfire mitigation program, we have addressed all these matters. This view will be explained and supported further in the remainder of this document.

3. Our new developments since our previous proposal

As indicated in the Introduction, we have developed two significant new strategies during the current regulatory period that we believe improve the analysis and effectiveness of our bushfire mitigation program.

- **Ultra-fast fault clearance protection strategy** – We have developed a new protection strategy, which should significantly reduce the probability that a network fault will result in a fire starting. Our program should allow us to implement this strategy on high risk feeders in HBFRAs.

- **Bushfire risk and cost-benefit analysis environment** – We have developed a model that allows us to quantify the bushfire risk from our network and perform formal cost-benefit analysis (the bushfire CBA model). We have used this model to assess the economic benefits (in terms of the bushfire risk reduction) of possible program elements, and importantly, ensure that the proposed program for the next regulatory period will provide a positive net benefit to the SA community (ie the benefits will exceed the costs in present value terms).

We provide an overview of these two developments in this section. More detailed discussions are provided in the following two documents:

- Bushfire Risk Mitigation High Speed Protection Settings and Philosophy; and
- Bushfire Mitigation Program Forecasting Methodology.

Our new ultra-fast fault clearance protection strategy

Background

Why our network can cause fires

Faults on our network can cause fires. For example, an energised broken conductor which falls to the ground onto dry fuels such as grass or bush, could start a fire. Similarly, a tree branch or other debris that has blown onto or touches an energized conductor could ignite and issue embers that could start a fire.

Whether or not the ignition occurs is related to many factors, which can be categorized as:

- environmental (eg combustibility of the material, air moisture, wind speed); and
- fault energy provided by the power system.

The second of these is more relevant to us as we can most directly influence this via our protection systems. If the fault energy is high enough, it can cause combustible material to ignite. Therefore, the higher the fault energy, the higher the probability *of an ignition event occurring because of a network fault (we call this the Probability of Ignition or POI).*

The fault energy is related to two main factors:

- the fault electrical current, which itself is related to the electrical impedance of the fault type – a lower impedance fault results in a higher fault current; and
- the duration of fault, where the longer the duration, the higher the energy for a given fault current.

Network protection and the probability of ignition

Our protection systems are used to detect fault conditions and isolate the affected network. This process de-energises the network that is supplying the fault, essentially removing the fault current. It is possible that some faults can clear themselves; for example, a tree branch or debris is blown against a line, causing a fault, but then falls off the line removing the fault. These are known as transient faults. To reduce the likelihood that these types of faults result in a sustained outage, often the protection will cycle through a de-energise/re-energise sequence, a set number of times in a short period (typically less than a minute) to confirm that the fault has cleared. If it has not cleared then the protection will de-energise the affected network for a final time, resulting in a sustained outage. Sustained outages require one of our crews to attend the outage, identify the fault location, repair any infrastructure damage and then restore supply.

Given this, there are two main ways that our protection systems can influence the POI following a fault:

- the reclose cycle of the protection has the effect of repeatedly cycling the fault current, increasing the fault energy received by combustible material; and
- slow operation of the protection results in a fault current occurring over a longer time, increasing the fault energy received by combustible material prior to the protection operation.

The Victorian Bushfire Royal Commission and changes to our protection practices

The Victorian Bushfire Royal Commission, initiated in response to the major bushfires in 2009, addressed the first of these, recommending that the reclose function be disabled on high bushfire risk days (Recommendation 32). We implemented this recommendation in 2011.

The second matter (slow protection operation) was investigated further by the Powerline Safety Taskforce (PBST), which was established by the Victorian government to investigate and advise on how a number of the recommendations of the Victorian Bushfire Royal Commission should be implemented, including disabling the reclose function.

A recommendation of the PBST was to replace older manual reclosers with modern remotely controlled devices. Importantly, research conducted during these investigations found that the POI could be reduced materially if the fault clearing time was reduced.

We have commenced replacing older reclosers with modern remote-controlled devices, but the main reason for this has been to more efficiently and safely disable the reclose function when needed. Also, we have installed additional reclosers on the boundaries of high bushfire risk areas, but the main reason for this has been to more effectively use our authority to switch-off parts of our network under catastrophic bushfire conditions.

Our analysis supporting our new strategy

The limitations of existing protection arrangements

Although replacing the older slower reclosers with new faster units has the potential to reduce the POI, investigations conducted by our protection group during the current regulatory period found that significant reductions were unlikely because of how we set-up and grade protection. We don’t consider this issue as unique to us; rather, it is a consequence of how protection is usually set up and operated to protect network equipment and minimize customer interruptions.

A feeder typically has a protection device at its source and a number of other protection devices installed along its length. The reason for these multiple devices is to limit the extent of the network that is de-energized to isolate the fault. Ideally, we want the upstream protection device closest to the fault, to operate in order that as few customers as possible are interrupted. However, all upstream devices see the fault current, and therefore, to achieve this discrimination, we need to coordinate the settings of the various devices to ensure that the closest will be the first to operate. To achieve this coordination, individual devices are typically programmed with a current vs time curve that is set in such a way that the closest upstream device should be the first to trip. However, this coordination method results in protection devices often operating significantly slower than their shortest possibly clearance time to ensure that the most appropriate device operates first.

Our analysis to investigate a new approach

As noted above, during the research conducted by the PBST, investigations were undertaken to determine the relationship between the POI and the fault clearing time[13].

We used these research findings and information on protective devices installed on our network to estimate the likely reduction in POI by operating circuit breakers or reclosers at or very near to their fastest operating time. This analysis confirmed that significant reductions in POI could be achieved for many of the protective devices that we use.

We then applied these findings to each feeder in our HBFRA to determine the reduction in POI that could be achieved with existing devices and if a further reduction could be achieved by installing a modern fast acting device. This analysis indicated that in the order of a 50% to 70% reduction in POI could be achieved on most feeders being assessed if this strategy was implemented.

This set of feeder-level POI reduction outcomes were then used in our cost-benefit analysis of the bushfire mitigation program, which is discussed later in this document.

Implementing the new ultra-fast clearance strategy

When we will apply this new strategy

As noted above, our analysis indicates that very significant reduction in POI can be achieved if we move to this ultra-fast fault clearance strategy. However, as also indicated above, this will mean that when this strategy is applied, we can no longer coordinate protection devices and so when a fault occurs, the most likely device to operate will be the source device or a recloser near the source .

Hence, while this strategy is applied, a fault on a feeder will result in more customer supplies being interrupted than under normal coordinated protection operation. Furthermore, this strategy applies very sensitive settings to devices, which means spurious trips are more likely, and so the overall outage performance of the feeder is likely to worsen.

As such, we expect that the overall reliability performance of any feeder operating under this strategy will worsen materially.

To mitigate this effect, we only intend to operate this strategy when the bushfire conditions associated with the feeder are classified as our two highest Fire Danger Levels, known as FDL2 and FDL3. These two levels broadly correspond to the Country Fire Service's E*xtreme* or C*atastrophic* bushfire danger ratings. As such, we expect to implement this operation on average 1.5 days per bushfire season.

We will discuss the reliability implications of this strategy and our bushfire mitigation program further when discussing the regulatory treatment of this program in Section 7.

How we will implement this new strategy

Implementing this strategy entails almost instantaneous sensing and clearing of any fault current. We have investigated various methods to achieve this. Our preferred method is to use the "Hot Line tag" functionality that is already provided in many devices.

[13] Probability of Bushfire Ignition from Electric Arc Faults, Final Report, Dec 2011. Report No HLC/201/195. By Dick Coldham , Andrew Czerwinski and Tony Marxsen

This functionality is provided for safety reasons and is normally enabled when live line work is being performed. Enabling this functionality disables the device's reclose action and provides ultra-fast clearance of faults so as to limit the risks to the live line crews should a fault occur while they're working.

Network investments required to allow for this strategy

Implementing this strategy will require different amounts of work for each feeder, which will ultimately determine the total costs to apply this strategy. These works are dependent on the existing source circuit breakers or source or midline reclosers, and include:

- developing and deploying the new protection settings to existing feeder source devices;
- developing and deploying the new protection settings to existing feeder midline reclosers;
- upgrading or replacing devices that have slow operating times or are not connected to our SCADA system; and
- installing new midline reclosers to reduce the extent of customers that could be interrupted through this strategy.

For our analysis, we have assumed the following replacement or upgrade devices will be used to provide ultra-fast clearance if the reduced POI from the replacement or upgrade shows a positive net benefit:

- 11kV feeders – a NOJA recloser, with a total fault clearance time of 81ms;
- 33kV feeders – a NULEC recloser, with a total fault clearance time of 70ms; and
- SWER feeders – FuseSaver device, with a total fault clearance time of 20ms.

We will discuss the cost and asset life assumptions associated with these works when we discuss our cost-benefit analysis of bushfire mitigation program options in Section 6.

Our new approach to developing the program

Our previous approach and why we have improved it

As we have noted above, the AER did not accept that the risk analysis we used to support our bushfire mitigation in our previous proposal was appropriate. Although, at the time, we believed that our analysis was reasonable for our circumstance, we accept the AER's criticisms. Our method at that time focused on demonstrating that we do start fires each year in high bushfire risk regions (which our historical data clearly shows we do) and providing an estimate of the Maximum Probable Loss that could result if one of these fires caused a major bushfire.

Although this analysis provided a qualitative indication of our bushfire risk on a regional basis, it did not quantify the risk or allow for a formal cost-benefit analysis. It also did not readily allow us to identify which of our assets could be contributing the most to the bushfire risk.

In response to these limitations and the AER concerns, in 2016, we commenced a significant project to improve our methodology and modelling. Key requirements of this project were:

- to more accurately assess and quantify the bushfire risk our network imposes on the SA community, including understanding where this risk is, what parts of our network are driving it, and how it is related to bushfire conditions; and

- provide an analysis framework to allow us to use this risk information to perform formal cost-benefit analysis of bushfire mitigation program options.

An important purpose for this project was to ensure that we can demonstrate that our bushfire mitigation capital program provides an economic net benefit. That is, the economic benefits resulting from the program should exceed the costs of the program.

We consider that our new approach is or is close to leading how bushfire risk is analysed in the NEM.

Why our new approach is appropriate

We believe that our new risk assessment and cost-benefit methodology should align with the recent AER statements on its expectation for formal quantitative risk assessments and cost-benefit analysis.

The key feature of our approach that we believe demonstrate the robustness of our analysis are as follows:

- **We are calculating risks across a large range of fire start locations and bushfire conditions**

  We determine the bushfire risk by separately calculating bushfire probabilities and bushfire consequences across a range of possible bushfire events, covering fire start locations that traverse our network and possible bushfire conditions. This ensures that we understand the make-up of the bushfire risk in the context of mitigation options, including supply switch-off conditions and the risks associated with this.

