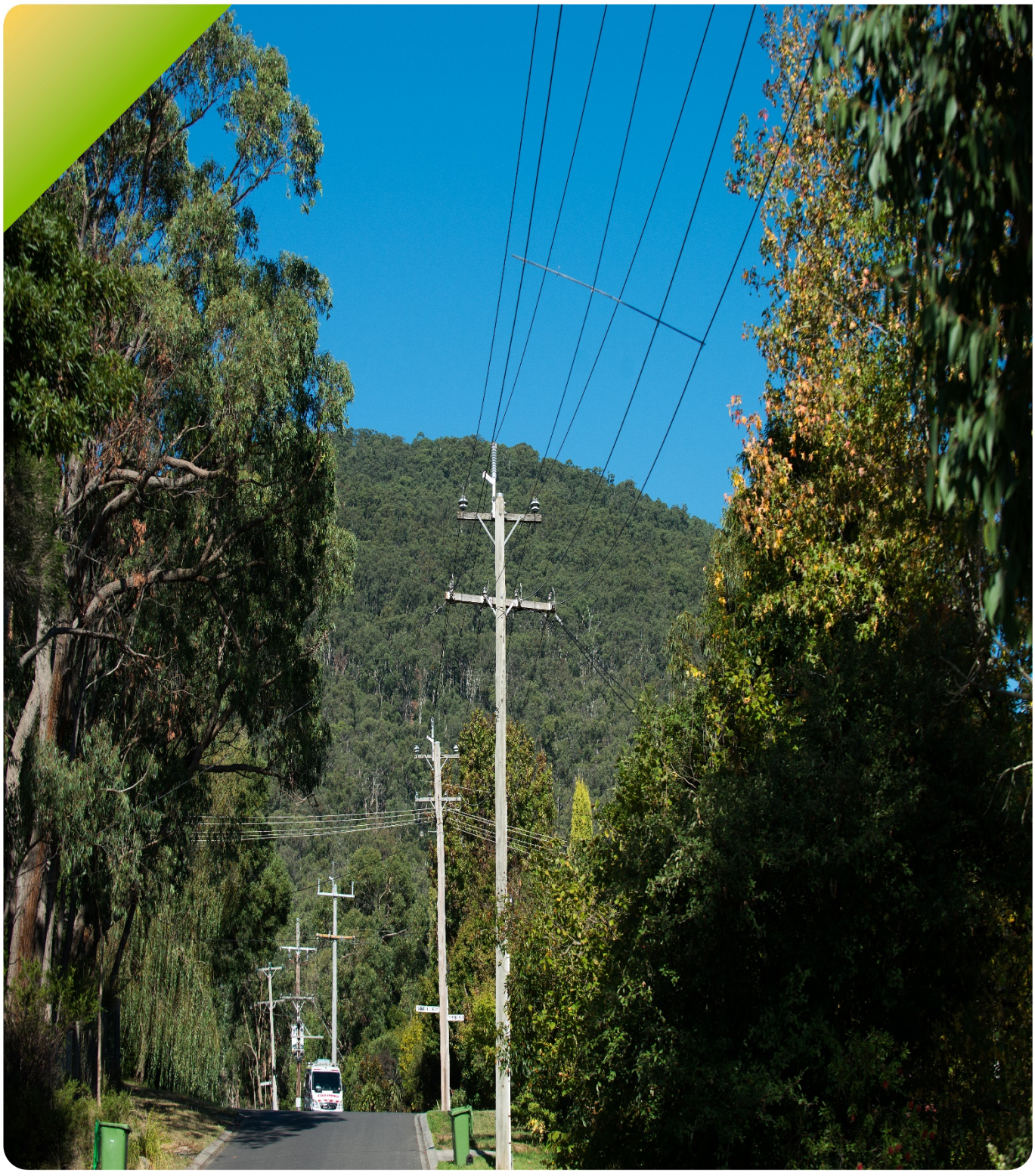


Powerline Bushfire Safety Program

Benefits Realisation Report

Department of Environment, Land, Water and Planning

2021-06-24

aurecon

Bringing ideas to life

Disclaimer:

This report has been prepared by Aurecon at the request of the Department of Environment, Land, Water and Planning ("Client").

The basis of Aurecon's engagement by the Client is that Aurecon's liability, whether under the law of contract, tort, statute, equity or otherwise, is limited as set out in this report and the terms of the engagement.

No other party should rely upon this report because:

- *It is not possible to make a proper assessment of this report without a clear understanding of the terms of engagement under which the report has been prepared, including the scope of the instructions and directions given to and the assumptions made by Aurecon.*
- *The report is a report scoped and completed in accordance with instructions given by or on behalf of the Client as defined in the Analytical Framework and Consultation Plan dated 10 August 2020. The report will not address issues which would need to be addressed with a third party if that party's particular circumstances, requirements and experience with such reports were known and, further, may make assumptions about matters of which a third party is not aware.*
- *Aurecon does not assume responsibility for the use of, or reliance on, the report by any third party and any use of, or reliance on, the report by any third party is at the risk of that party.*

Limited Scope, Investigation and Information

The limited scope of Aurecon's brief in this matter as defined in Analytical Framework and Consultation Plan dated 10 August 2020, including the limited scope of review requested by the Client, means that the report necessarily addresses items on a "by-exception" basis only and concentrates on readily apparent major items.

The report is also based on information provided to Aurecon by other parties, including but not limited to the documents set out in Appendix A of this report. The report has been prepared strictly on the basis that the information that has been provided is accurate, complete and adequate.

Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that any person may suffer resulting from any conclusions based on information provided to Aurecon.

