Bushfire Risk Mitigation Programs Forecasting Approach

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SA Power Networks

Empowering South Australia

1. Introduction

1.1 Program Overview

The bushfire risk mitigation programs are intended to reduce the existing risks associated with bushfires and how SA Power Networks manages its network because of bushfires. They have two components:

1. **Bushfire start reduction** - Reducing the community risk (ie land and property damage and public safety impact) resulting from bushfires started by our electricity distribution network by reducing the likelihood that our network will start a bushfire during the bushfire season.
2. **Customer supply interruption reduction** - Reducing the extent of interruptions to our customers' supply because of bushfires or how we manage the network during bushfire conditions.

Our stakeholder and customer engagement conducted in early 2022 (called "Broad and Diverse Engagement"[1]) sought to explore and seek input from these parties into various Reset themes identified in the earlier stages of engagement. This engagement found some support for programs of this type, with the majority of customers supportive of improving the safety of the network and making it more resilient to major events such as bushfires.

We will continue to engage with our stakeholders and customers on these programs as the programs' expenditure and benefits are more accurately forecast. This engagement will seek to understand our customers' preferred trade-off between the costs and benefits that these programs can achieve.

1.2 Where this program fits into the SA Power Networks proposal

The bushfire risk mitigation programs form part of our network augmentation capital expenditure (augex) forecast, which relates to assets that we use to provide Standard Control Services (see Box 1 for an overview of our augex forecast).

The bushfire risk mitigation programs allow for the need to install additional network assets and/or upgrade the service provided by existing assets to address bushfire risk. These programs may have elements of asset replacement. But this activity is not primarily driven by the condition of the network assets, rather the need for the enhanced service provided by the new asset. The programs also will have elements that affect the reliability of supply to our customers. But the intention of these elements is to enable us to reduce supply interruptions at a particular time when public safety is at its most extreme, not improve reliability more generally. Therefore, we have treated all expenditure for these programs as augex and allocated this to the safety component of our augex forecast.

It is also important to note that both components of the bushfire risk mitigation programs can be considered as part of our broader initiatives to make our network more resilient to major weather events. However, the bushfire risk mitigation programs are being treated separately from the Network Resilience program, which is a separate component of our augex forecast, because of the more unique characteristics and significant safety implications of bushfire risks.

The interactions with other elements of our proposal and how we have accounted for them are covered in more detail in the sections below.

Augex has recently made up approximately 20% of our capital expenditure (capex) providing Standard Control Services, with the capex associated with similar bushfire mitigation programs accounting for under 5% of this augex (approximately 1-2% of overall capex). It is anticipated that the bushfire mitigation programs will form a similar portion of capex in the next regulatory period, dependent on the level of investment that customers support.

[1] A more detailed explanation of the 'Broad and Diverse' engagement phase and its findings are provided at SA Power Networks' consumer engagement website, [www.talkingpower.com.au]

Box 1. Augex description

The SA Power Networks augex forecast comprises the following components:

- Capacity-driven augmentation – works required to meet forecast demand that necessitates the extension or upgrade of the sub-transmission, distribution and LV networks,
- Reliability – installation of assets required to maintain the reliability of supply services, ensure compliance with jurisdictional reliability service standards, and improve poor reliability where there is customer support,
- Network Resilience – works to prepare the network to be resilient to major weather events, and contribute to community resilience to major weather events,
- Customer Energy Resources – investments in the network to integrate CER and enable export services,
- Strategic – specific one-off programs to manage key network risks and compliance issues and/or optimise long-term expenditure,
- Environmental – works necessary to address environmental risks within the network to comply with Environmental Protection Authority (EPA) requirements,
- Safety – expenditure necessary to maintain the safety of our network (excluding repex) for SA Power Networks' workforce and the public, which also includes a number of initiatives arising from our customer engagement program, such as the Bushfire Risk Mitigation Programs; and
- Power Line Environmental Committee (PLEC) – expenditure on underground parts of the network in accordance with State Government legislation.

1.3 Program History

Bushfire start reduction component

The bushfire start reduction component of the program is a continuation of programs we commenced in the 2015-20 Regulatory Control Period (RCP), which have continued in the current period (2020-25). Over this time, the programs have focused on feeders in designated High Bushfire Risk Areas (HBFRA).

The programs included:

- upgrades to existing feeder protection systems to allow an ultra-fast fault clearance protocol, which can be implemented during high bushfire risk periods (also known as Hot Line Tag, discussed further below) - this significantly reduces the likelihood that a network fault will cause a fire during these periods
- replacing some fire-prone assets (namely, some old surge arrestor technologies[2]).

To support these programs in the 2020-25 proposal to the AER, CSIRO was engaged to undertake detailed bushfire risk analysis and SA Power Networks developed a cost-benefit analysis model (the bushfire CBA model) to prepare the forecasts for these programs. This model demonstrated that all elements of the program should provide net benefits. The AER accepted this forecast and approach in making its Distribution Determination for the 2020-25 RCP.

We commenced the roll-out of these two programs during the 2020-25 RCP. The program to upgrade protection systems is progressing broadly in line with the original forecast of the feeders to be upgraded. However, the order of the feeders being upgraded has changed because it became clear during the initial

[2] These devices have open air gaps that can be short circuited by animals, particularly birds, which can then result in a fire.

phases of the roll-out that it was more cost effective to group and schedule upgrades by zone substation, rather than individual feeders as in the original plan.

The program to replace fire-prone arrestors commenced. However, during the early phases of this program, it became clear that there were far more of the old arrestors on the identified feeders than assumed in the modelling. Consequently, the actual cost per feeder to undertake the upgrades was much higher than assumed in the modelling, significantly reducing the expected net-benefit of this program. Therefore, this program has been paused in order to re-evaluate its costs and benefits, with funds used to accelerate the upgrade of protection systems.

To support the 2025-30 proposal, CSIRO have been commissioned again to revise their analysis and extend this analysis into Medium Bushfire Risk Areas (MBFRA). This analysis has found that the bushfire risk in MBFRA is high, and for many feeders traversing these areas, at similar levels to the HBFRA.