  The range of bushfire events cover:

  - 29,765 individual fire start locations, along the feeders covered by our study (at 500m increments); and
  - 36 different weather and bushfire conditions for each of these fire start locations, ranging from the lowest bushfire danger conditions during the bushfire season to the highest.

  In total, this amounts to us analysing over 1 million bushfire events.

- **We have engaged expert advice on bushfire modelling**

  To understand the potential range of major bushfires that we could start under different conditions discussed above, we engaged CSIRO to undertake extensive bushfire simulation of the areas covered by our study. As part of this project, CSIRO has performed nearly one million bushfire propagation simulations using its own bushfire simulation software.

- **We have calibrated many aspects of our model using historical data of SA bushfire events**

  We have calibrated many of the inputs and assumptions of our modelling using our own fires starts database as well as other databases of SA bushfire events. In this way, we can have confidence that the calculated risks are a reasonable representation of *our* risks. Most notably:

  - we have estimated fire start probabilities from our own recent history, allowing for the improvements we have made over this period;
  - we have used various data sources to ensure that assumed fire suppression rates are moderated such that the fire sizes and event frequencies predicted by our model reflect actual SA outcomes; and
  - we have tested various bushfire cost metrics predicted by our model (e.g. costs per hectare burned) against actual bushfire costs in the public domain and our own recent insurance claims.

- **Consultation with key stakeholders to validate model**

  In addition to the engagement of CSIRO, during the development and application of this new approach, we have also consulted with key SA stakeholders that have bushfire analysis and management expertise. This consultation has been used to test model assumptions and gain general support for our approach and its findings. These stakeholders include the Country Fire Service (CFS) and SA Department of Environment and Water (DEW).

- **We have only included program elements where we can demonstrate that there should be a net-benefit due to that element.**

  We have used our new approach to assess the proposed program options and test whether they produce a net-benefit (i.e. the benefits exceed the costs in discounted cash flow terms). Using our new approach, we have been able to do this analysis and testing for specific feeders and feeder segments, such that we can determine where on our network it would be prudent and efficient to implement the program, and in turn have reasonable confidence that the proposed program is optimal.

More detailed explanations of our risk analysis and cost-benefit model are provided in our Bushfire Mitigation Program Forecasting methodology paper.

The areas covered by our new approach and bushfire mitigation program

Our new approach uses a large amount of analysis to ensure we can have a reasonably accurate estimate of the bushfire risk. Therefore, at this stage, we have limited our analysis to only the high bushfire risk areas that our network traverses.

There are 417 feeders which traverse the high bushfire risk area, representing 13,900 route km of overhead HV and sub-transmission line. These feeders are located in the following CFS Fire Ban Districts (as shown in Figure 1):

- the Mount Lofty Ranges;
- the South East; and
- high bushfire risk regions of the Mid North, Flinders, Lower Eyre Peninsula, and Kangaroo Island.

Our bushfire mitigation program is focused on reducing bushfire risk in these areas.

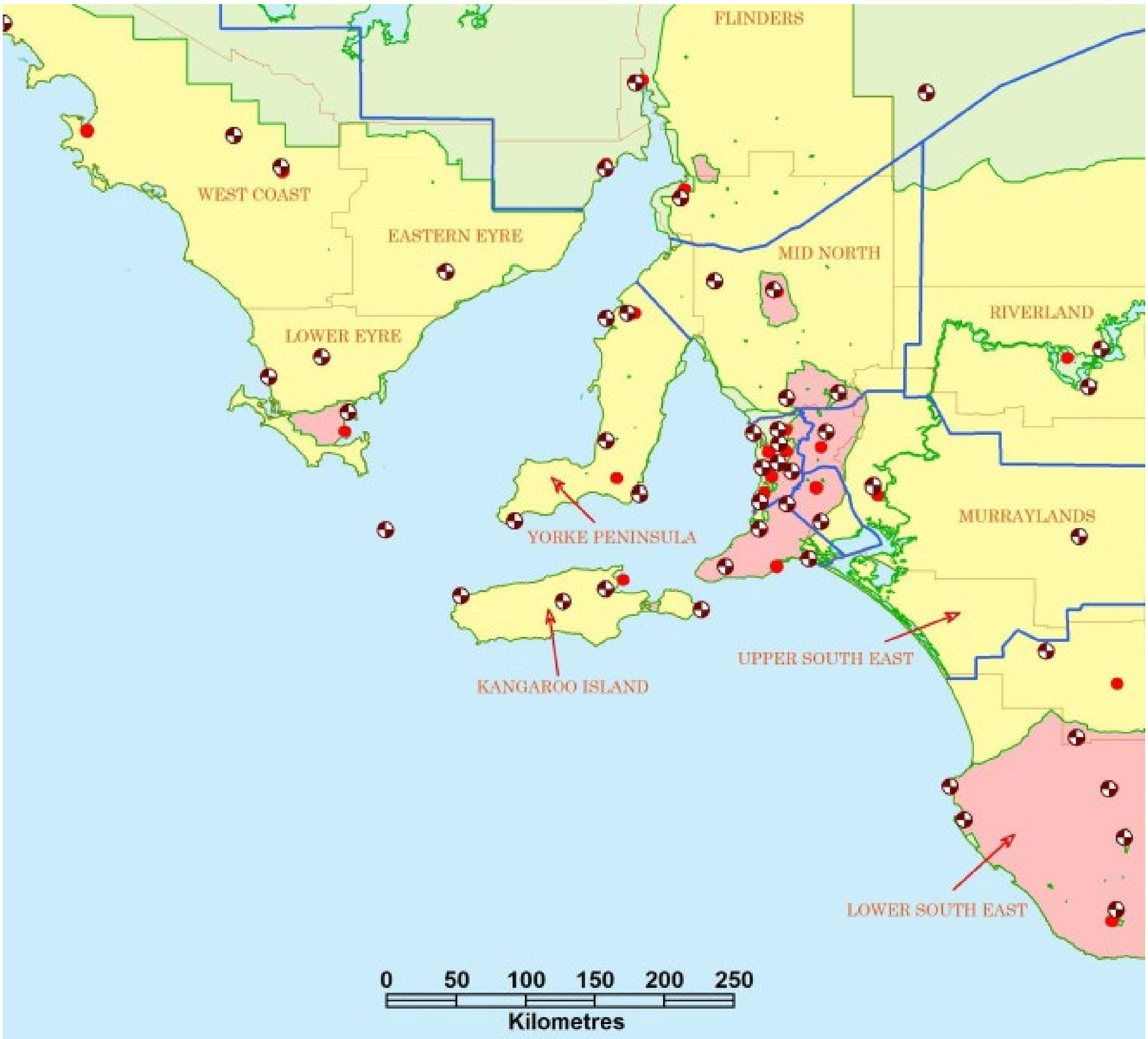

Figure 1 Coverage of our new bushfire risk analysis and cost-benefit model (the pink areas)

4. Our recent fire start performance

In this section, we present metrics of the recent historical fire start performance of our network. We aim to demonstrate that we do start fires, which is relevant to our analysis and underpins the case for our bushfire risk mitigation program. We will also highlight matters that are relevant to the understanding of our risk, which we cover in the next section.

The analysis presented here is based on our fire start database which is a record of every fire start associated with our network. We have been maintaining this database in its present form, since 2007.

Our recent fire start performance

Figure 2 shows the total number of fires caused by our network each year during the bushfire seasons[14], from 2008 to 2017. These fire counts only cover the fire starts associated with 417 feeders that we have analysed through our model (ie the feeders supplying HBFRA).

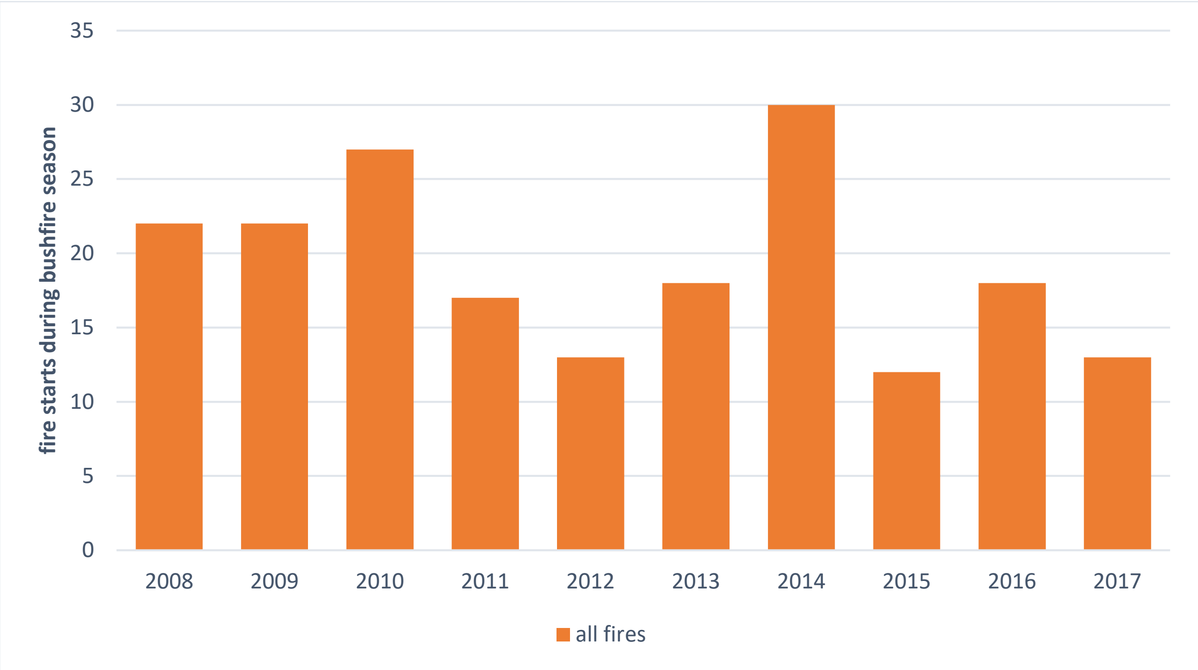

Figure 2 Fires started by our network per bushfire season for the regions covered by our model

This chart shows that on average we started 19 fires per bushfire season across these feeders, ranging from 12 fires in 2015 to 30 fires in 2014. This clearly demonstrates that we *do* start fires in high bushfire risk areas during the bushfire season.

While there is significant variability in the number of fire starts per year, this is to be expected as the number of network faults in any year is dependent on the weather in that year. Nonetheless, the figure suggests an improving trend in fire starts per annum over this historical period. This is also in line with our expectations, as over this period we have implemented a number of enhanced patrol, inspection and vegetation management initiatives in bushfire risk areas. Importantly, our new risk analysis approach has allowed for this improvement in predicting our current bushfire risk.

[14] For this analysis, we consider the bushfire season to run from the beginning of November to the end of April.