The findings, observations and conclusions expressed by Aurecon are not, and should not be considered as, an opinion concerning the commercial feasibility of the property or asset, nor as a recommendation to take or not take any particular course or action.

If the reader should become aware of any inaccuracy in or change to any of the facts, findings or assumptions made either in Aurecon's report or elsewhere, the reader should inform Aurecon so that it can assess its significance and review its comments and recommendations.

Nothing in this report shall be read or applied so as to purport to exclude, restrict or modify, or have the effect of excluding, restricting or modifying the application of all or any of the provisions of the Competition and Consumer Act 2010 (Cth) or any other legislation which by law cannot be excluded, restricted or modified.

This report, in whole or in part, may only be reproduced or published with the prior written permission of Aurecon, and this explanatory statement must accompany every copy of this report.

Document control record

Document prepared by:

Aurecon Australasia Pty Ltd
ABN 54 005 139 873
Aurecon Centre
Level 8, 850 Collins Street
Docklands, Melbourne VIC 3008
PO Box 23061
Docklands VIC 8012
Australia

T +61 3 9975 3000
F +61 3 9975 3444
E melbourne@aurecongroup.com
W aurecongroup.com

Document control						aurecon
Report title	Benefits Realisation Report					
Document code			**Project number**	510053		
File path	Https://aurecongroup.sharepoint.com/sites/510053/7 Deliver Service/Report/PBSP Benefits Realisation Report Rev3.docx					
Client	Department of Environment, Land, Water & Planning					
Client contact	Madelyn Anderson		**Client reference**			
Rev	**Date**	**Revision details/status**	**Author**	**Reviewer**	**Verifier** (if required)	**Approver**
0	2020-10-16	Draft Report for comment	LR, RM	CL		SO
1	2020-12-18	Incorporating first round of feedback from DELWP	LR, RM, CL	CL		SO
2	2021-02-05	Incorporating second round of feedback from DELWP	LR	CL		SO
3	2021-04-16	Incorporating third round feedback from PBSP exec team and ESV incorporated	LR	SO, JH		SO
4	2021-04-30	Final with feedback from DELWP	LR	SO		SO
Current revision	**4**					

Approval			
Author signature		Approver signature	
Name	Lea Reeves	Name	Steven Owens
Title	Senior Consultant	Title	Technical Director

Contents

Figures

Tables

Acronyms

ABC	Aerial Bundled Conductor
ACR	Automatic Circuit Reclosers
AER	Australian Energy Regulator
AusNet	AusNet Services
BMP	Bushfire Mitigation Plan
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBs	Distribution Business
DELWP	Department of Environment, Land, Water and Planning
EFD	Early Fault Detection
ELCA	Electric Line Construction Area
ESV	Energy Safe Victoria
FY	Financial Year
HBRA	Hazardous Bushfire Risk Area
HCAP	High Voltage Customer Assistance Program
HV	High Voltage
KEA	Key Evaluation Area
KPI	Key Performance Indicator
LGA	Local Government Area
LIAF	Local Infrastructure Assistance Fund
LV	Low Voltage
PBSP	Powerline Bushfire Safety Program
PCB	Program Control Board
PLC	Powerline Carrier
POELs	Private Overhead Electric Lines
PRF	Powerline Replacement Fund
R&D	Research and Development
REFCL	Rapid Earth Fault Current Limiter
RIS	Regulatory Impact Statement
RRM	Risk Reduction Model
SAPS	Standalone Power System
SWER	Single-Wire Earth Return
Taskforce	Powerline Bushfire Safety Taskforce
TFB	Total Fire Ban
VBRC	Victorian Bushfires Royal Commission
ZSS	Zone Substation

1 Executive summary

Following the 2009 Black Saturday bushfires, where six of the most catastrophic fires were caused by powerlines, the Victorian Bushfire Royal Commission (VBRC) and later the Powerline Bushfire Safety Taskforce provided recommendations to make powerlines safer. These recommendations formed the foundation of the Powerline Bushfire Safety Program (PBSP), which comprises five interrelated projects:

- The Network Assets Project;
- The Powerline Replacement Fund (PRF);
- The Research and Development Fund (R&D Fund);
- The Local Infrastructure Assistance Fund (LIAF); and
- The Network Operations Project.

Aurecon has been engaged by the Department of Environment, Land, Water and Planning (DELWP) to undertake a benefits realisation review ('the Review') of PBSP. The Review included the Network Assets Project, the PRF and the R&D Fund, as well as the f-factor Scheme and legislative amendments in relation to PBSP delivery. The LIAF was excluded from the scope and the Network Operations Project was not assessed as an individual project but incorporated into the overall assessment of benefits for PBSP.

The purpose of the Review was to determine the extent to which the anticipated benefits of the five projects under review are on track to be realised by 2023 within the allocated budget and timeframe for delivery.

Program delivery review

This review found that PBSP has been implemented successfully (Table 1).

The PRF and LIAF were delivered ahead of time, while the R&D Fund was completed in line with the anticipated timeframes. The Network Assets Project is currently on track to be completed by 2023..