Therefore, we are using this revised data to evaluate the merits of extending these programs to the feeders in MBFRA and re-evaluating the feeders in the HBFRA. A similar risk quantification methodology and bushfire CBA model is being used to produce the program forecast as used previously. However, some inputs have been revised using the most recent information and CSIRO results, and some enhancements to the methodology have been made.

Customer supply interruption component

The customer supply interruption component of the program is a new component that we are proposing for the 2025-30 RCP. A similar program was included in our 2015-20 Regulatory Proposal. This program was rejected by the AER at that time primarily because there was not suitable quantitative evidence of the supply risk and the net benefit of the proposed program.

However, there are various reasons that the merits of this program should be reconsidered, most notably:

- we now have much greater visibility and quantification of the bushfire risk associated with our network through the CSIRO risk analysis discussed above, and a better understanding and experience of performing the quantitative cost-benefit analysis of programs of this type,
- as noted in the introduction, our customers and other stakeholders are indicating some support of us making customer supplies more resilient to major weather events, including bushfires; and
- climate change is expected to increase the likelihood of major bushfire events, and so is placing increasing focus on the supply risks associated with these events.

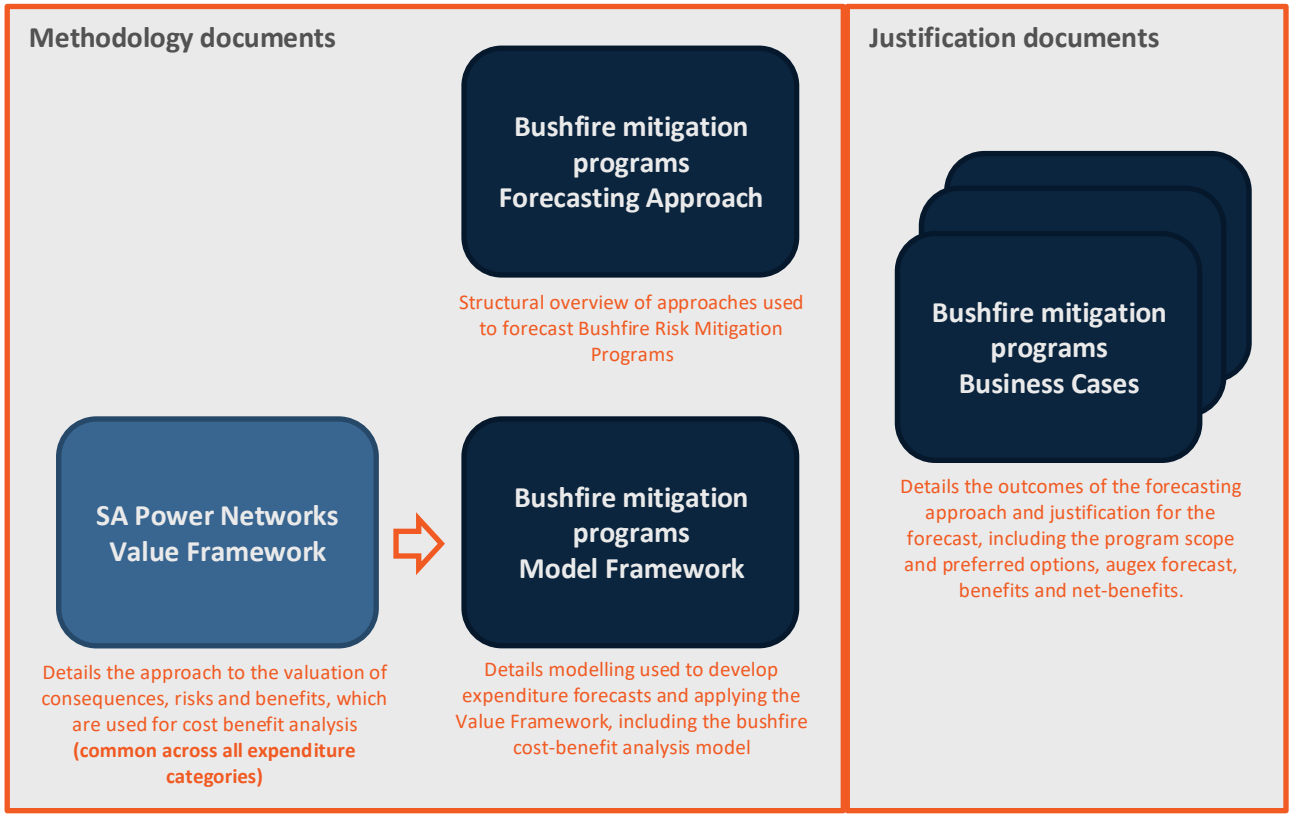
Therefore, during the 2020-25 RCP, research, analysis and model development is being undertaken to better quantify this supply risk and evaluate network options to reduce the risk. As part of this research, we are engaging with our customers to better understand whether and to what degree they want supplies to be resilient to bushfire events. As part of this exercise, we are undertaking quantitative Customer Value Research (ie willing-to-pay studies) to estimate the value customers place on avoiding interruptions to supply during these extreme conditions. The findings from these investigations will inform whether we continue to evaluate this program and include a forecast for it in our Regulatory Proposal for 2025-30.

1.4 Document purpose

The purpose of this document is to outline our methods for preparing the forecasts of the bushfire risk mitigation programs, covering the 1 July 2025 to 30 June 2030 RCP.

This document forms part of a suite of documents supporting these programs, which explain the forecasting approach, the modelling methods used in this approach, and the forecasts resulting from this approach, as set out in Figure 1. The Value Framework is a document common across all proposal expenditure categories, which defines how we value (in dollar terms) the risks and benefits that form important inputs into investment evaluations, including cost-benefit analysis models.

Figure 1 Bushfire Augex document suite



2. Motivation for the program

2.1 Explanation of need and drivers – bushfire risk

As noted earlier, the motivation for the bushfire risk mitigation programs is to reduce two categories of bushfire-related risk:

1. risk resulting from bushfires started by our distribution network assets; and
2. risk resulting from interruptions of supply to our customers because of a bushfire or SA Power Networks bushfire management practices.