Figure 3 shows a breakdown of the above fire starts in the six fire danger rating categories, for the same HBFRA[15]. We have normalized the fire start counts to show the number of fire starts per 100 days for that fire danger rating category[16].

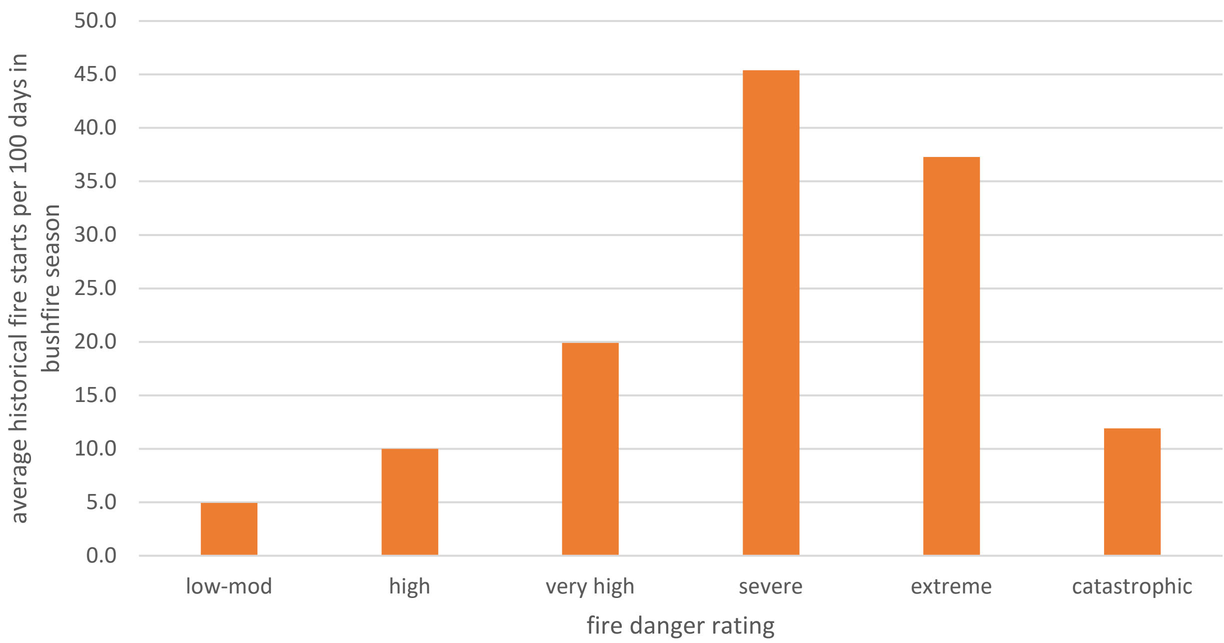

Figure 3 Fire starts per 100 days by fire danger rating

This figure shows that as the fire danger rating rises, the likelihood of a fire start from our network rises significantly. However, the likelihood of a fire start begins to fall again in the highest categories. The peak likelihood of fire start is when the fire danger rating is Severe.

To develop the relationship between fire danger rating and fire starts, feeders were associated with a Bureau of Meteorology (BOM) Automatic Weather Station (AWS). Hence the fire start rate is dependent on which AWS (and hence fire danger rating) is assumed for each fire start. Nonetheless, this result tends to support a view that the highest likelihood of starting fires is in the higher fire danger rating bands.

Recent significant fire events

Although we have shown that our network is responsible for a number of fires start in HBFRA during the bushfire season, the majority of these will be suppressed (ie extinguished by the CFS or the public, or self-extinguished) before becoming a major bushfire.

In the period 2008 to 2017, we have only started 6 major fires in our designated bushfire risk areas; a major fire is defined here as a fire with a footprint greater than 100 hectares. These fires are summarized in the table below.

[15] For this chart, we have used the fire danger ratings on the day of fire start, based on the weather data advice provided by CSIRO.

[16] Note, this metric is calculated as the 100*actual number of fires on days of that fire danger rating / number of days of that fire danger rating

Date	Region	Feeder	Estimated size (Hectares)
29-03-17	RIVERLAND	WK91	400
24-12-16	FLINDERS	HK02	1600
23-09-14	MURRAYLANDS	MTB81	100
29-11-11	MID NORTH	G05	900
07-02-09	MID NORTH	GA22	100
13-01-09	LOWER EYRE PENINSULA	PL04	230

Table 3 Major fires due to fire starts in bushfire risk areas

Based on our modelling and a suppression model developed by CSIRO, we estimate that 98% of the fires we start will be suppressed before becoming a major fire. However, the CSIRO suppression model indicates that the probability of a fire start being suppressed falls significantly as the fire danger rating increases. The effect of this is that on days of the highest fire danger ratings, we have a higher likelihood of starting a major bushfire.

Figure 4 below shows the daily major fire start rate for each bushfire danger rating category, indicating an increasing likelihood of our network starting a major fire as the fire danger rating worsens. This figure shows that the likelihood of a major fire starting from our network on a day with a catastrophic fire danger rating is much higher than on other days, which tends to support the use of our authority to switch off on these days[17]. Nonetheless, this figure also shows that the likelihood we will start a major bushfire in the severe and extreme bushfire ratings is also significant, and much higher than the other three fire danger ratings.

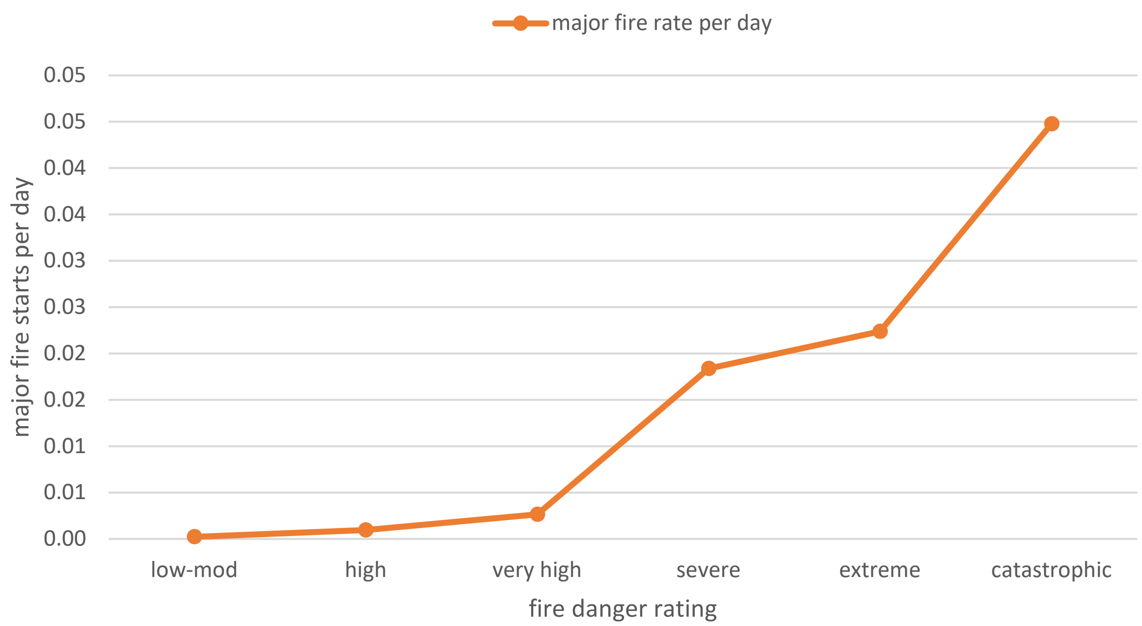

Figure 4 Probability of starting a major bushfire on days of a given fire danger rating

It should be noted that parts of the HBFRA are in the Severe and Extreme rating for a longer period over the bushfire season than they are in the Catastrophic rating. Specifically, we estimate that these areas are in Extreme rated conditions for approximately 6 times longer than the Catastrophic rating, and in Severe rated conditions for approximately 29 times longer than Catastrophic. This means that if we used our authority to switch off to mitigate bushfire risk, we would need to switch off supplies much more often ie multiple times per season rather than the once-every-few-years that we presently do.

[17] Note, the true major fire start rate in the catastrophic fire danger rating could be higher, as this data does not allow for fires we could have started had we not used our authority to switch off historically.

We discuss how the bushfire risk is distributed in these bushfire danger ratings further in the following section. A more complete discussion of our fire start rates and the CSIRO suppression model is provided in our Bushfire Mitigation Program Forecasting methodology paper.

5. Overview of our bushfire risk

In this section we present some of the key results from our new approach to quantifying network bushfire risk. These risks represent our *current* risk position entering fire danger season 2018/19 for the areas and feeders covered by our analysis ie the presented risk allow for the recent improvements in our fire start rates and the current application of our authority to switch off.

Aggregate bushfire risk

Our analysis indicates that the expected bushfire risk due to fire starts from our network in the HBFRA is **$18.6 million** per annum (ie the long-term average bushfire risk per annum).

Our analysis indicates that, on average, in the HBFRA, we will start approximately 16 fires each year during the bushfire season[18]. However, over 98% of these fires will be suppressed and consequently there are only 0.284 major bushfires on average per bushfire season. We have assumed that the suppressed fires have a negligible economic cost.

Figure 5 presents a view of this bushfire risk, indicating how the average time between major bushfire events increases as the economic cost of the fire increases. For example, this figure indicates that at current fire start rates:

- we'll start a major bushfire with an economic cost of $50 million or greater every 10 years on average
- we'll start a catastrophic bushfire with an economic cost of $250 million or greater (ie an Ash Wednesday scale fire) every 70 years on average.

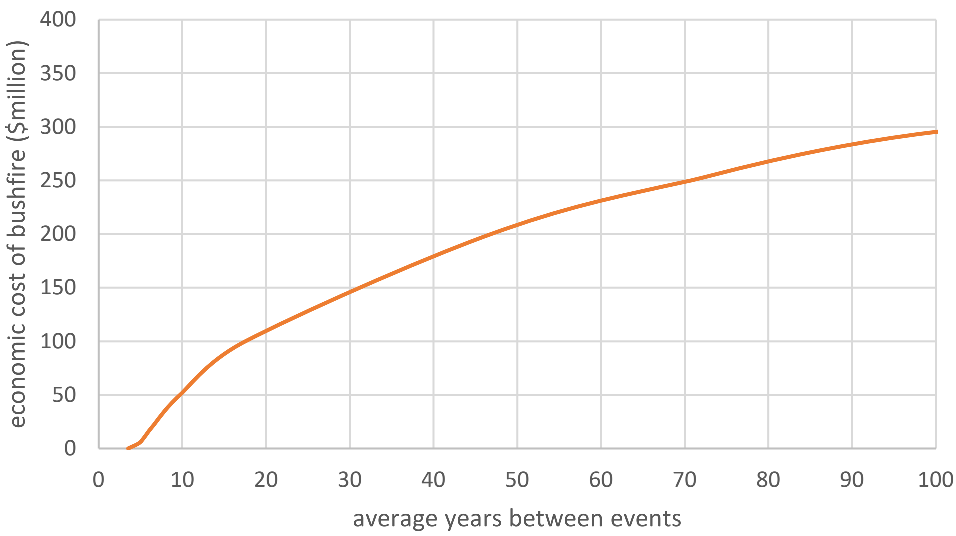

Figure 5 Current bushfire risk profile

Our analysis indicates that the long-term average unsuppressed fire size is 5,730 hectares at an average cost of $65 million per unsuppressed fire.