Table 1: Delivery performance of PBSP projects delivering infrastructure upgrades[1]

PBSP project	Budget ($ million)		Total cost ($ million, nominal)	Budget	Timeline	Overall
	real, 2011 dollars	nominal				
Network Assets Project	500.0	596.8	1,113*	Over budget	On time	
PRF	175.0	200.7	186.2	On budget	Ahead	
R&D Fund	9.5	10.0	8.3	Under budget	On time	
LIAF	35.0	40.0	29.4	Under budget	Ahead	
TOTAL	**719.5**	**847.5**	**1,336.9**			

Fully met targets Somewhat met targets Did not meet targets

** Costs for the Network Assets Project are inclusive of HV customer expenses (Nous, 2020).*

[1] The anticipated budget for the PBSP is typically reported as a $750 million package. This includes $500 million (2011 dollars) for the Network Assets Project, $200 million (nominal) for the PRF, $10 million (nominal) for the R&D Fund and $40 million (nominal) for the LIAF. It is noted that a proportion of the PRF budget was allocated for project management expenses (Ernst & Young, 2012, p.53).

The costs for the PBSP projects outlined in Table 1 have all been on or below budget except for the Network Assets Project. The expected overspend on the Network Assets Project is primarily due to technical and cost uncertainties associated with the first-time use and implementation of Rapid Earth Fault Current Limiters (REFCLs) for bushfire safety purposes.

Realisation of program objectives

PBSP seeks to fulfil six objectives (Table 2), which were developed during the program planning stage in 2011. The objectives include a program level objective (objective 1) and separate objectives for each of the five individual projects (objectives 2 to 6).

The successful delivery of the projects included in this Review has led to several significant achievements that have contributed towards meeting the PBSP objectives (Table 2). Based on current progress, a reduction in relative powerline bushfire risk of close to 50 per cent is expected by 2023 which will help reduce the future number of bushfires in Victoria and the associated harm to human life and property.[2]

Network safety upgrades implemented via the Network Assets Project and PRF have both been underpinned by research and testing supported through the R&D Fund. For example, the identification of areas to target with infrastructure upgrades and the rollout of REFCLs were heavily reliant on the development of a Risk Reduction Model (RRM) and the outcomes from REFCL trials.

The timely and targeted delivery of infrastructure upgrades was further facilitated through changes to legislation and compliance requirements such as the introduction of the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016*.

Table 2: PBSP objectives and related achievements

Objective	Achievements
Objective 1: Reduce the harm to human life and property from bushfires started by powerlines, within the parameters of: ▪ a $750 million program of works; ▪ 10 years duration ▪ no material reduction in electricity supply reliability.	This objective has been met through: **48.1%** relative reduction in powerline bushfire risk by June 2023 with **36.6%** risk reduction achieved to date. This means that the likelihood of loss of life or damage to property as a result of powerline ignited bushfires will almost be halved by June 2023. Reduction in annual powerline related fire starts in Hazardous Bushfire Risk Areas (HBRAs) since the beginning of the PBSP.
Objective 2: Operate network assets so as to prevent bushfire starts at the times and locations of greatest risk, whilst minimising disruptions to customer supply.	This objective has been met through: Enhanced network protection devices to lower ignitions in high bushfire risk conditions. Heightened safety settings lead to location and isolation of more powerline faults, thereby preventing them from starting a fire.
Objective 3: Ensure businesses invest in those new and replacement assets needed to achieve a heightened bushfire risk standard at least cost.	This objective has been met through: **1,288** remotely controlled automatic circuit reclosers (ACRs) installed contributing to the protection of Victoria's entire single wire earth return network. **45** zone substations to be REFCL protected by June 2023 with **17** mandated REFCL zone substations operational and compliant to date.
Objective 4: Bring forward the replacement of those powerlines which currently pose the most severe bushfire hazard without imposing additional costs on consumers.	This objective has been met through: **734** kilometres of bare-wire powerlines in areas of highest bushfire risk replaced with underground or insulated overhead conductors, reducing the ignition likelihood associated with those powerlines by >90%.

[2] Further reduction of the relative powerline bushfire risk to 57.3 per cent is expected beyond this timeframe due to the legislated requirement for distribution businesses to replace all bare-wire powerlines within 33 electric line construction areas (ELCAs) once they reach their end of life.

Objective	Achievements
Objective 5: Mitigate the risks caused by program-related power outages for people who are dependent on power for their health and wellbeing.	This objective has been met through: Installation of back-up generators at **343** residential care facilities providing backup power supply for **15,937** vulnerable Victorians.
Objective 6: Improve the cost effectiveness of the broader program, and reduce unintended negative consequences, by obtaining new and better information.	This objective has been met through: Development of leading-edge risk reduction modelling and REFCL trial outcomes to improve the delivery of the PBSP. Use of above and other research outcomes to contribute to a knowledge base to improve power distribution and bushfire management practices.

Broader benefits of the bushfire safety initiatives

In addition to the reduction in relative powerline bushfire risk, several broader benefits have stemmed from the effective delivery of PBSP including, but not limited to:

- Reduced risk of electrocution for people working in the vicinity of undergrounded powerlines;
- Local industry development and job creation through commercialisation of R&D funded products;
- World-leading bushfire expertise;
- Increased robustness of the electricity network;
- Reduced fire risk for complex faults;
- Improved fire starts data collection;
- Greater focus by distribution businesses on reducing fire risk; and
- Increased support for funding of safety related expenditure.

Overall, this Review finds that the effective delivery of PBSP and legislative amendments have helped to ensure that the anticipated benefits of the bushfire safety initiatives will be largely realised by the conclusion of the program in 2023.

2 Key findings

Aurecon conducted a benefits realisation assessment of PBSP by comparing program outcomes to the program objectives set by PBSP (Chapter 5). The main findings of the assessment are highlighted below:

Objective 1: Reduce the harm to human life and property from bushfires started by powerlines, within the parameters of a $750 million program of works, 10 years duration of the program and no material reduction in electricity supply reliability.