These risks are elements of and defined in the SA Power Networks Value Framework. The Bushfire Model Framework document explains how the Value Framework is applied to calculate these risk components.

This section provides a further explanation of these risks in the context of the bushfire risk mitigation program and other programs associated with managing bushfire risk.

Risk resulting from bushfires started by distribution network assets

Bushfire risk in this context concerns the direct consequences of the damage caused by a bushfire started by the SA Power Networks network (ie public injury and death, and property and land damage).

All overhead electricity infrastructure has an inherent fire risk associated with it. Faults on the electricity distribution network are the primary cause of fires. These faults arise from a range of reasons, including vegetation or fauna directly contacting the network (eg vegetation blowing onto the network), vehicles hitting the network, and in some circumstances assets failing.

Large parts of our network traverse designated bushfire risk areas, and therefore, our network can impose a significant bushfire risk to the SA community through these network fault mechanisms. We have routine processes to reduce the likelihood that faults occur, with enhanced protocols in designated bushfire risk

areas (eg through our vegetation management processes, and asset maintenance and replacement programs).

The expenditure forecasts of these routine programs typically maintain bushfire risk, in face of the changing environment that the network traverses and the aging of the asset fleet, and the effects these have on specific fault causes. For example:

- our vegetation management program is primarily aimed at maintaining minimum distances of vegetation from the network to statutory requirements, but this has the effect of maintaining bushfire risk performance associated with some types of vegetation faults; and
- our replacement programs are aimed at maintaining the risk performance associated with age/condition-related asset failures.

These routine programs can have localised risk reduction benefits, but overall are not aimed at reducing bushfire risk. Importantly, faults cannot be completely eliminated, particularly for the overhead networks that supply most bushfire risk areas. Therefore, there remains a possibility that a fire may start.

Whether or not a fault results in a fire depends on many factors. One of the most important is the fault energy provided from the network to the environment through the fault (eg an energised broken conductor which falls to the ground onto dry fuels such as grass or bush). The higher this fault energy, the more likely this will result in a fire.

This fault energy is partly dependent on the protection systems and settings that are used to detect and clear network faults. The quicker the protection system can detect and clear the fault, the lower the fault energy. However, faster protection can impact on the ability for all the protection systems along the feeder to operate effectively (eg the closest upstream device to the fault should trip to minimise the number of customers interrupted), as well as the ability for protection systems to maintain supply after transient faults.

To balance this trade-off, we have developed a new protection setting protocol that can be applied to feeders in bushfire risk areas, called Hot Line Tag. This setting enables ultra-fast fault clearance, but at the expense of protection discrimination and coordination during the time they are applied. Given this reduction in fault discrimination and coordination between devices, and the effect this could have on supply reliability, Hot Line Tag is only applied at times of high bushfire risk (typically Total Fire Ban days).

For a feeder to have these settings, it must have modern ACRs or circuit breakers and protection systems that can detect faults and open at the very fast speed necessary to reduce the likelihood of the fault starting a fire. These protection devices also need to have SCADA capabilities so that these settings can be applied remotely and the status monitored. Upgrades to enable these capabilities form part of the bushfire mitigation programs in the current period, and are being evaluated for the next period.

The bushfire risk mitigation programs are aimed at reducing bushfire risk by:

- reducing the likelihood that a fault will cause a fire (eg upgrading protection systems to enable the application of Hot Line Tag); or
- reducing the likelihood that faults will occur along a feeder – but only in circumstances where the other routine programs would not instigate the necessary network upgrade or replacement.

Risk resulting from interruptions to our customers' supply because of a bushfire or SA Power Networks' bushfire management practices

Bushfire risk in this context concerns the direct consequence to our customers due to the interruption of their supply directly due to bushfires or how we manage the network because of bushfires.

This risk can be viewed as including two components:

- the Value of Customer Reliability (VCR) associated with the energy not served to customers during the interruption; and

- some additional amount reflecting the heightened safety consequences that occur when the interruptions affect customers in a high bushfire risk community, specifically at times when there are extreme bushfire conditions in that community's area (eg loss of cooling during extremely high temperatures, loss of important communications, loss of water pumps, etc.).

The electricity supply to customers can be interrupted for various reasons directly related to bushfires or how we manage the network because of bushfires, including:

- interruptions directly due to a bushfire in the vicinity of the network causing a network fault (irrespective of fire start cause);
- the increased likelihood of network outages when using the more sensitive fast protection settings we can apply during the bushfire season (the Hot Line Tag (HLT) discussed above);
- the deliberate de-energisation by SA Power Networks of localised portions of the network for public safety reasons, which can occur in rare circumstances to reduce the likelihood of that portion of the network causing a fire during catastrophic bushfire conditions in those locations (known as Public Safety Power Shutoffs) [3]; and
- the deliberate de-energisation by SA Power Networks of localised portions of the network at the request of the Country Fire Service (CFS) for the safety of their personnel who may be operating in that location[4].

We have programs to manage the reliability of the supply to our customers, including programs to improve reliability for customers in targeted parts of the network. However, these programs focus on reliability more generally and areas with poor performing reliability (as measured by annual SAIDI and SAIFI metrics). These programs do not specifically target high bushfire risk communities or the factors that result in interruptions at these specific high-risk times. In many cases, bushfire-related outages are excluded from reliability metrics under Force Majeure conditions.

The bushfire risk mitigation programs focus on these high bushfire risk communities, targeting:

- locations with the highest level of bushfire risk (ie expected loss due to a bushfire);
- locations with the highest expected frequency of interruptions due to bushfires or SA Power Networks' bushfire management practices; and
- locations with a high level of bushfire risk where the economic cost of the interruptions is high.

The bushfire risk mitigation programs address two related needs associated with interruptions to supply:

- To reduce the extent that supply to our customers will be interrupted for these bushfire-related reasons.