It is worth noting that the low frequency but high value fires are a big contributor to the bushfire risk of $18.6 million. We estimate that approximately 90% of the risk is due to events that have a longer than 1 in 10-year frequency. The important point here is that care is needed in gauging the scale of our bushfire risk

[18] Note, this current expected number of 16 fire starts per season is lower than the historical average of 19 discussed in Section 4 because we have allowed for the improving trend in fire start performance of our network in calculating the current risk results presented in this section.

or average fire sizes in terms of short- to medium-term recent outcomes. That is, averaging over recent outcomes over the last 10 years is likely to be a poor estimator of the bushfire risk. Given we have not started anything approaching a catastrophic fire over this period, it is likely these outcomes will understate the bushfire risk.

Bushfire risk and the fire danger ratings

The proportion of the bushfire risk due to fires starting in the six fire danger rating zones is shown in Figure 6. The make-up of the bushfire risk is shown further in Table 4.

This figure indicates that most of the bushfire risk (80%) is due to fires we start in Severe and Extreme fire danger ratings. This result is due to a combination of the higher fire start rates in these rating bands and the period of time that the HBFRA is in these rating bands. Although, as we noted previously, if a day is rated as a catastrophic fire danger then we are much more likely to start a major fire (because any fire starts on these days are least likely to be suppressed), only approximately 10% of our bushfire risk is associated with this fire danger rating because of the much shorter period of time we are in that rating band, on average over the bushfire season. For example, as also shown in this figure, the HBFRA is on average in the Severe rating band for 132.5 hours per bushfire season and 27.3 hours in the Extreme rating, compared to only 4.5 hours in the Catastrophic rating band.

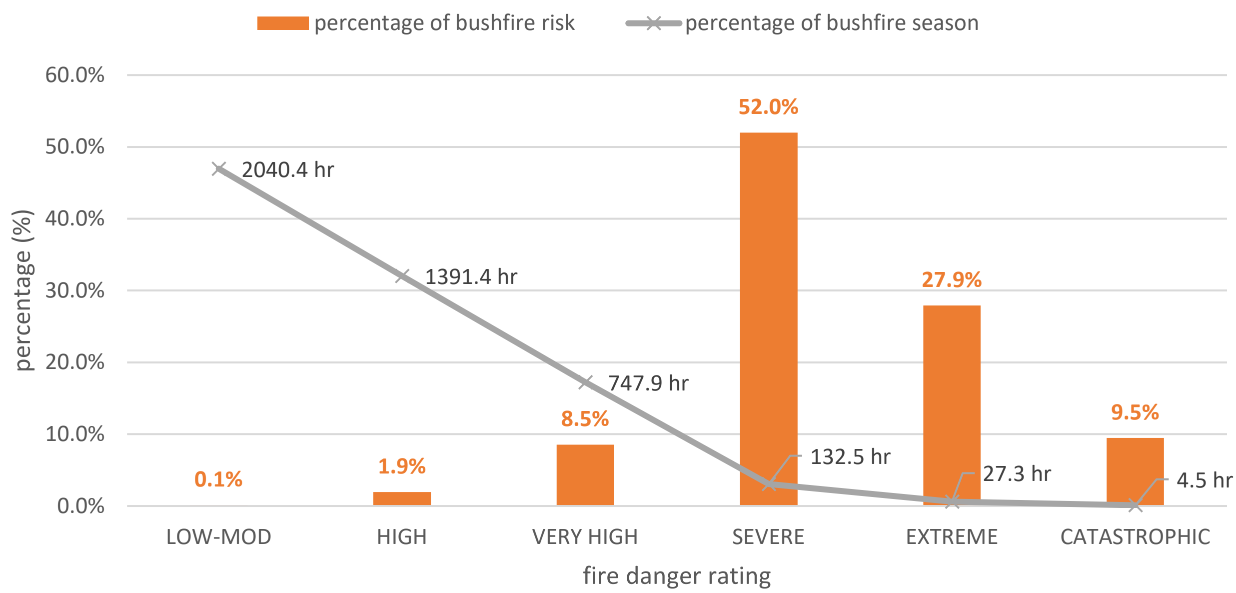

Figure 6 percentage of bushfire risk by fire danger rating

	LOW-MOD	HIGH	VERY HIGH	SEVERE	EXTREME	CATASTROPHIC	Total
fire starts	4.883	3.543	3.833	3.007	0.660	0.048	**16.0**
unsuppressed fires	0.022	0.034	0.051	0.122	0.040	0.015	**0.284**
average unsuppressed fire size (ha)	106	992	2840	7085	10358	11138	**5730**
average fire size (ha)	0.5	9.5	37.7	286.6	621.9	3603.7	**101.7**
unsuppressed total area (ha)	2.3	33.6	144.4	861.9	410.4	172.1	**1624.8**
suppression rate	99.5%	99.0%	98.7%	96.0%	94.0%	67.6%	**98.2%**
unsuppression rate	0.5%	1.0%	1.3%	4.0%	6.0%	32.4%	**1.8%**
risk ($ millions)	$0.0	$0.4	$1.6	$9.7	$5.2	$1.8	**$18.6**

Table 4 Overview of bushfire risk by fire danger rating

Although the HBFRA is in three lowest rating bands for the longest period (4,179.7hrs compared with 164.3hrs) during a bushfire season, there is very little risk (approximately 10%) associated with these rating bands. This is because although approximately 77% of the fire starts are in these rating bands, a far greater proportion of these will be suppressed (over 99%), and the few that do become major bushfires will be on average smaller than the fires in the higher rating bands.

This breakdown of bushfire risk by fire danger rating is most relevant to gauging how effective our authority to switch off supply can be in mitigating bushfire risk. These results already allow for how we currently use this authority, which is typically under catastrophic bushfire conditions. However, the majority of risk occurs on days with a fire danger rating of Severe or lower. Our network is in these rating bands for much longer periods of the bushfire season (nearly 7 days on average). Therefore, using this authority to suppress fire start risk on these days as well, would require us to switch off supply over much longer periods, most likely multiple times each year.

Regional variations in bushfire risk

Table 5 shows a regional breakdown of the bushfire risk and its various components, including fire start events, unsuppressed fires, and average fire sizes.

	MOUNT LOFTY RANGES	ADELAIDE METROPOLITAN	FLINDERS	KANGAROO ISLAND	LOWER EYRE PENINSULA	MID NORTH	MURRAYLANDS	UPPER SOUTH EAST	LOWER SOUTH EAST
fire starts	9.28	0.05	0.28	0.25	1.11	1.79	0.50	0.29	2.43
unsuppressed fires	0.177	0.001	0.009	0.004	0.017	0.031	0.010	0.004	0.030
risk cost ($ million)	$12.4	$0.1	$0.5	$0.1	$0.8	$2.7	$0.6	$0.1	$1.5
risk area (ha)	880.6	0.5	56.0	3.1	47.9	297.8	99.8	43.6	195.4
average unsuppressed fire cost ($ million)	$69.8	$80.7	$54.1	$14.0	$48.2	$85.0	$56.5	$21.3	$49.1
average fire cost ($ million)	$1.3	$1.9	$1.8	$0.2	$0.7	$1.5	$1.1	$0.3	$0.6
average unsuppressed fire size (ha)	4,966	464	5,956	794	2,903	9,549	9,894	10,685	6,545
average fire size (ha)	95	11	198	13	43	167	200	153	80
suppression rate	98.1%	97.7%	96.7%	98.4%	98.5%	98.3%	98.0%	98.6%	98.8%
unsuppression rate	1.9%	2.3%	3.3%	1.6%	1.5%	1.7%	2.0%	1.4%	1.2%

Table 5 Regional bushfire risk

This table indicated the following:

- The majority of the bushfire risk (67%) is associated with feeders in the Mount Lofty Ranges Fire Ban District. This high proportion is partly due to this region having the highest portion (40%) of feeder length in the model), but also because our analysis shows that the network in this region has a higher fire start rate per length of feeder than other regions. We believe that this is partly due to the higher density of flora and fauna in this region, which makes feeders more prone to network faults

- The Lower South East region also has a large portion of the feeder length in the model (40%). However, this region has a much lower proportion of bushfire risk (only 8%). The much lower proportion of risk compared to the Mount Lofty Ranges is partly because the fire start rates are much lower in this region, and also because the cost per unsuppressed fire is lower (even though the average fire size is higher)[19].

- The highest costs per unsuppressed fires are associated with feeders supplying the Mid North region, at an average $85 million per unsuppressed major fire. These fires are also some of the largest, on average.

- The feeders supplying some of the rural boundaries of the Adelaide Metropolitan area are the second highest cost fires, at an average $80 million per unsuppressed major fire. Although these fires are the smallest, they have by far the highest cost per hectare burned (approximately $175,000). This is because these feeders supply the most heavily populated areas, and so the property damage and public safety costs are the highest.

- Kangaroo Island has the lowest average cost per unsuppressed fire, at $14 million. This region also has much smaller fires compared to the other rural regions, with an average size of 794 hectares. We understand that this is because our network is situated where most fires will be limited in size by the boundaries of the island.

- The Upper South East region also has a low average cost per unsuppressed fire, at $21 million. However, it has on average the largest fires, at an average size of 10,685 hectares. This low fire cost is because this region has the lowest cost per hectare by a significant amount ($2,000 per hectare compared to $14,000 for the Mount Lofty Ranges). We understand that this lower cost per hectare is due to the much lower population density in this area, and so much lower property damage and public safety costs.

Bushfire risk by feeder

In addition to the aggregate and regional views of bushfire risk discussed above, our model also estimates the bushfire risk at the feeder level and 500m segments along each feeder. It is this more detailed picture of the bushfire risk that allows us to perform feeder-level and segment-level cost-benefit analysis of our mitigation programs, which we will discuss further in the next section.

Figure 7 shows the risk distribution of feeders, indicating the number of feeders in different risk ranges. Similarly, Figure 8 shows the risk distribution by length (km) of feeder.

These figures show that approximately 44% of the feeder that we have modelled (185 feeders) impose a relatively low bushfire risk, at less than $10,000 per annum per feeder. However, 42% of the modelled feeders (177 feeders) have a bushfire risk greater than $20,000 per annum. 103 of these feeders impose a bushfire risk greater than $50,000 per annum, and 55 impose a bushfire risk of greater than $100,000 per annum, with 5 of these imposing a bushfire risk greater than $350,000 per annum.