- Up to 50 per cent reduction in state-wide powerline related bushfire risk by June 2023 due to PBSP initiatives, with REFCLs being the largest contributor to this risk reduction. This is expected to reduce the number of powerline related bushfires in the future, thereby helping to avoid harm to human life and property.
- Total annual powerline related fire starts have reduced from the 2006-10 historical average of 870 to be consistently below 650 since the introduction of the risk weighted f-factor scheme in 2016/17. However, more data is needed to confirm this trend and account for the long-term seasonality of the weather.
- Key components of PBSP have been delivered within the allocated budgets and timeframes, with the PRF and LIAF delivered ahead of schedule. REFCL costs are anticipated to amount to approximately double the amount originally estimated by the Taskforce due to technical and cost uncertainties associated with the first-time use and implementation of this technology for bushfire safety purposes.
  - The economic impact on consumers from customer-funded PBSP activities has surpassed initial forecasts by the Taskforce. While the Victorian Government cannot directly influence the amount of costs distribution businesses (DBs) are allowed to recover, it is committed to limiting the impact of the investment on consumers and continues to review regulations in relation to the rollout of infrastructure upgrades against intended outcomes.
- Reduced reliability outcomes have been observed on feeders of REFCL protected zone substations (ZSSs) for sustained faults where REFCLs may trip the entire line causing an outage for all customers supplied by the powerline. Compatibility issues between in-service REFCLs and some existing equipment are being addressed by DBs to achieve better fault detection.

Objective 2: Operate network assets so as to prevent bushfire starts at the times and locations of greatest risk, whilst minimising disruptions to customer supply

- The proportion of customers affected by outages on Total Fire Ban (TFB) and Code Red days due to altered safety settings affected by outages has not changed significantly since the start of the PBSP.
- The average period for which supply was lost by customers who were affected by the PBSP's altered safety settings for network protection devices appears to be trending upwards. However, more data is needed to confirm this trend over future years and determine whether supply reliability has been adversely impacted by the enhanced safety settings on days of extreme fire risk.
- Feedback from Powercor and AusNet Services (AusNet) suggests that the introduction of the f-factor scheme has positively affected network operational practice and associated safety outcomes. The f-factor scheme prompted the collection of reliable data on bushfires and their causes, which has since been used to enhance operational settings and support targeted reduction of fire starts. The scheme has also raised the profile of bushfire risk within the organisations of the DBs and has helped shape their asset management strategies.

Objective 3: Ensure businesses invest in those new and replacement assets needed to achieve a heightened bushfire risk standard at least cost

- Since 1 January 2012, 1,288 single-wire earth return (SWER) ACRs were installed under the PBSP commitment, which is in line with the 1,300 ACRs anticipated at the start of the program.
- DBs are making good progress with the installation of REFCLs. By 30 June 2020, 20 ZSSs had been REFCL protected across the state, including 17 mandated ZSS which had achieved regulatory compliance. The delivery of tranche two REFCLs is well advanced and planning for tranche three is also underway.

- During the 2019-20 summer at least four instances could be identified where REFCL technology prevented a fire start from a powerline fault on a TFB day, confirming that REFCLs are effective at preventing ignitions in high fire risk situations.

Objective 4: Bring forward the replacement of those Powerlines which currently pose the most severe bushfire hazard without imposing additional costs on consumers

- The PRF facilitated the replacement of 733.6km of bare-wire powerlines without imposing additional costs on consumers. The total amount of powerlines replaced is at least 100km lower than what was originally anticipated by the Victorian Government, likely because a large proportion of powerlines were undergrounded rather than insulated. Undergrounding powerlines is more expensive that insulating them, but it reduces the ignition likelihood associated with those powerlines even further.
- The PRF investment has expedited the relative bushfire risk reduction in areas of highest bushfire risk across Victoria. Furthermore, the level of risk reduction achieved in these areas is well above average and is expected to increase even further once all mandated ZSSs have been REFCL protected.

Objective 5: Mitigate the risks caused by program-related power outages for people who are dependent on power for their health and wellbeing

- The LIAF delivered generators to 343 residential care facilities (RCFs) across the state.
- This provided backup power supply for 15,937 vulnerable Victorians. These numbers have significantly exceeded earlier targets for the project.

Objective 6: Improve the cost effectiveness of the broader PBSP, and reduce unintended negative consequences, by obtaining new and better information

- PBSP funded research outcomes were critical to the success of the entire program. REFCL trials provided a world-first proof of concept for the use of REFCL for bushfire mitigation purposes, paving the way for their widespread deployment. They also helped identify the necessary performance standards to achieve the desired bushfire risk reduction. Improvements to the fire loss consequence mapping capability in combination with the development of the RRM ensured that infrastructure upgrades targeted areas of highest risk and with the highest return on investment.
- REFCL and Early Fault Detection (EFD) technology are now being applied in international markets such as the United States and Asia. The PBSP and the research conducted with the help of the R&D Fund have positioned Victoria at the forefront of bushfire expertise, creating a pool of knowledge and experience which is expected to continue to bring benefits to Victorians and other jurisdictions beyond the duration of the program.

3 Introduction

3.1 Scope of the benefits realisation review

Program elements under review

The benefits realisation review focuses on three of the initiatives that make up the PBSP:

- The Network Assets Project;
- The PRF; and
- The R&D Fund.[3]

In addition, the f-factor Scheme (described in Section 4.2) and legislative amendments made to facilitate PBSP activities were also considered.

Purpose of the benefits realisation review

The purpose of the benefits realisation review is to examine the extent to which the PBSP objectives and benefits anticipated by the Taskforce and the Victorian Government have been or will be met by the end of the program in 2023 within the parameters set by the VBRC, the Taskforce and the Victorian Government.