  This need is similar to the more typical supply reliability risks that can be quantified via a suitable VCR. Although, in these circumstances, the usual VCR may not be appropriate given the heighten risks associated with interruptions of supply at times of high bushfire risk.

- To reduce the community impacts of supply interruptions, particularly those associated with Public Safety Power Shutoffs.

  Stakeholders have indicated through the recent engagement process fairly strong support for these types of initiatives. This need is different to typical supply reliability risks as the risk associated with

[3] SA Power Networks has the right to undertake these Public Safety Power Shutoffs under the South Australian Electricity Act 1996. SA Power Networks has recently commissioned research by the CSIRO to inform its policy that defines the criteria it should apply to decide when to de-energise parts of its network for bushfire safety reasons.

[4] In these circumstances, the CFS will contact the SA Power Networks control room to advise of their location and activity and request the relevant part of the network to be de-energised.

specific critical community facilities may not relate to their energy consumption, and as such, the VCR approach is unlikely to be relevant here.

The approaches to quantify the benefits of these two needs are discussed further below (see Section 3.5 Assessment of program benefits). Depending on the preferences of our customers for addressing these two needs, network upgrades could include options aimed at:

- reducing the need for or extent of Public Safety Power Shutoffs;
- reducing the number of customers that could be interrupted during a Public Safety Power Shutoff or the duration of the interruption;
- reducing the extent of the network exposed to the effects of a bushfire in its vicinity; and
- providing alternative or back-up supplies to critical community services and infrastructure.

2.2 Relationship to customer service outcomes

Bushfire start reduction

The programs aimed at reducing the number of bushfires started by our network are intended to reduce the community risk associated with these bushfires, where community risk in this context is the land and property damage and/or fatalities and injuries directly caused by those bushfires. It is not expected to materially affect the reliability or quality of the supply to our customers.

Some program options could have marginal impacts on supply reliability. But it is not anticipated that these will be material. For example:

- The implementation of the fast protection settings has the potential to increase the possibility of spurious trips, while these settings are in place. However, the likelihood of these events is low and these settings are only applied for limited periods during the bushfire season, so this effect is not expected to be material.
- Some options, such as replacing overhead bare wire construction with covered conductors or underground cable, could improve reliability notionally. But we are not anticipating that it will be found efficient to upgrade significant sections of line. Therefore, it is unlikely to have a material improvement on the reliability of supply for customers served by that line.

These matters will be reassessed during the course of the modelling, to investigate whether their impacts could become material.

Reduced customer supply interruptions

The programs aimed at reducing customer supply interruptions are specially focused on improving the reliability of supply services to our customers in high bushfire risk locations.

However, as noted above, these programs are only focused on maintaining supply for these customers during very extreme bushfire conditions, which only occur for brief periods each year. Therefore, it is unlikely that there will be a material improvement on those customers supply reliability more generally (ie their annual SAIDI and SAIFI measures are unlikely to improve materially).

Nonetheless, some elements of the program could also have broader reliability benefits, including making the network serving the areas addressed by this program more resilient to storms and other fault causes. Therefore, in these circumstances, the forecasting approach will quantify the broader SAIDI and SAIFI effects of the program to determine whether they could be material on SAIDI and SAIFI settings, and calculate the necessary adjustments.

2.3 Regulatory requirements and the principle underlying our approach

We have sought to align its approach to forecasting the bushfire risk mitigation programs with the following.

Industry best practice

Our methodology to quantify bushfire risk, using expert bushfire risk modelling by CSIRO and using this within a cost-benefit model, represents a good practice approach within the electricity industry for these purposes.

National Electricity Rules (NER) requirements

Our forecasting approach and the resulting expenditure forecast accords with the expenditure objectives, factors and criteria in sections 6.5.7 and 6.5.6 of the NER:

- the program's forecast capital expenditure is in accordance with NER capex objectives as it is required to continue to comply with regulatory obligations and maintain the safety of the SA Power Networks distribution system and the services provided by our network;
- the program's forecast capital expenditure is in accordance with NER capex criteria, most notably because we have a robust approach to quantify risks and have applied cost-benefit analysis to ensure that the programs and all elements of the programs provide a net-benefit;
- we have engaged with customers during the development of the program; and
- our approach considers trade-offs between different elements of our proposal.

3. Forecasting approach

3.1 Forecasting process

The table below summarises the high-level stages during the current period to produce the expenditure forecast of the bushfire risk mitigation programs, showing how the forecasting process interacts with and is informed by customers, stakeholders and AER staff at multiple times during this period.

Table 1 Summary of the process to prepare the Bushfire Risk Mitigation Programs forecast

Year	Forecasting aims	Interactions with Consumer and AER Engagement
2021 and 2022 Q1-Q2	High-level definition and planning of bushfire mitigation programs to inform early stages of consumer engagement. This stage also included further bushfire simulation and risk quantification with CSIRO to help quantify the bushfire risk in the high and medium bushfire risk areas that our network traverses. This stage produced a high-level 'book-end' range of the program expenditure forecast, with a qualitative view of the possible program scope and benefits.	Preliminary program investigations provided inputs into the 'research and insights' and 'narratives and themes' planning stages of our consumer engagement process, which were conducted during 2021. The 'Broad and Diverse' stage of our consumer engagement, conducted during 2022 Q1 and Q2, provided some support from our customers for us to consider these programs further.
2022 Q2 - Q4	Detailed forecast methodology development for early AER engagement, and the application of this methodology to quantify bushfire risk and provide the scenario expenditure forecasts and benefits for consumer engagement.	The AER's 'deep dive' reviews, conducted during 2022 Q3/Q4, will allow the AER to understand and challenge the methodology we are using to prepare the program forecasts. To inform certain inputs and assumptions of the Bushfire Mitigation Programs, we are also undertaking