As would be expected, the feeders with a low risk tend to be the shorter feeders in these regions (ie the number of fires a feeder can start rises with its length as there is more overhead line that can be faulted).

[19] Note, we have not examined this in detail, but we would expect that the lower average fire cost but higher average fire size in the Lower South East compared to the Mount Lofty ranges is because there is a lower property and population density in the Lower South East, and therefore, less property damage and lower public safety impacts associated with major fires.

This can be seen in Figure 8, where only 17% of the length being studied (2,319 km of the 13,900 km) is in the two lowest risk bands (segment risk lower than $10). Approximately 56% of the feeders, by length (7,845 km) are in the higher risk bands, with a segment risk above $100, and 22% of the feeder length (3,039 km) has a segment risk greater than $1000 per annum.

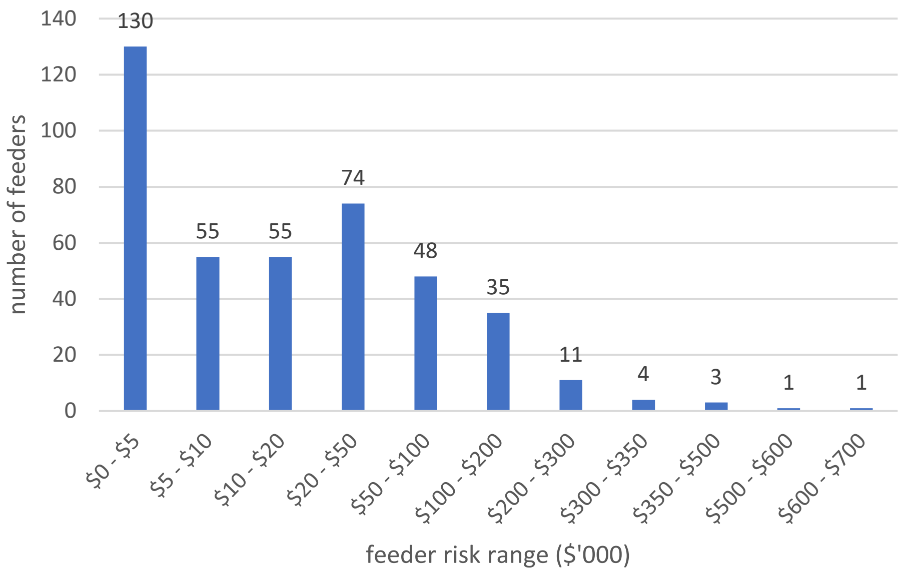

Figure 7 The distribution of bushfire risk by feeder

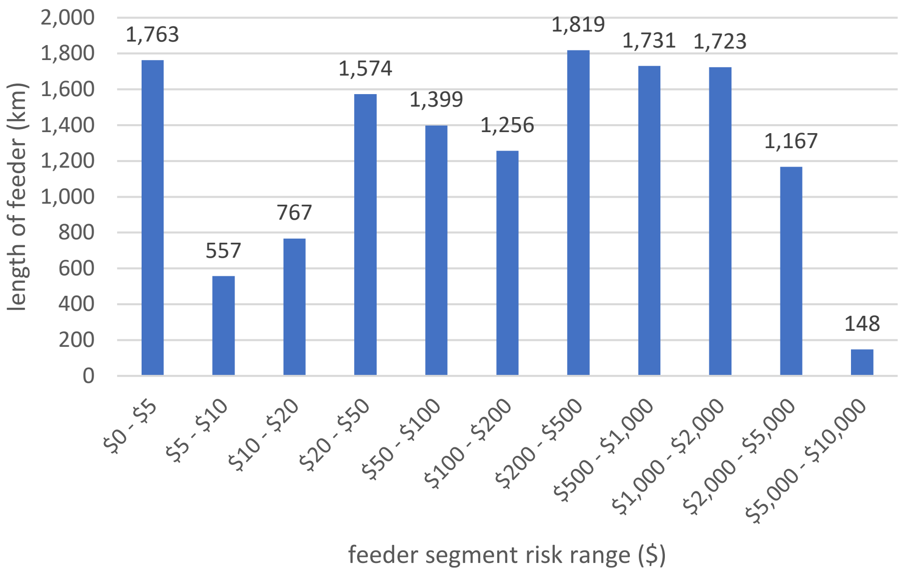

Figure 8 The distribution of bushfire risk by feeder segment

This relationship to feeder length can also be seen in Table 6, which lists the “top 10” feeders in terms of bushfire risk. These 10 feeders account for 22% of the bushfire risk. This table indicates that the worst feeders, in terms of bushfire risk, are typically our longer 11kV feeders, with only one 33kV line and no SWER line making this top 10. Five of these feeders are in the Mount Lofty Ranges, two are in the Mid North, and one each in the Murraylands, Flinders and Lower Eyre Peninsula.

GA53 (a feeder in the Mount Lofty Ranges) is not only our highest risk feeder, but it also has a significant number of the highest risk segments, with 17 of the “top 30” bushfire risk feeder segments on that feeder. Similarly, GA02 (a feeder in the Mid North) has 9 segments in the “top-30” segments. Typically, high risk segments occur where the feeder segment is in close proximity to more densely populated areas, and so, unsuppressed fires due to that segment are more likely to have higher property damage and public safety costs associated with them.

Rank	Feeders	risk ($'000)	region	length (km)	voltage (kV)
1	GA53	641.3	MOUNT LOFTY RANGES	57	11
2	ST41	561.8	MURRAYLANDS	101	11
3	R21	478.5	MID NORTH	67	11
4	MTB13	412.3	MOUNT LOFTY RANGES	86	11
5	GA02	377.7	MID NORTH	33	11
6	PP08	345.5	FLINDERS	84	11
7	GU31	340.5	MOUNT LOFTY RANGES	96	11
8	EL11	332.4	MOUNT LOFTY RANGES	61	11
9	PL33	305.3	LOWER EYRE PENINSULA	102	33
10	NU13	294.5	MOUNT LOFTY RANGES	48	11

Table 6 Top 10 feeders by bushfire risk

More comprehensive risk results for all feeders and feeder segments is provided in our bushfire CBA model. This model provides detailed information on the make-up of the risk by fire danger rating, including fire start numbers, unsuppressed fire numbers, and consequential major fire costs.

In addition, geographical representations of feeder and feeder segment risks can be viewed in a GIS environment, which we have developed to provide a spatial indication of the bushfire risk associated with all the feeders that we have studied.

6. Our bushfire mitigation program

We have used our new bushfire cost-benefit analysis model to develop our bushfire mitigation program. This section discusses the results of this analysis and other considerations associated with developing our bushfire mitigation program.

Mitigation options we have evaluated

We have considered the following four options through our cost-benefit model:

- replacing the fire prone arrestor technology;
- replacing overhead bare wire conductors with overhead covered conductors;
- replacing bare wire overhead conductor with underground cable; and
- upgrading feeders to enable the new ultra-fast clearance protection strategy.

All options have been evaluated using our bushfire CBA model, but the methodology has differed slightly due to the specifics of the options and how they reduce the bushfire risk.

For the first three options, we have analysed each feeder segment in the model to determine whether the risk reduction achieved by replacements of that segment (ie the benefit of the replacements) would outweigh the cost of those replacements. That is, these options are optimised at the feeder segment level (ie 500m increments) to determine the scope of the option for that segment, which will produce a positive net benefit.

The ultra-fast clearance strategy will be implemented on individual feeders, and therefore, the risk reduction (ie benefit) should occur across all segments associated with that feeder. Consequently, we have evaluated this option at the feeder level. Furthermore, as discussed in Section 3, implementing the ultra-fast clearance strategy on a specific feeder can require a range of activities, depending on the capabilities of the existing protection devices on that feeder. At this stage of its development, the bushfire CBA cannot be used to optimize the individual protection works necessary for each feeder. Therefore, we have developed and evaluated the feeder-level scope using the following three-stage process.

First, we used the model to calculate the upper limit on the upgrade cost which would achieve a positive net benefit, given the change in the probability of starting a fire that has been calculated by the protection group (see the discussion of this in Section 3). This analysis produces two cost limits, based on two fire start probability reductions prepared by our protection group:

- the reduction if we only implement the works necessary to enable the ultra-fast strategy for the existing devices; and
- the additional reduction if we also upgrade existing slow devices with modern fast-acting devices, and/or install new mid-line devices.

Second, we undertook a detailed investigation of the existing capabilities of each feeder identified by the model as having a positive cost-benefit outcome, to develop a scope of work for that feeder that is within the cost limit.

Thirdly, we input to the model the feeder-level costs associated with the developed scope, together with the associated fire start reduction probability, to determine the resulting benefits and net benefits for that scope.

Note: the "do-nothing" option
It is important to note that our method inherently allows for the consideration of the "do nothing" option. When the feeder mitigation costs exceed the benefits then we reject those elements of the option – and effectively choose the do-nothing option.

For all cost-benefit analysis we use formal discounted cash flow techniques. That is, we compare the present value of benefits with the present value of the costs, to confirm that the benefit will exceed the costs[20]. The key cost, life and fire start reduction assumptions we have used are summarised in the table below.

	Capital cost ($)	Life (years)	Fire start reduction
Replacing arrestors	$3,532	40	95% (of arrestor fire starts)
Covered conductors	$195,000 per km	50	90% (of line fire starts)
Undergrounding	$227,500 per km	60	99% (of line fire starts)
Ultra-fast clearance strategy			
Existing feeder source device protection setting implementation	$15,000 per device	15	The probability of reduction has been provided for each feeder, based on the analysis of the capability of the devices on that feeder, as calculated by our protection group (see the discussion Section 3)
Existing midline recloser protection setting implementation	$15,000 per device	15	
Existing midline recloser upgrade / replacement	$75,000 per device	25	
New midline recloser	$75,000 per device	25	

Table 7 Summary of bushfire mitigation program option assumptions

In addition, we have assumed that operating expenditure associated with the capital investment will be 2% of the capital investment (which is assumed to be an additional cost for our cost-benefit analysis). Discounting uses our proposed pre-tax real weighted average cost of capital, which we have calculated to be 2.89%.

Options considered but rejected as feasible mitigation options

We considered other options for bushfire risk mitigation, but these were rejected as discussed below.

- **Installation of Rapid Earth Fault Current Limiters (REFCL)**

  We have not evaluated REFCL through our cost-benefit model. We acknowledge that REFCL is being applied as a method to reduce bushfire risk in Victoria. However, a number of characteristics of our network are, significantly different to Victorian arrangements (eg our predominant use of steel cross arms and our earthing arrangements), and hence significant time and effort would be required to design and develop a REFCL system that would work on our network, without any guarantee that this can be achieved. At this stage, we consider that if we allowed for the uncertainty in the cost and benefits of this for our specific purposes then this would not be shown to be a preferred option, particularly against our new protection strategy, which is a low-cost option that should provide a significant reduction in bushfire risk when it is in operation.