Approach to developing the benefits realisation review

Aurecon adopted a four-stage approach to conducting the benefits realisation review:

1. An agreed **analytical framework** with DELWP that was cognisant of timeframe, budget and the complexities of the program.
2. A **literature review** of key PBSP documentation was then undertaken to identify baseline parameters and determine the focus of stakeholder consultation interviews.
3. Following the initial literature review, Aurecon conducted a **stakeholder consultation process** with representatives from different stakeholder groups affected by or involved in the PBSP delivery.
4. **Analysed data and insights** obtained through the literature review, stakeholder consultation sessions and public information to develop this report.

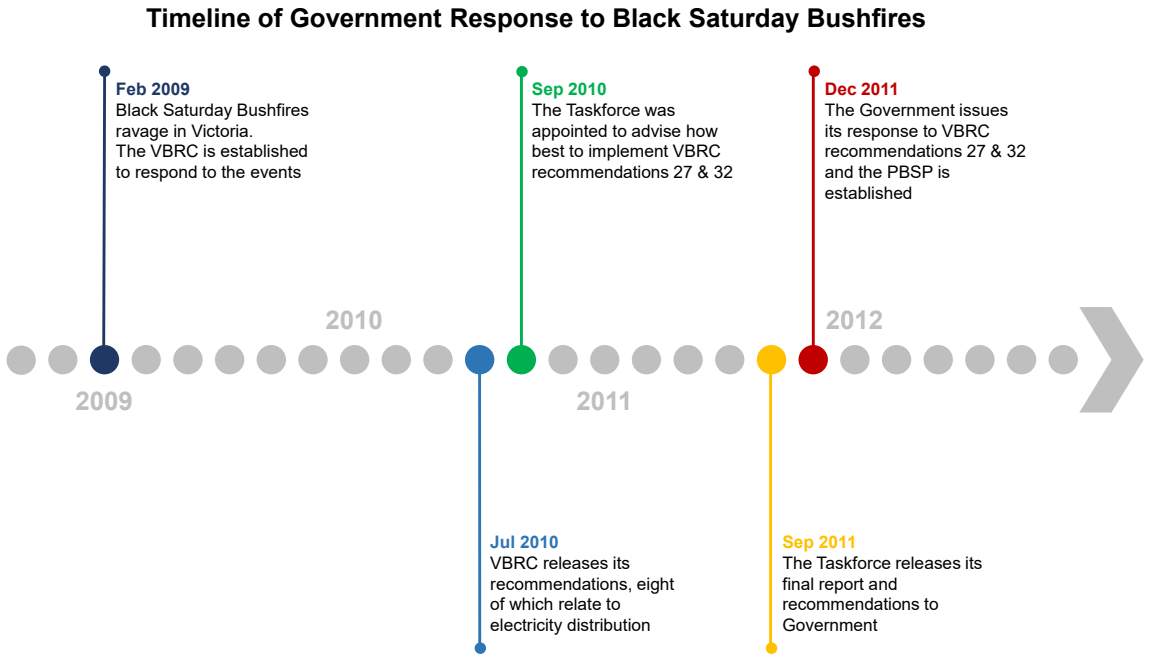
Each stage of the approach and boundaries of our analysis are discussed in further detail in Appendix A.

3.2 Background and context

Figure 1 below provides a schematic overview of the catalyst and chronology that led to the establishment of PBSP. Each of the elements included in the timeline is discussed in further detail below.

[3] The LIAF has been excluded from the scope of the assessment, as it was completed ahead of schedule in 2018 and the benefits linked to its delivery have already been assessed (Powerline Bushfire Safety Program, 2018a). The Network Operations Project, which provides oversight of operational requirements for DBs to apply new safety settings for ACRs throughout each fire season, is only a small component of the overall PBSP scope and has no formal budget allocation. It has therefore not been discussed as an individual project in this Review but has been incorporated into the overall assessment of benefits for the program.

Figure 1: The catalyst and chronology that led to the Powerline Bushfire Safety Program



3.2.1 The Black Saturday Bushfires

The 2009 Black Saturday Bushfires were some of the most destructive bushfires in Australia's history, resulting in tragic loss of life and property. Approximately 400 fires were recorded across several Victorian communities including, but not limited to, Beechworth, Bendigo, Bunyip and Kinglake. This led to 173 fatalities (of which 159 were due to fires started from powerlines), 414 injuries, 2,029 homes and 61 businesses destroyed. The Insurance Council of Australia has estimated that the cost of damages for the Victorian community due to the Black Saturday Bushfires was over $1 billion.[4]

3.2.2 Establishment and findings of the Victorian Bushfires Royal Commission

The VBRC was established on 16 February 2009 to investigate the causes of and responses to the Black Saturday Bushfires. Follow 12 months of investigation and consultation, the VBRC found that of the 15 most damaging fires five were associated with the failure of electricity assets (2009 Victorian Bushfires Royal Commission, 2010).

The VBRC also found that there was scope to further improve the policies, systems and structures needed to ensure that all relevant stakeholders are able to make informed and effective decisions about their response to bushfires in a way that protects life and minimises loss.

In July 2010, the VBRC delivered a total of 67 recommendations to the Victorian Government, eight of which related to improvements or upgrades to the Victorian electricity network. The Victorian Government accepted all 67 recommendations but recognised that two powerline-related recommendations would require further analysis to identify how they could best be addressed.