	This stage also includes the processes to reconcile and allow for interactions of the Bushfire Risk Mitigation Programs with other proposed programs. This stage produces the detailed quantification of bushfire risk, program expenditure forecasts and expected benefits for each defined scenario. This stage also produces drafts of the our forecasting methodology and business case documents.	the following research and investigations with its customers: • quantitative 'willingness to pay' research with our customers in 2022 Q3/Q4 to understand and quantify the 'value' our customers place on avoiding interruptions to supply during dangerous bushfire conditions • investigations with our customers into their views on climate change and how this should be allowed for in the Regulatory Proposal. The 'Focused Conversations' stage of our consumer engagement, conducted in 2022 Q3, will provide our customers with a greater understanding of the program needs and options, and ability to engage on the scenarios and their implications on costs and benefits.
2023	Finalising of program expenditure forecasts based on AER staff and consumer feedback, including the identification of the preferred scenario forecast to be included in our Regulatory Proposal. This will be a two-step process, first producing preliminary-final forecasts and documents, based on the findings of the 'People's Panel', and then the finalizing of these forecasts and documents based on the findings of the 'Draft Proposal review'.	The 'People's Panel' stage of our consumer engagement, conducted during 2023 Q1/Q2, will ensure customers understand the cost-benefit trade-offs in the programs and scenarios, and seek recommendations on the preferred scenario to inform our draft Regulatory Proposal. The 'Draft Proposal Review' stage of our consumer and stakeholder engagement, conducted during 2023 Q3, will seek feedback on our draft proposal to confirm it aligns with customers' preferences and our regulatory requirements.

3.2 Program outcome scenarios

Three investment scenarios have been defined to inform the customer engagement for the development of our Regulatory Proposal for the 2025-30 RCP.

These scenarios weigh program investment costs against the outcomes delivered by the programs (ie the benefit of the risk reduction, resulting service outcomes, etc). In this way, the scenarios produce differing counterfactuals of service performance outcomes (post investment risk) and program costs for customers to consider. These counterfactuals aim to transparently identify the trade-offs for customers between different levels of investment.

The three scenarios currently proposed are shown in the table below.

Table 2 Bushfire Risk Mitigation Programs and Investment scenario

Scenario		Description	Relevance to costs and benefits
1	Basic	No Bushfire Risk Mitigation expenditure outside of ongoing seasonal preparation operational expenditure	No proposed investment for bushfire risk mitigation, and so ongoing costs will reduce from the current period. No further reduction in bushfire risk in the next RCP from the level at the end of the current period.
2	Maintain	Continuing the current bushfire risk mitigation program (aimed at reducing fire start risk).	Costs will be maintained at around the current level. Bushfire risk (due to fire starts related to our network) will continue to be reduced where this provides a net-benefit. The reduction should be at a similar magnitude to that achieved in the current period through similar programs.

3	New Value	Continuing the current bushfire risk mitigation program (aimed at reducing fire start risk). Implementing a new program to reduce the risk associated with interruptions to customer supplies due to bushfires and how SA Power Networks manages bushfires.	Costs will increase from current level. Bushfire risk (due to fire starts related to the SA Power Networks network) will continue to be reduced where this provides a net-benefit. The reduction should be at a similar magnitude to that achieved in the current period through similar programs. Bushfire risk (associated with interruptions to customers supply) will be reduced from current levels where this provides a net-benefit and customers have indicated a 'willingness-to-pay' for the bushfire risk reduction.

3.3 Program options for evaluation

A set of credible options has been developed that can address the needs of the two components of the bushfire risk mitigation program. These options include the approaches set out above that have been implemented during the current RCP, which were found then to provide the greatest cost/benefit ratio.

The options that can address the needs of the two components of the bushfire risk mitigation program are different to some degree. Therefore, these options are defined separately for the two risk components in the two tables below. Further details of these options are provided in the Bushfire Model Framework Document.

It is important to note that the options listed below are not strictly mutually exclusive. That is, the aim of the cost-benefit analysis is not to determine which of these options maximises the net-benefit. Rather, the optimal 'blend' of these options for any specific feeder is evaluated through the cost-benefit analysis. In this regard, it could be that the optimal solution (ie the solution that maximises the net-benefit) includes a range of these options[5]. For the component aimed at addressing the risk of interruption to customer supplies, it could be that variations of one of these options are evaluated to determine which one maximizes the net-benefit.[6]

It is also worth noting that, based on investigations we conducted for the Bushfire Risk Mitigation Programs included in our 2020-25 Regulatory Proposal, it is very unlikely that installing Rapid Earth Fault Current Limiters (REFCL) technology will be a credible option in our circumstances, due to the technical challenges and high costs of implementing it on our network. Nonetheless, we are continuing to monitor and investigate the suitability of REFCL.

Table 3 Options to address the risk of a bushfire start from network assets

Option	Description of scope and how it addresses the need
Implementing feeder-level ultra-fast protection scheme	This option was the primary preferred solution found through our modelling for our 2020-25 Regulatory Proposal. The scope of works of this option includes installing, upgrading and/or recommissioning protection devices with the following features: • Hot Line Tag (HLT): a settings profile that provides near instantaneous fault clearance for all faults detected by the device – these settings can then be applied on high fire danger days • SCADA control: to enable remote disabling of reclose, remote application of HLT and remote disconnection. This option does not reduce the likelihood of a fault occurring. However, it reduces the likelihood that fault currents will last long enough to start a fire.

[5] For example, with regard to the options reducing the fire start risk, the optimal solution for an individual feeder could include implementing the ultra-fast protection scheme, replacing fire-prone assets along the feeder, and undergrounding a small number of very high-risk feeder sections.

[6] For example, for a specific community or feeder, it could be that a different number or scale of back-up or stand-alone microgrids could be feasible for customers supplied by that feeder. The cost-benefit analysis would evaluate which of these variations maximises the net-benefit.