[20] For this assessment within the model, we use the Equivalent Annual Cost of the mitigation option, using an assumed life for the option, to compare the annual benefit (in terms of bushfire risk reduction) against the capital cost.

That said, our intention is to continue to monitor the development and application of REFCL in Victoria with a view to consider it in the future if are satisfied that proven positive results in Victoria could be replicated in South Australia.

- **Increased use of our authority to switch off supply**

  As detailed in the sections on our fire start performance and the make-up of our bushfire risk, it is unlikely that we can achieve significant reductions in bushfire risk by increasing the use of our authority to switch off supply, without very significantly increasing the period we would need to use this authority. This is likely to require use of this authority many more times each year, which would introduce additional costs which we consider would outweigh the benefits of the avoided bushfire risk. Most notably these costs would include:

  - the economic costs associated with significantly increased supply interruptions; and
  - the additional public safety costs associated with communities in bushfire risk areas not having electricity supply at times of extreme heat.

  For these reasons, we have not considered significantly increasing use of our authority to switch off the network as a bushfire mitigation option, in the context of the mitigation strategy discussed here. Nonetheless, we will continue to evaluate our implementation of this authority to see whether we can further improve and optimise its use. This however is more likely to optimise it in terms of the extent of customers interrupted.

The key findings from our evaluation of options

The key findings from our evaluation of the four options discussed above are as follows.

- **Replacing existing overhead bare wire with covered conductor and undergrounding the segment**

  We found a very small number of feeder segments where the value of the avoided bushfire risk outweighed the cost of using covered conductor or undergrounding the segment[21]. This result is broadly in line with the AER's assessment of our lower bushfire risk compared to other DNSPs.

  We are not proposing to include any programs to underground line segments or use covered conductor in our bushfire mitigation strategy at this time. However, we will continue to consider and evaluate these options in the future, as other benefits may accrue by their use, which are not allowed for in our analysis here.

- **Replacing fire-prone arrestor technologies**

  We have found **3,408 feeder segments** on **158 feeders** where the benefits of avoided bushfire risk outweigh the cost of replacing a fire-prone arrestor. We have estimated that we will have approximately **1,447 arrestors** installed on this length of feeder[22].

[21] Note, currently the model has found a very small number of segments where the benefits of installing covered conductor or undergrounding appeared to exceed the cost. But on more detailed investigation of these specific results, we found that these were more likely to be anomalous results, and therefore, we have not included these in our program.

[22] Note, we do not have detailed records of the location of every arrestor. Therefore, we have estimated this volume of arrestors, based on our overall knowledge of arrestor volumes per length of feeder.

- **Upgrading feeders to enable new ultra-fast clearance protection strategy**

  We have found **177 feeders** where the benefits of avoided bushfire risk outweigh the costs of the works necessary to achieve the ultra-fast protection strategy.

Our preferred bushfire mitigation program

Based on the findings of our evaluation of options, summarised above, we have limited our bushfire mitigation program to only include those elements where our bushfire CBA model has found the benefits (in terms of avoided bushfire risk) outweighs the costs, namely:

- to include the replacement of 1,447 fire-prone arrestors on the feeder segments identified by our model, improving the risks associated with 158 feeders in HBFRAs; and
- to allow for the implementation of our ultra-fast clearance protection strategy on 177 feeders in HBFRAs, as identified by our model.

This program will be implemented over the next seven years, covering:

- the remaining two years of this regulatory period (2018/19 to 2019/20); and
- the five years covering the next regulatory period (2020/21 to 2024/25).

We have profiled the program over this seven-year period to reflect what we consider we can feasibly and efficiently perform over this period – in the context of other plans. We have also scoped and prioritized the specific works based upon the feeder-level risk (ie undertaking works on the highest risk feeder first).

The breakdown of the scope of the program and its capital costs in the current and next regulatory period is shown in Table 8.

Program scope	Remaining current period (2 years 2018/19-2019/20)		Next period (5 years 2020/21-2024/25)	
	units	cost ($ millions)	units	cost ($ millions)
Replacing arrestors	**417**	**$1.47**	**1,031**	**$3.64**
Ultra-fast clearance strategy	**71**	**$4.01**	**239**	**$9.41**
Existing feeder source device protection setting implementation	16	$0.24	119	$1.79
Existing midline recloser protection setting implementation	6	$0.09	23	$0.35
Existing midline recloser upgrade / replacement	34	$2.55	33	$2.48
New midline recloser	15	$1.13	64	$4.80
Total bushfire mitigation program		**$5.48**		**$13.04**

Table 8 Bushfire mitigation program summary

The benefits of our preferred bushfire mitigation program

The overall benefits of our program

Based on the analysis using our bushfire CBA model, our bushfire mitigation program should have significant net benefits in avoided bushfire risk.

We estimate that our bushfire mitigation program will reduce the expected annual bushfire risk by 26%, or $4.8 million, reducing the bushfire risk from its current level of $18.6 million per annum to $13.8 million per annum. A reduction in bushfire risk of $2.1 million per annum will be achieved by the program planned for the remaining two years of the current period, and a further $2.7 million per annum reduction in risk will be achieved in the next period.

The significance of this improvement in bushfire risk is shown further in Figure 9, which indicates the change in the average event period between major bushfire events as the fire size increases. For example, this figure indicates that by the end of the next period, following the implementation of this bushfire mitigation program:

- we should have achieved a modest reduction in the frequency of our network starting a major bushfire (i.e. $50 million or greater fire), changing this from a 1 in 10-year event to a 1 in 13-year event – on average; and

- we should have achieved a greater reduction in the frequency of our network starting a catastrophic bushfire (i.e. $250 million fire or greater), changing this from a 1 in 70-year event to be a 1 in 115-year event – on average.

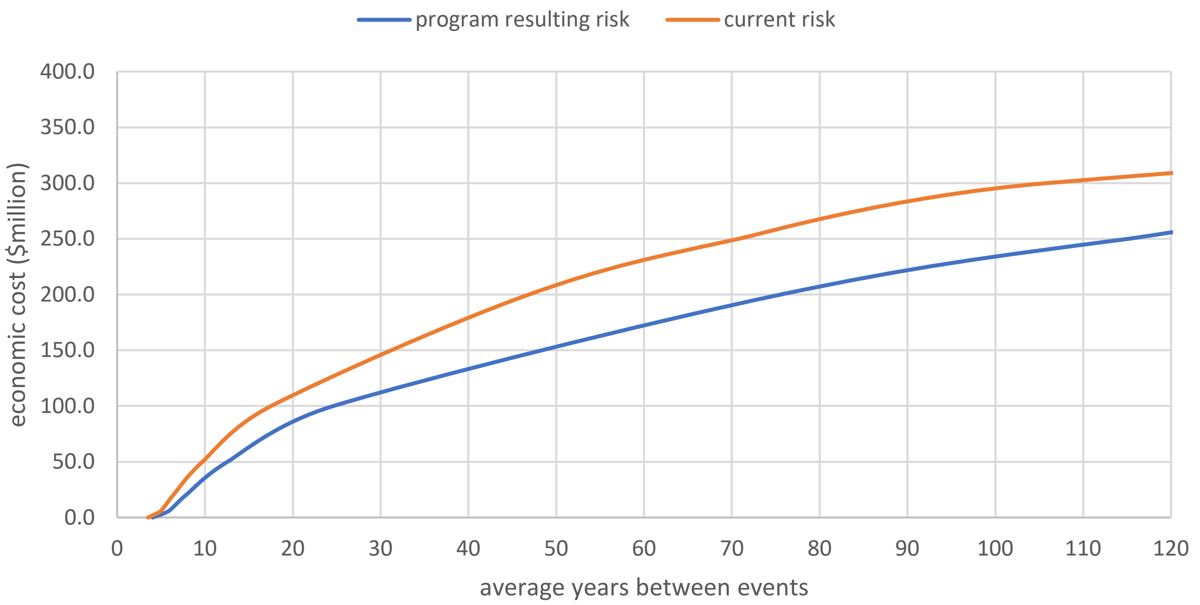

Figure 9 Improvement in bushfire risk achieved by the bushfire mitigation program

Importantly, we estimate that the total net benefit (ie benefit minus cost in present value terms) due to the implementation of our program will be $3.4 million per annum. This net benefit is equivalent to approximately $66 million over the average 25-year life of the assets[23]. Approximately half of this life-time net benefit will be achieved by the program elements planned for the remaining two years of the current period, and the other half of these net benefits will be achieved through the program elements planned for the next regulatory period[24].

[23] We have used a lower life here than we may achieve from the assets to ensure we are not overstating the likely net benefit.

[24] The higher proportion of net benefits in the current period is due to the prioritization of the program using bushfire risk, which causes the higher net benefit works to be planned to be implemented earlier in the program.

The distribution of the benefits achieved by our program

Figure 10 below shows the percentage of the $4.8 million economic benefit in each of the six fire danger rating zones. For context, this figure also shows the percentage breakdown of the current bushfire risk.

This figure shows that the majority of the benefit (93%) is occurring through risk reductions associated with the two highest fire danger ratings, Extreme and Catastrophic, with most of the reduction occurring in the Extreme rating zone. Only a small proportion of the benefit is occurring through a risk reduction in the four lowest rating zones, with most of this being achieved in the Severe fire danger rating.

This profile of the benefits is different to the profile of the current risk, which has more risk associated with the Severe fire danger rating. However, this profile of the benefits is as expected given how we intend to implement our new ultra-fast clearance protection strategy, which we intent to only apply in the two highest ratings (see the discussion in Section 3). This intended approach is allowed for in our cost-benefit analysis, hence this profile.

The lower level of risk reduction in the other rating zones is being achieved through the arrestor replacement program, which should achieve benefits in all rating zones as this program should reduce the fire starts irrespective of fire danger rating.