3.2.3 Formation of the Powerline Bushfire Safety Taskforce

Following the release of the findings from the VBRC, the Powerline Bushfire Safety Taskforce (the Taskforce) was established to investigate how to effectively and efficiently implement Recommendations 27 and 32, which are outlined below.
The Taskforce included members of fire-affected communities, representatives from the Country Fire Authority (CFA) as well as DBs and was supported by a Stakeholder Reference Group and a Victorian Government Interdepartmental Working Group. The Taskforce was required to:

[4] For more information, please see: https://knowledge.aidr.org.au/resources/bushfire-black-saturday-victoria-2009/

- Investigate all potential options to address Recommendations 27 and 32, and to the Victorian Government to provide advice to the Victorian Government on implementation measures and procedures based on the findings of the investigations.
- Consider and balance an achievable reduction in powerline bushfire risk against any adverse effects the associated actions could have on electricity customers, landowners and the environment.

Recommendation 27: progressive replacement of 22kV and SWER powerlines

The State amend the Regulations under Victoria's *Electricity Safety Act 1998* and otherwise take such steps as may be required to give effect to the following:

- the progressive replacement of all SWER (single-wire earth return) power lines in Victoria with aerial bundled cable, underground cabling or other technology that delivers greatly reduced bushfire risk. The replacement program should be completed in the areas of highest bushfire risk within 10 years and should continue in areas of lower bushfire risk as the lines reach the end of their engineering lives
- the progressive replacement of all 22-kilovolt distribution feeders with aerial bundled cable, underground cabling or other technology that delivers greatly reduced bushfire risk as the feeders reach the end of their engineering lives. Priority should be given to distribution feeders in the areas of highest bushfire risk.

Recommendation 32: disabling or adjustment of powerline reclose functions

The State (through Energy Safe Victoria) require distribution businesses to do the following:

- disable the reclose function on the automatic circuit reclosers on all SWER lines for the six weeks of greatest risk in every fire season
- adjust the reclose function on the automatic circuit reclosers on all 22-kilovolt feeders on all total fire ban days to permit only one reclose attempt before lockout.

3.2.4 The Taskforce's recommendations and the formation of the PBSP

In its Final Report, of 30 September 2011, the Taskforce recommended a package of measures for Victorian Government consideration with six recommendations (see Appendix B). The Victorian Government released its response to the Taskforce recommendations in December 2011. It accepted all recommendations and committed $750 million (2011 dollars) towards PBSP, which commenced in 2012 with the following projects:

- **Network Assets Project** that required DBs to install ACRs and REFCLs across the State over the next decade.
- **Network Operation Project** that required DBs to adjust the settings of ACRs in rural Victoria on TFB and Code Red days.
- **Powerline Replacement Fund** for a program of powerline conductor replacement.
- **Research and Development Fund** to support research into identifying cost-effective risk reduction technologies and procedures.
- **Local Infrastructure Assistance Fund** to provide support for people and communities that required practical solutions for when power is disrupted.

4 Overview of PBSP initiatives

This chapter provides and overview of the five bushfire safety elements under review and the tasks and activities that were undertaken to refine the scope and ensure targeted delivery.

4.1 Research and Development Fund

Summary of key points

- The R&D Fund was established to facilitate an ongoing research program to improve understanding of powerline related bushfires and underpin the delivery of network safety upgrades.
- A thorough process was undertaken to identify priority research areas including a scan of international bushfire-related R&D developments in 2013 and a multi-organisational roundtable forum convened by PBSP in 2012-13. This process led to a total of 15 projects from seven focus areas being supported through the R&D Fund.

4.1.1 Overview of the Research and Development Fund

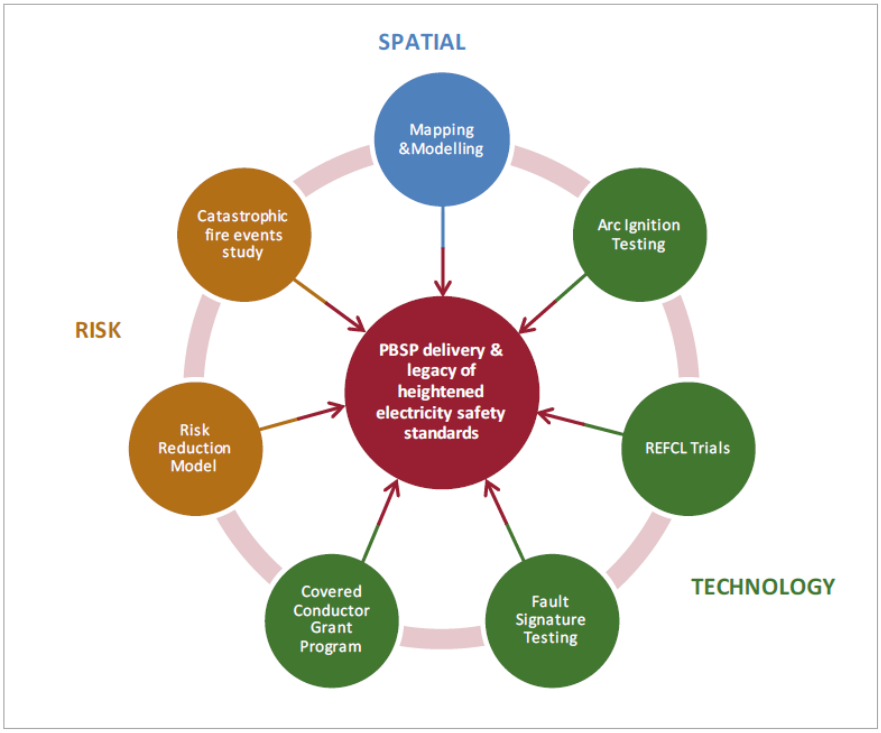
The R&D Fund was established to facilitate an ongoing research program to improve knowledge and understanding of powerline related bushfires and new technologies that can reduce bushfire risk from powerlines. Up to $10 million of Victorian Government funding was available to fund R&D activities within the first five years of PBSP to enable research outcomes and inform program decisions.[5] Bushfire mapping and arc ignition research were initially identified as priority projects to receive appropriations through the R&D Fund.[6]