	The specific works necessary on any feeder to implement HLT and the resultant reduction in likelihood of starting a fire is dependent on the current protection devices. As part of the forecasting approach, any feeder that shows a benefit from implementing HLT is assessed to determine the specific works necessary, and to estimate the resulting reduction in the likelihood of a fire start.
Replacing fire-prone assets	The main asset type on our network that is considered fire-prone is an old type of surge arrestor with open air gaps. These arrestor types have had a history of starting fires through animals, particularly birds, bridging the air gaps. These are the arrestor types that have been replaced through this program during the current period. Although, as discussed above, this replacement program has been paused due to the costs being higher than anticipated. These arrestor types still function adequately, and therefore, outside the bushfire risk mitigation program, they would not typically be replaced. Replacing these arrestor types on high-risk feeders eliminates this fire start event mechanism from that feeder.
Replacing sections of overhead bare conductor with covered conductor	This option involves replacing overhead bare conductor with covered conductor on sections of the feeder that have a sufficiently high bushfire risk (ie the risk associated with fire starts in that section). Upgrading to covered conductor reduces the likelihood of some faults, reducing the likelihood of a fire start in that section.
Undergrounding sections of overhead bare conductor	This option involves undergrounding sections of the existing feeder that have a sufficiently high bushfire risk (ie the risk associated with fire starts in that section). Undergrounding eliminates the types of fault that can cause a fire start in that section.
Installing REFCL	This option involves installing Rapid Earth Fault Current Limiter (REFCL) at the zone substations supplying feeders with sufficiently high bushfire risk in aggregate. REFCL devices greatly reduce the likelihood that faults on any of the feeders covered by the REFCL device will start a fire.

Table 4 Options to address the risk of interruption of customer supply due to bushfire or SA Power Networks bushfire mitigation practices

Option	Description of scope and how it addresses the need
Installing remote controlled switches	This is a 'low complexity' option to implement and represents a solution we routinely implement through our reliability programs. Installing remote switches provides much greater discrimination when applying the Public Safety Power Shutoffs, reducing the extent of the feeder being de-energised and thus reducing the number of customer interruptions. It will also provide greater flexibility in restoring supplies following outages caused by bushfires.
Undergrounding sections of overhead bare conductor	This is also a relatively 'low complexity' option, involving undergrounding sections of the existing feeder that supply high bushfire risk areas. Undergrounding eliminates the outages due to bushfires in the vicinity of that section. Also, as noted above, it also eliminates the likelihood of bushfire starts caused by that section. Depending on the extent of the undergrounding, this could reduce bushfire risk to the extent that the need for Public Safety Power Shutoffs is reduced. Depending on the extent of undergrounding, this option could have broader reliability benefits to the relevant customers. Note – this option would also have significant fire-start reduction benefits, and therefore, if it was considered credible then its use would be co-optimised with the fire start reduction component of the Bushfire Risk Mitigation Program.

Portable and mobile SAPS and generation	This is a moderately complex option, involving investment in alternative supply options, of different scales, that can be transported to different locations to provide an alternative supply source. This solution could be used in anticipation of high bushfire risk conditions at specific locations, to allow parts of the network to be de-energised without losing supply. Alternatively, it could be used after a bushfire event that has caused a network outage, to enable supplies to be restored prior to the network fault being repaired. These types of portable alternative supplies would have broader benefits across the network, as they could also be used at non-bushfire risk periods for other purposes (eg to reduce planned interruptions and restore supplies due to other events).
Installing microgrids and stand-alone power systems (SAPS)	This is a more complex option, involving the development of a microgrid or SAPS to provide an alternative supply to particular high bushfire risk areas and customers. Outages of the existing feeders supplying that area, either due to Public Safety Power Shutoffs or fault-driven outages, can still occur to the feeder supplying the area. But in these circumstances, supplies to customers in that area can be maintained using the microgrid or SAPS. These options could have broader reliability (and possibly price) benefits to the relevant customers. Furthermore, this type of option – particularly when used to provide alternative supply to critical community services and infrastructure - could also be undertaken as a joint initiative with local councils, customer groups or other service providers. In these circumstances, there may only be a portion of the overall costs that we would fund. The possibility of this type of option will be investigated through the course of the consumer engagement.
Installing REFCL	This option involves installing Rapid Earth Fault Current Limiters (REFCL) at the zone substations supplying feeders with sufficiently high bushfire risk in aggregate, reducing the likelihood that Public Safety Power Shutoffs during high bushfire risk time will be necessary. Note – this option would also have significant fire-start reduction benefits, and therefore, if it was considered credible then its use would be co-optimised with the fire start reduction component of the Bushfire Risk Mitigation Program.

3.4 Program options costs

The capital and operating costs of the options have been estimated using the following methods:

- for options (or option elements) that we have applied during the current period, we use actual costs and work volumes to estimate average unit costs and/or rates
- for other options (or option elements) that are more complex and would be site specific (eg installing a medium to large microgrid), our experience and knowledge of the likely scope of works, unit costs and rates are used to estimate a reasonable cost of the option for the specific circumstances; these cost estimates may be supported by quotes for similar scopes.

Where relevant, these option costs are escalated to ensure that the costs are all on the same real dollar terms and consistent with the benefits value.

The sources and basis of specific option costs are discussed in more detail in the business cases that support these programs.

3.5 Assessment of program benefits

The main program benefits being assessed relate to the reduction in the bushfire risk achieved by the programs, where the two components of risk are those described above. As such, the benefits of the two components are different and are defined by:

- Fire start reduction program – the long-term average reduction in the community bushfire risk (ie reduction in public safety incidents, land and property damage) due to the long-term average reduction in fire starts achieved by the option.
- Customer supply interruptions – the long-term average reduction in the risk due to the interruption to electricity supply during dangerous bushfire conditions. As discussed above, this supply interruption risk (and the benefits of reducing it) can be further categorized into two forms:
    - The long-term average reduction in the direct risk to our customers due to interruptions to their supply. This risk and the benefit of avoidance can be estimated using the usual VCR approach used to quantify supply reliability risks and benefits. However, as noted below, the usual VCR (published by the AER) is likely to have some limitation to valuing risks and benefits during the more extreme bushfire conditions.
    - The long-term average reduction in the community risk due to interruptions to critical community facilities during dangerous bushfire conditions. As noted in Section 2.1, this risk and the benefit of avoidance is less suited to a VCR-type approach to quantification as the critical facilities or more likely to have their unique values to the community that is unlikely to be directly related to their energy consumption.