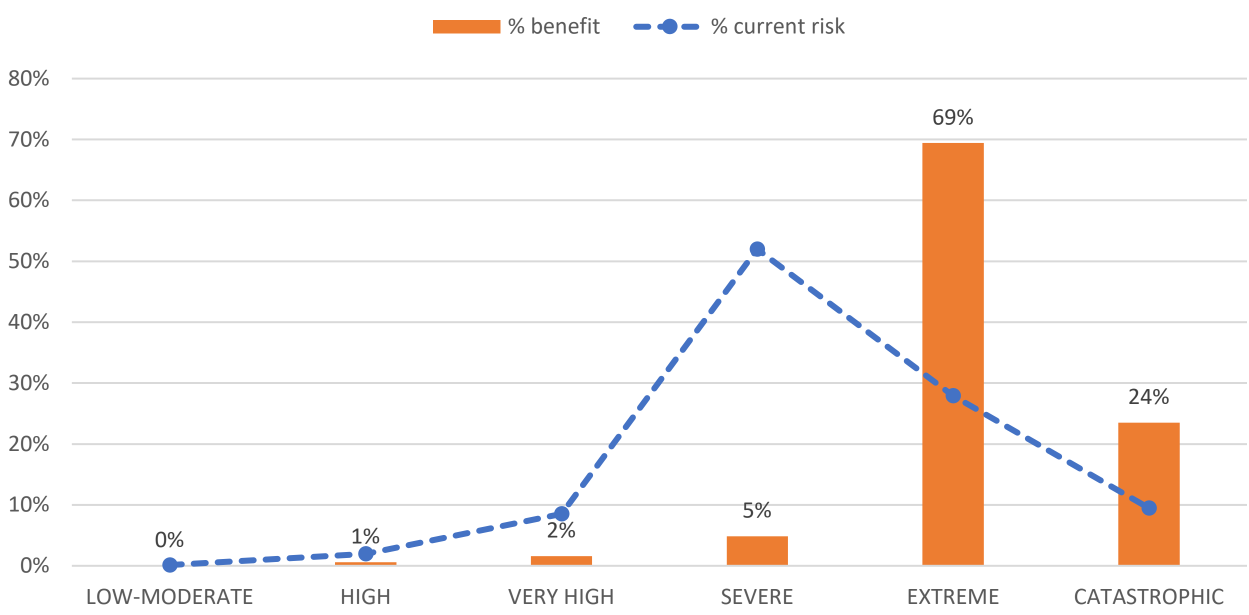

Figure 10 Distribution of the program bushfire risk benefits by Fire Danger Rating

Figure 11 shows the distribution of the benefit, net benefit and program capex in the various bushfire regions covered by our analysis, provided as percentage of the total of each of these measures. The total line length we have analysed in each region is also shown as a similar percentage to provide context of the scale of each region.

This figure shows that the majority of benefit, net benefit and program capex is associated with improving lines in the Mount Lofty Ranges. This high percentage of these measures is partly due to this region having the largest proportion of the lines covered by our analysis. But the proportion of these measures in this region is appreciably higher than the percentage of line associated with this region, indicating that our cost-benefit analysis has found that the Mount Lofty Ranges is a preferred region for bush mitigation (ie it must have greater benefits provided per unit of cost).

Similar higher proportions, relative to line length, are also shown for the Mid North, Flinders, Lower Eyre Peninsula and Murraylands. Although, the proportion of the benefits and program capex in these regions is much lower, as these regions have a much lower proportion of the line length under analysis.

Conversely, the Lower South East has a similar proportion of line being analysed as the Mount Lofty Ranges. But this region only has a small proportion of the program and its benefits. This indicates that this region is not a preferred region for bushfire mitigation (ie it must have low benefits provided per unit of program cost).

It is also worth noting that Kangaroo Island is the only region being analysed where we have found no investments that would provide a net benefit. Although, it is also worth noting that lines in this region are only a small percentage (1%) of the total lines we have analysed.

These results associated with Lower South East and Kangaroo Island (and also the Upper South East) are in line with the discussion on the differences in the regional bushfire risk, provided in Section 5. For example, the Lower South East and Kangaroo Island both have a much lower risk per length of line (on average, $266 and $528 per km of line respectively) compared to the Mount Lofty Ranges (on average, $2,203 per km of line). Hence, there is less scope for risk reductions per unit cost of a mitigation option, and therefore, it is less likely a mitigation option will provide a net benefit.

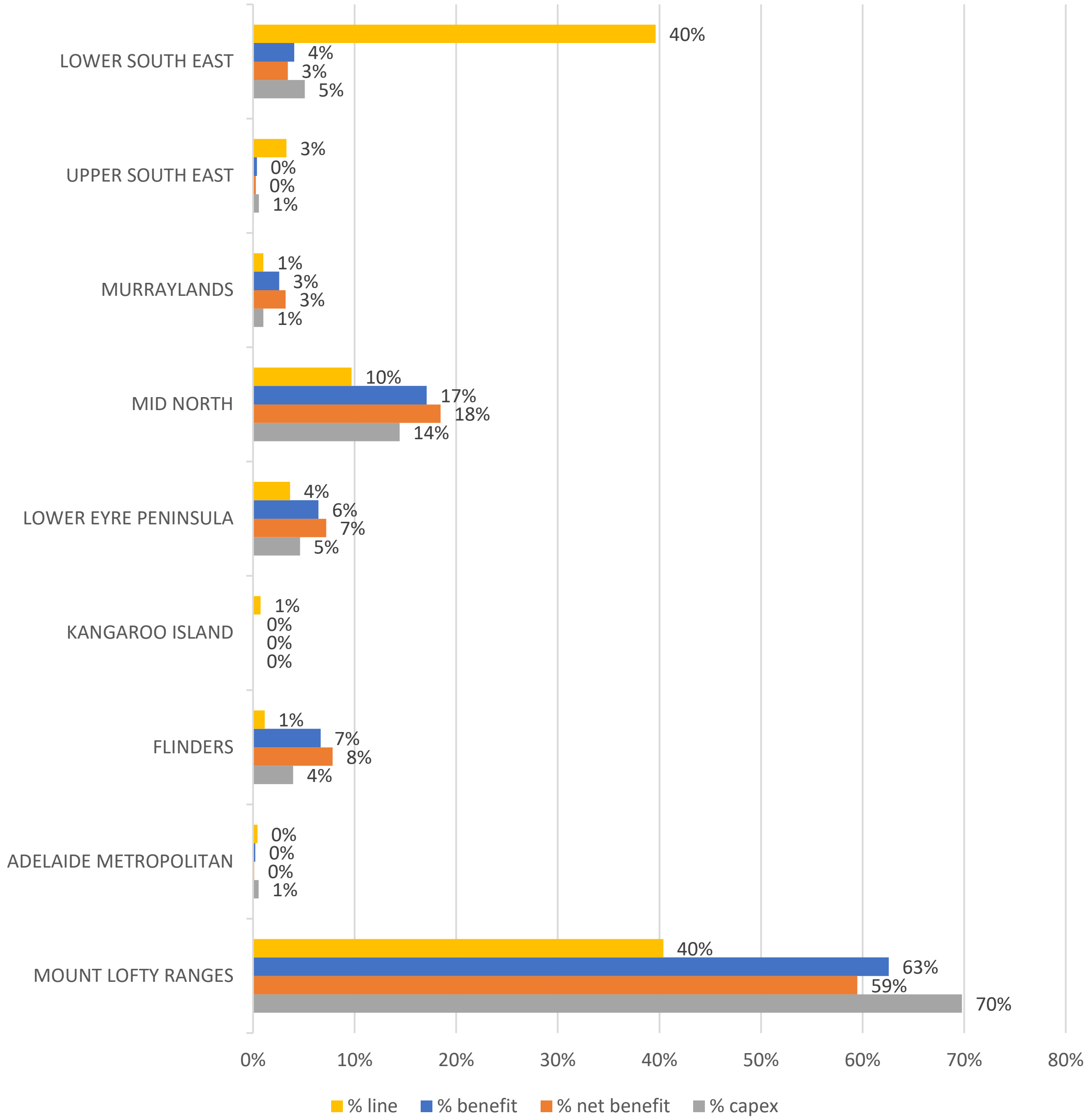

Figure 11 Distribution of benefits by region (provided as percentage of total)

Figure 12 shows the distribution of the benefit achieved by the program, indicating the number of feeders in different benefit ranges. Figure 13 provides a similar distribution of the net benefit achieved by the program.

These figures indicate that 84% of the feeders (186) covered by the program should see a benefit (in terms of bushfire risk reduction associated with fire starts due to that feeder) of greater than $1,000 per annum, with 54% (120) having a benefit greater than $10,000 per annum, and 12% (26) have a benefit greater than $50,000 per annum.

Similarly, the feeder-level net benefit (ie the benefits associated with that feeder minus the program costs associated with that feeder) achieved by the program for 75% of the feeders (167) will be greater than $1,000 per annum (over the life of the investment), with 50% (110) with a net benefit greater than $5,000 per annum, and 23% (50) with a net benefit greater than $20,000 per annum.

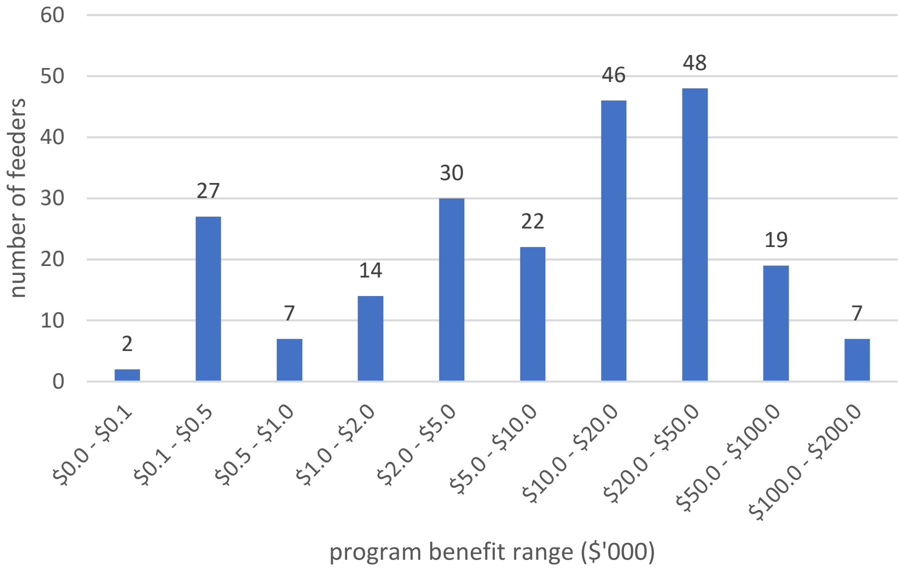

Figure 12 Distribution of benefits by feeders

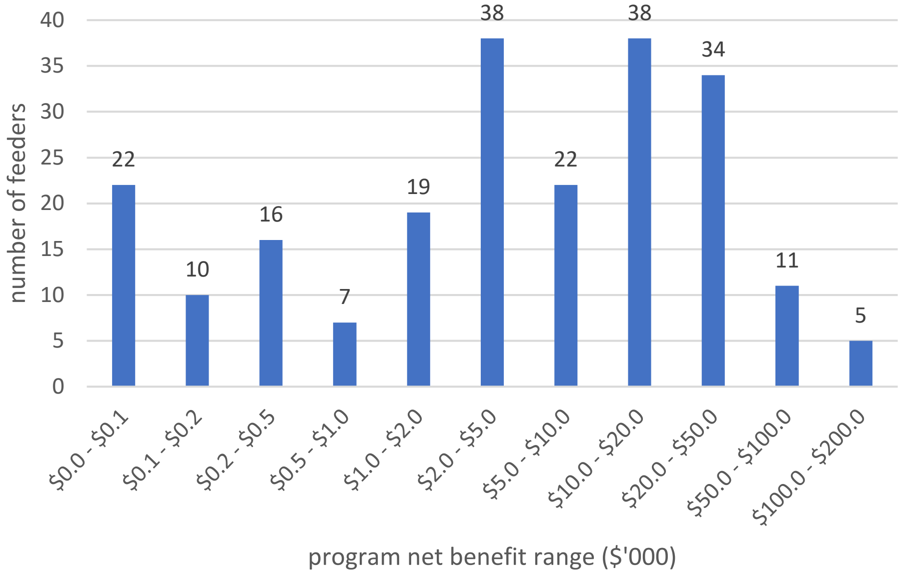

Figure 13 Distribution of net benefits by feeders

The “top-20” feeders (ranked by the benefit) are listed in Table 9. This table shows the feeder, the region of the feeder, the benefit provided by the program works for that feeder, and the capital cost associated with the program works for that feeder. The table also provides the equivalent annualised cost associated with that capital to show how the life time program costs for these feeders are significantly lower than the benefits, hence these feeders will all have high net benefits.