4.1.2 Project delivery

Priority research areas were further refined following a scan of international bushfire-related research developments in 2013 and a multi-organisational roundtable forum convened by PBSP in 2012-13. The outcomes from these discussions were captured in an integrated R&D Plan. This process identified seven focus areas for the R&D Fund as illustrated in Figure 2, which includes the priority areas identified by the Taskforce and in the PBSP Business Case.

[5] This is consistent with the Taskforce's Recommendation 4, which suggested that the Victorian Government provide annual funding of no less than $2 million for five years to improve the capacity for ongoing research and development.
[6] Additional research proposals were to be considered with the remainder of the funding based on research needs identified by the PCB (Ernst & Young, 2012, p.54). However, some flexibility regarding these processes was suggested, to enable the PCB to test the market for new ideas.

Figure 2: Focus areas of the R&D Fund



Source: Powerline Bushfire Safety Program, 2015.

A total of 15 projects were supported through the R&D Fund (Powerline Bushfire Safety Program, 2019, p. 31). A sample of these projects are outlined below, with more detail provided in Appendix C.

- **Arc ignition research:** In 2011-12 Energy Safe Victoria (ESV) received funding to study arc-ignition, specifically metal-metal arcs near dry grass. The aim was to determine how arcs behave, how they ignite fuel and the performance required to prevent fires under these circumstances.
- **REFCL trials:** Trials of REFCLs were conducted at two different ZSS to determine their potential to detect and contain faults on 22 kV lines and to identify optimum performance standards for effective bushfire mitigation.
- **Vegetation conduction and fault signature testing:** A testing program was conducted at Springvale ZSS where different types of vegetation were brought into contact with electrical equipment under conditions that exist on days of high bushfire risk. The aim of this project was to identify fault signatures and fire probability for different vegetation types.
- **Early Fault Detection project:** Funding was provided to IND Technology to progress and trial their EFD technology to determine whether the system is capable of correctly identifying faults on SWER lines. EFD trials on parts of the Powercor and AusNet networks indicated that the technology could cut fire-risk on rural SWER lines and support pre-emptive asset replacement and maintenance.
- **Bushfire mapping and risk modelling:** Bushfire risk modelling and mapping capabilities have been significantly enhanced to account for fire loss consequence, fire ignition likelihood, and fire response complexity. These technical innovations have helped to support analysis, planning and reporting across the PBSP.

4.2 F-Factor Scheme

Summary of key points

- The f-factor Scheme was introduced to address the lack of formal incentives for DBs to refine their risk management approach and lower the number of network ignitions.
- Review and monitoring of initial outcomes linked to the scheme led to a revision of the f-factor Scheme to provide further incentive for DBs to focus on the prevention of ignitions occurring at times and in places of highest bushfire risk.
- Bushfire mapping and risk modelling capabilities supported through the R&D Fund were utilised to design the revised f-factor Scheme.

4.2.1 Overview of the f-factor Scheme

Following the Black Saturday Bushfires, amendments were made to the *National Electricity (Victoria) Act 2005* to introduce the f-factor Scheme to encourage improvements in the management of powerlines. Prior to the implementation of this scheme there were no formal economic incentives in place to lower the number of network ignitions and influence the behaviour of DBs in relation to their risk management approach.

Before the incentive scheme was introduced, DBs were not required to accurately track and report the number of fires started by their distribution assets, which made it difficult to establish trends and develop targeted mitigation strategies.

4.2.2 Project delivery

The initial f-factor Scheme

The initial f-factor Scheme, which was modelled on the existing Service Target Performance Incentive Scheme, set an annual powerline related ignitions benchmark for each DB based on a historical five-year average. DBs were rewarded or penalised $25,000 for every fire start above or below their benchmark.[7] This Scheme, which commenced on 1 January 2012, treated all fires as equal irrespective of risk difference associated with the location or weather.

A Victorian Government review of the scheme's effectiveness found that treating all ignitions as equal and imposing the same penalties for fires in high and low risk areas failed to reduce the overall number of fires (refer Table 3)[8] and drive targeted bushfire risk reduction (Powerline Bushfire Safety Program, 2016, p. 14). It also found that the initial f-factor Scheme provided little incentive for DBs to achieve the largest possible bushfire risk reduction from the deployment of network protection technologies, especially REFCLs.[9]

A change to the f-factor Scheme was therefore proposed by the Victorian Government that would be based on a targeted risk reduction approach to direct investment towards operational improvements in high bushfire risk areas.

[7] The f-factor Scheme was thus anticipated to balance costs to DBs and consumers over the long term.
[8] It is noted that the number of fires is heavily dependent on the weather. Hence, a weather weighted number would give a better indication of success or failure of the original scheme, as would a longer timeframe.
[9] Since fire starts in high risk areas did not attract a higher penalty than fire starts in low bushfire risk areas, it was concluded that this was likely to distort the decisions DBs would make around when and how they would choose to operate the devices (Powerline Bushfire Safety Program, 2016, p. 14).