If considered material on the option evaluation, other benefits may be quantified, most notably:

- avoided network costs achieved by the option
- the value of improved customer supply reliability more generally (ie via the usual VCR/SAIDI/SAIFI as discussed in our Value Framework.

However, typically, these benefits are only included when they are material and worth the effort to estimate. More usually, it is assumed that these additional benefits are negligible for evaluating an option, to reduce the possibility of overstating the benefits of an option in its evaluation process.

More details of how these bushfire risks and program benefits are calculated are covered in the Value Framework and Bushfire Model Framework documents.

The VCR used to calculate the benefits of avoided customer supply interruptions

To support the valuation of risks associated with interruptions to supply during times of high bushfire risk, we will undertake additional research to test our customers' willingness-to-pay to avoid supply interruptions during times of catastrophic events (such as times of bushfire risk). If this provides good support to a program of this type then further surveys or research may be conducted to better quantify the value our customers place on avoiding supply interruptions, including interruptions to the supply of critical services (eg communications), at times of very high bushfire risk.

With regard to the value of the direct risk to our customers due to interruptions to their supply, if the quantitative research produces an alternative VCR, more representative of these bushfire risk conditions, then this VCR may be used to evaluate the benefits of this component of the Bushfire Risk Mitigation Programs, in place of the usual VCR determined by the AER. However, in this circumstance, the impact of the difference in VCR will be tested through the sensitivity analysis (discussed below).

With regard to the value of the community risk due to interruptions to critical community facilities, if the quantitative research produces a suitable loss value for this risk, then this will be used to evaluate the benefits of this component of the Bushfire Risk Mitigation Programs.

3.6 Evaluation of options – determining preferred solutions

All credible options of both components of the bushfire risk mitigation programs are assessed using detailed cost-benefit analysis. This analysis aims to ensure that only elements are included in the program forecasts where it can be demonstrated that the benefits achieved by that element will exceed its costs over the life of the investment.

Importantly, this analysis is performed at a granular level to ensure that the overall program should maximise the net-benefits.

Evaluating the fire start reduction program

For the fire start reduction program, options specific to an individual feeder (eg implementing fast protection settings) are evaluated based on the total benefits and upgrade costs of the feeder, whereas for options more specific to sections of a feeder (eg upgrading to covered conductor or undergrounding) the benefits and upgrade costs associated with the individual sections of an individual feeder are evaluated.

Evaluating the customer interruption reduction program

For the customer interruption reduction program, options are developed and evaluated that are specific to the identified locations for investigation. For each of these locations, tailored options will be developed that take into account factors such as:

- local preferences and network topology
- co-benefits with other needs such as addressing capacity constraints or storm resilience
- the current policy for implementing Public Safety Power Shutoffs for that location.

The set of options developed for each identified location are then evaluated through a cost-benefit analysis model to determine which option, if any, maximises the net benefit.

With regard to the evaluation of options to reduce the community risk due to interruptions to critical community facilities, the extent that cost-benefit analysis can be used to evaluate these options will depend on whether a suitable loss value can be determined through the willingness-to-pay surveys conducted with our customers and whether an option is a joint-initiative with other parties (who could have their own benefits value associated with the option). In these circumstances, the customers engagement process will be used to test which options customers would be willing to pay for in terms of the critical community services that could be secured by the options and the cost (to SA Power Networks customers) of that option.

3.7 Climate change projections and the evaluation of the program

Climate change is expected to increase the number of days each year that regions in South Australia are in the higher risk bushfire danger ratings. As such, climate change is highly likely to materially increase bushfire risk, and in turn, increase the benefits of mitigating bushfire risk.

We are currently engaging with customers on their views of climate change and how this should be allowed for in our 2025-30 Regulatory Proposal, including the climate change projections that we should plan for.

The significance of the climate change projections on the bushfire risk, the program benefits, and the optimal programs will be evaluated through the forecasting approach. The effect of climate change projections on the bushfire risk mitigation programs will be considered through sensitivity studies discussed below. However, depending on the views of our customers, the preferred climate change projection could be allowed for as a base-case assumption in the bushfire risk and benefit quantification. The climate change assumptions and their significance on bushfire risk and the optimal program will be clearly set out in the program business cases.

3.8 Sensitivity studies

Sensitivity analysis has been undertaken to test outcomes of the above evaluation process to changes in important inputs. The results of these studies have been used to inform the preferred forecast of the three scenarios for discussions during the consumer engagement process.

The input parameters being analysed include:

- Discount rate
- Probability of a fire start
- Bushfire Consequences
- Capital input costs
- Assumed fire-start likelihood reduction achieved by the program
- The assumed VCR, including the difference between the AER-defined VCR and an alternative VCR produced through our 'willingness-to-pay' research if this is available.

In addition, as discussed above, the effect of the climate change projections agreed with our customers (eg a low, medium and high climate change projection) will be examined through the sensitivity studies. This will consider how each agreed climate change projection varies the assumed average number of days per bushfire season in the different fire danger ratings, which form inputs into our bushfire risk calculations[7].

This analysis will evaluate how the climate change projections will affect:

- the bushfire risk moving forward, without the proposed bushfire mitigation program
- the benefit of the base case program[8] ie the resulting bushfire risk after the program's implementation
- the optimal programs for the next regulatory period allowing for the climate change projections.

3.9 Assessing and quantifying interrelationships with other programs

There will be interrelationships between the two components of the bushfire risk mitigation programs. For example:

- options through the fire-start reduction component reduce the likelihood that the feeder will cause a major bushfire, which in turn, reduces the likelihood that high-risk customers will lose supply because of such a bushfire
- options through the customer supply improvement component (particularly undergrounding or providing an alternative supply) could reduce the likelihood that the feeder that usually supplies those customers will start a fire during bushfire conditions (eg backup supply could be used in anticipation of the bushfire condition, in order to allow the high-risk feeder section to be de-energised and so unable to start a fire during these conditions).