This table indicates that the top-6 benefit feeders are located in different regions, covering Flinders, Mid North, Lower Eyre Peninsula, Mount Lofty Ranges, and Murraylands. However, the majority of feeders in the top-20 are located in the Mount Lofty Ranges. These results are broadly in line with results discussed previously, associated with the distribution of analysis feeder number, risks and benefits across regions.

Benefit rank	Feeder	Region	Benefit ($'000)	Program capital ($'000)	Program capital EAC ($'000)
1	PP08	FLINDERS	198.8	300.9	15.1
2	R21	MID NORTH	178.2	206.0	9.4
3	PL33	LOWER EYRE PENINSULA	132.6	151.4	8.6
4	GA53	MOUNT LOFTY RANGES	130.2	311.7	15.4
5	ST41	MURRAYLANDS	122.3	173.4	10.1
6	CL04	MID NORTH	115.4	392.5	19.4
7	GU31	MOUNT LOFTY RANGES	109.0	301.2	15.5
8	MTB13	MOUNT LOFTY RANGES	94.4	357.4	18.4
9	G04	FLINDERS	94.4	266.8	14.1
10	GU41	MOUNT LOFTY RANGES	91.2	345.3	18.5
11	GA02	MID NORTH	90.7	180.2	9.3
12	GA745B	MID NORTH	74.0	226.3	11.8
13	MTB81	MOUNT LOFTY RANGES	72.8	239.6	12.9
14	VH17	MOUNT LOFTY RANGES	72.3	233.6	12.1
15	ST11	MOUNT LOFTY RANGES	69.8	269.6	14.2
16	SD38100	MOUNT LOFTY RANGES	69.5	301.9	15.0
17	NU13	MOUNT LOFTY RANGES	68.4	273.1	14.3
18	VH44	MOUNT LOFTY RANGES	64.8	169.3	9.9
19	ST36	MOUNT LOFTY RANGES	64.7	212.9	11.8
20	ST12	MOUNT LOFTY RANGES	64.4	402.8	22.0

Table 9 "Top 20" feeders in program (ranked by benefit)

More comprehensive results of the cost-benefit analysis for each feeder in the covered regions is provided in the bushfire CBA model.

7. Regulatory treatment in our next proposal

We have included $13.04 million in the capital expenditure forecast in our regulatory proposal to the AER to allow for the elements of our bushfire mitigation program that we have planned for the next regulatory period (2020/21 to 2024/25).

We believe that the AER can have confidence that this forecast is in accordance with the National Electricity Rules (NER), given the methodology we have used to determine this amount. This methodology represents a significant improvement in the approach we applied in our previous proposal.

NER capex objectives

We consider that this program's forecast is in accordance with the NER capex objectives[25] as it is required to continue to comply with regulatory obligations and maintain the safety of our distribution system:

- we have a duty to take "reasonable steps" to ensure that the distribution system is safe and safely operated (Section 60(1) of the Electricity Act) and to maintain and operate the distribution system in accordance with good electricity industry practice (NER Clause 5.2.1(a)). These duties require us to have regard to objectively determined standards of safety;

- given the thorough analysis, including cost-benefit analysis, we have applied to determine appropriate actions to reduce the bushfire risk, we consider that we have demonstrated that the proposed program can be consider to reflect the "reasonable steps" we will need to take to continue to comply with these obligations and maintain the safety of our distribution system into the future; and

- furthermore, we believe that the need for us to continue to look for cost-effective methods to reduce bushfire risk is important given reports released by reputable bodies such as the Bureau of Meteorology, which indicate that extreme bushfire conditions will be more likely in the future.

NER capex objectives

We also consider that the program's forecast is in accordance with the NER capex criteria[26] as it reflects the efficient cost that a prudent operator would require to achieve the NER capex objectives, most notably:

- we have applied a robust approach to develop our bushfire CBA model and its input parameters, including

  - the use of experts, such as the CSIRO, to develop key bushfire risk inputs;
  - the use of our historical fire start data and SA historical bushfire data to calibrate and verify various model inputs;

- we have applied formal cost-benefit analysis to all elements of the program, which demonstrates that it only includes elements that should provide a positive net-benefit (in terms of avoided bushfire risk); and

- we have used recent historical unit costs to develop the program cost estimate, which we consider can be assumed to reflect efficient costs for our circumstances given our good benchmark performance compared to other DNSPs.

[25] NER 6.5.7 (a)
[26] NER 6.5.7 (c)

Our customers support our program

As noted in Section 2, we also consider that we have customer support for this program. We began the mitigation program in the current period and have spoken to our customers through the recent engagement process about continuing the program. Our customers supported the program provided that the benefits to the community exceeded the costs. We consider that we have demonstrated that this is the case.

This program and other elements in our regulatory proposal

We are not including any adjustments to other incentive mechanisms because of our bushfire risk mitigation program. However, we have allowed for this program in our replacement capex forecast. The following are important in understanding this treatment:

Reliability (STPIS) impact

The program elements that allow for our new ultra-fast fault clearance strategy includes some investments in new midline reclosers, which can be used to improve supply reliability[27]. However, on the days when we implement the ultra-fast fault clearance, we expect the reliability to worsen due to less optimal fault clearance and spurious trips resulting from the far more sensitive protection settings required to enable ultra-fast clearance. We have undertaken analysis of these reliability benefits and dis-benefits and have found that the dis-benefits would probably outweigh the benefits.

Our analysis found that, overall, reliability performance is likely to degrade by approximately 0.2 system SAIDI minutes per annum if we implement our ultra-fast fault clearance strategy. We estimate that the additional midline reclosers included in this mitigation program should provide an improvement in reliability of approximately 2.7 minutes, when they are operating under our normal protection arrangements. However, we have also estimated that reliability will worsen by 2.9 minutes during the time that we will operate feeders under our new ultra-fast clearance strategy (ie days when the fire danger rating is extreme or catastrophic). Further details of the methodology we have used to calculate the reliability implications are provided in Appendix A.

Although we estimate a small deterioration in reliability performance due to this program, we are not proposing a negative step change in the STPIS targets to allow for this program. Instead, we consider that further optimisation of the implementation of the new ultra-fast clearance strategy should result in a better balance of these factors, such that affected customers do not see a significant difference in reliability performance over the whole year.

Opex (EBSS) impact

It could be argued that the reduced number of fires and arrestor faults achieved by this program will have some benefits in reduced operating expenditure. However, given the small number of fires we start in any year, we would expect this reduction to be largely immaterial. Furthermore, any actual reduction because of these factors would be offset by increases necessary to maintain the higher number of reclosers and implement the ultra-fast clearance strategy.

Relationship to replacement capex (and other augmentation programs)

The replacement of some reclosers in this program does overlap with a small number of replacements in the replacement program. To ensure we have not double counted replacements in our proposal, we have

[27] Note, the planned changes to protection settings and the planned replacement of slower devices should not improve reliability as these will not change how the normal operation of these devices.

undertaken a reconciliation exercise of the recloser works across all programs. Where there is an overlap with the replacement program, we have removed the replacements from the replacement program.

It is also worth noting that this program is largely focused on different drivers of risk than the replacement program. The risks in this program are largely driven by “assisted” asset failures, due to weather and the associated environmental impacts that are predominantly unrelated to asset age. The risks addressed by the replacement program are largely driven by “unassisted” failures and operational cost increases due to the age and condition of the assets. Therefore, the risk reduction achieved through this program cannot be traded with the replacement program, without increasing age-related risks above current prudent and efficient levels as the asset population continues to age over the next period.

A. Overview of our methodology to calculate reliability implications

In Section 7, we explained that we have estimated that the bushfire mitigation program discussed in this document will result in a deterioration of the reliability of our network by approximately 0.2 minutes of system SAIDI.

The reliability impact can be considered in terms of two competing factors:

- the SAIDI improvement through the installation of additional midline reclosers; and
- the SAIDI deterioration when the ultra-fast clearance strategy is enabled on high bushfire risk days.

The following summarises the methodology and key assumptions we have used to estimate these two factors.

The SAIDI benefit (2.7 system minutes per annum) was calculated as follows:

- We assumed either a 25% or 50% improvement in reliability of the individual feeders where midline reclosers will be added through our program (i.e. 79 additional reclosers on 65 feeders).
- The percentage improvement was selected based on the current feeder arrangements and number of additional midline reclosers installed through this program.
- The percentage improvements have been estimated used based upon the approximate historical improvements we have achieved on other feeders when introducing midline reclosers.
- The feeder reliability is calculated based on actual reliability performance over the previous 5-year period, 2013/14 – 2017/18.

The SAIDI dis-benefit (2.9 system minutes of SAIDI) was calculated as follows:

- We identified the number of customers and feeders associated with each weather station (AWS) that qualified for a FDL 2 or 3 condition between 2013/14 – 2017/18 (i.e. the FDL conditions we expect to enable our new ultra-fast clearance protection strategy).
- We determined the average number of feeders (8) and customers per feeder (1,039) per historical FDL event.
- We assumed 20% of these feeders had an additional trip due to being in the ultra-fast (ie more sensitive) mode i.e. 3 feeders out of every 16 feeders. This assumption seems reasonable given the much greater sensitivity required to achieve reliable ultra-fast clearance of fault currents.
- We assumed a 6-hour restoration time for each additional trip. This assumption seems reasonable, given the extreme weather at the time of the trip, which would require us to wait for FDL conditions to abate, and then require us to carefully patrol the tripped feeder.
- We then multiply the customer minutes due to each additional trip by the number of FDL events per year (4.6).