Therefore, the common feeders (and communities where relevant) being addressed by the two components will be identified through the forecasting process to ensure any co-benefits are quantified and allowed for in determining benefits and evaluating options.

Additionally, as noted above, the bushfire risk mitigation programs have some interrelationships with other programs in our Regulatory Proposal. These relationships cover both the effect on benefits (and underlying risk) achieved by programs, and the works activities that will form the programs. This relationship is the most

[7] For more details see document 5.6.3 - Bushfire Model Framework – Methodology.

[8] The base-case in this context can be considered the optimal program developed from the base case assumptions, which do not allow for future projections of climate change (ie they are based on the historical distribution of days in the various fire danger ratings).

material for the replacement expenditure (repex) forecast and the reliability and resilience expenditure forecast.

Several processes have been applied to ensure that these interrelationships are identified, quantified, and allowed for across our proposal.

Replacement expenditure – addressing risk interactions and optimisation

As noted above, replacement expenditure is aimed at maintaining bushfire risk, driven by the age/condition of assets and how this affects asset failures. This could result in some localised improvements in bushfire risk, but it is not expected that these improvements will be material on the drivers of the bushfire risk mitigation program in most cases. This is because these improvements will be very localised to specific assets being replaced on a feeder, which will likely constitute a very small component of the overall risk of a feeder or feeder section.

However, the risk improvements achieved through the fire start component of the bushfire risk mitigation program, particularly the feeder-level improvements provided by the feeder protection upgrades, could materially reduce the risks calculated through the models used to develop the replacement programs. Therefore, as part of the forecasting approach, the feeder-level improvements provided by the bushfire mitigation programs are estimated and these are then fed back into the risk models used for evaluating the replacement programs.

Finally, as a concluding step, to align the overall bushfire risk profile with customer preferences, the complementary impact of repex on bushfire risk will be considered as a post-model adjustment to ensure the overall impact of the augex and repex programs meets scenario goals. For example, if customer support is demonstrated for a program that maintains overall bushfire risk, both augex and repex programs will be optimised so that the combination of both programs maintains overall bushfire risk.

Replacement expenditure – addressing program double counting

Although the bushfire risk mitigation programs are largely aimed at upgrading assets, it can include some elements of replacement. For example, there could be circumstances where an existing slower ACR or circuit breaker is forecast to be replaced with a modern faster unit. The forecasting approach and models used in this approach mean that the assets on specific feeders that are required to be replaced through the Bushfire Risk Mitigation Program can be identified.

Therefore, as a concluding step of the forecasting approach, a reconciliation is applied between the forecast works scope of the Bushfire Risk mitigation Program, the replacement program, and other programs that could result in similar replacements to ensure that there is no double counting of replaced assets between programs.

Reliability and resilience expenditure – addressing supply reliability interactions

There is the possibility of interactions on customer supply reliability of the customer supply interruption component of the bushfire risk mitigation program and the reliability and resilience programs in the augex forecast. This interaction can apply both ways.

As part of the evaluation process for each identified high-risk location, the reliability benefits expected to be achieved through the forecast reliability and resilience programs on the feeders supplying that location is fed into the options evaluation for that location.

Similarly, for each of the preferred solutions for an identified location, the overall STPIS impact and any localised SAIDI and SAIFI implications are calculated, which are then allowed for in the analysis supporting the reliability and resilience programs.

Reliability and resilience expenditure – addressing program double counting

As a concluding step of the forecasting approach, we apply a reconciliation approach between the forecast scope of works of the Bushfire Risk Mitigation Program and the reliability and resilience programs to ensure that there is no double counting of upgraded assets or missed interactions with supply reliability.

It is also worth noting that where specific elements of the bushfire risk mitigation programs and network resilience programs could have very similar options (eg installing a micro-grid or SAPS for the same communities identified for both programs) then the set of options and combined benefits may be evaluated together and the preferred options would be allocated to the most appropriate proposal category (ie bushfire mitigation or network resilience, most likely based on which produces the greatest benefit). These cases would be clearly set out in the relevant business cases, indicating where costs have been allocated and where benefits should occur[9].

3.10 Individual business cases

We have prepared two business cases covering the two risk components of the Bushfire Risk Mitigation Programs. These two documents set out the results of the above forecasting approach for each scenario relevant to that risk component, including:

- the preferred program scope and expenditure forecast
- the options being evaluated and the basis of their costs and other assumptions
- the benefits and net benefits associated with each option evaluated
- the results of the sensitivity studies, including the effects of climate change projections
- the reasoning for the preferred options
- relevant interactions and interrelationships with other programs.

The following table summarizes the proposed business cases.

Table 5 Summary of business case programs being prepared for the Reliability Management Programs

Business Case	Programs	Needs addressed	Options*	Scenarios covered
5.6.1 - Bushfire Risk Management -business case	Bushfire start reduction	Reduce risks directly due to bushfires started by our network (ie land and property damage and public safety)	Ultra-fast feeder protection schemes Replacing fire-prone assets Replacing sections of overhead bare conductor with covered conductor. Undergrounding sections of overhead bare conductor. Installing REFCL	Maintain New Value
	Customer supply interruption	Reduce risks due to interruptions to customers' supply due to bushfires or we manage bushfires	Remote controlled switches Undergrounding sections of overhead bare conductor. Portable and mobile SAPS and generation Microgrids and stand-alone power systems (SAPS) REFCL	New Value

[9] For example, if a number of projects have been allocated to the Network Resilience Program that address communities identified for the bushfire mitigation risk programs, then these communities (or feeders) would be identified in the bushfire risk mitigation business case and the avoided bushfire risk achieved by these projects would be provided in that business case. Similarly, these communities (or feeders) would be identified in the network resilience business case and these additional bushfire risk benefits allowed for in the evaluation would be noted in that business case.

* Note, these options represent the range of options that could be considered for specific circumstances. These options will differ depending on the feeder (or community) being addressed through the programs, and in some circumstances the preferred option could include a number of these options. These options do not represent the either/or choice for the overall program. This is discussed above in Section 3.3.