Table 3: Network fire starts under 2012 F-Factor Scheme

Item	Citipower	Powercor	Jemena	AusNet	United Energy
Benchmark	***30.4***	***401.8***	***56.8***	***256.8***	***124.2***
2012 Ignitions	30	303	42	178	85
2013 Ignitions	33	498	91	176	127
2014 Ignitions	31	463	84	182	214
2015 Ignitions	14	345	54	120	102
2012-15 Average	**27**	**402.3**	**67.8**	**164.0**	**132.0**

Source: Powerline Bushfire Safety Program, 2016. f-factor Incentive Scheme: Regulatory Impact Statement.

Revision of the f-factor Scheme

A Regulatory Impact Statement (RIS) was prepared by the Victorian Government outlining options to improve the f-factor Scheme (Powerline Bushfire Safety Program, 2016).

The Victorian Government published the 'f-factor Scheme order 2016' in December 2016, which revoked the previous f-factor Scheme. At the same time the fire starts reporting and evaluation period was changed from calendar years to financial years to encompass a whole fire season within a single reporting period. The revised scheme would take effect in the 2016-17 financial year with a six-month transition period from January 2016 to June 2016 to close out the previous arrangement. The current f-factor Scheme has the following features:

- Applies ignition risk unit (IRU) weightings based on the location and geography of the fire start and the Fire Danger Rating at the time of the ignition;
- Compares the aggregated annual IRU score for each DB to a benchmark target based on a four-year historical average of the DB's network ignitions performance;
- The DBs are rewarded or penalised based on the difference between their annual benchmark and actual annual IRU score; and
- Benchmarks are adjusted at set intervals to account for new safety measures already paid for by consumers which are expected to deliver reductions in fire starts.

Data from a RRM developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Dunstall S, Towns G, Huston C and Stephenson A, 2016) is used to adjust annual benchmarks based on the extent to which new protection technologies are estimated to deliver reductions in fire starts (Powerline Bushfire Safety Program, 2016, p. 27). Similarly, the improved bushfire mapping and modelling capability supported through the R&D Fund was utilised to determine the weighting metrics to be used for the location of each fire start. This highlights how research supported through the R&D Fund is further contributing to improve safety outcomes.

The revised f-factor Scheme incentivises DBs to focus on ignitions occurring at times and in places of highest bushfire risk.

4.3 Legislative amendments

Summary of key points

- Following a review of progress made against PBSP objectives and targets in 2014-15, a series of legislative amendments were enacted in order to provide DBs with sufficient incentive to undertake the necessary network safety upgrades.
- Without the legislative amendments it is improbable that the current objectives and targets of PBSP would have been achieved within the 10-year timeframe.

4.3.1 Overview of the legislative amendments

A series of legislative amendments were enacted in order to provide DBs with sufficient incentive to invest in the network safety upgrades required to achieve the targets and objectives of the PBSP (Box 1).

Box 1: Rationale for legislative amendments

The benefits from improved powerline bushfire safety have the characteristics of a public good i.e. the benefits of improved bushfire safety are not limited to a particular DB and its customers, but to individuals and businesses that reside outside of a given distribution area and also benefit from reduced bushfire risk.

Because the full benefits of improving powerline bushfire safety do not accrue directly to the DBs, the incentives for improving powerline bushfire safety are weak. In the absence of additional incentives to invest in bushfire safety, DBs may not have invested to the level considered appropriate by the Victorian Government.

4.3.2 Project delivery

Following a review by PBSP of the measures implemented by DBs up until 2014-15, and new information that had become available from trials of protection technologies, the Victorian Government concluded that under the existing regulatory regime, the timely and comprehensive rollout of assets was unlikely. It was decided that additional regulations would be required to implement the Taskforce's recommendations (ACIL Allen, 2015, p. ix).

Regulatory Impact Statement

The Victorian Government commissioned a RIS that was prepared by ACIL Allen Consulting in November 2015 to outline options and associated costs to address the problem identified above.

In the RIS, the options were evaluated based on data obtained from previous assessments, including the reports prepared by the VBRC and the Taskforce, revised data and costs provided by the DBs, relative bushfire risk reduction calculations based on the RRM, stakeholder consultation sessions, REFCL performance data from international experience and trials at Frankston South ZSS as well as a range of other documentation (ACIL Allen Consulting, 2015, p. 65).

A detailed cost benefits analysis was prepared for the seven options by ACIL Allen Consulting, which identified the preferred solution to be a combination of amending the regulations to:

- Enhance the network protection for polyphase powerlines;
- Enhance the network protection for SWER powerlines; and
- Require powerlines in declared areas to be put underground or insulated.

Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016

Based on the analysis outlined in the RIS, the Victorian Government enacted the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* on 1 May 2016, that legislated the deployment of protection technologies and replacement of bare-wire powerlines. Key amendments to the regulations included:

- Installation of remotely controlled ACRs across all SWER lines in Victoria by 31 December 2020.
- Provision of heightened protection (consistent with REFCL performance) for 22kV lines at 45 Zone Substations by 30 April 2023, in three milestone delivery tranches:
  - Tranche 1 delivery by 30 April 2019;
  - Tranche 2 delivery by 30 April 2021; and
  - Tranche 3 delivery by 30 April 2023.
- Obligation to ensure that from 1 May 2016 any line replaced or constructed in any of the 33 Electric Line Construction Areas (ELCAs) is covered or placed underground.

While the regulations specified which ZSS had to be REFCL protected, they provided DBs with flexibility in relation to the sequence of the works. Each ZSS was allocated between one and five points based on the potential that REFCL protection of the ZSS would have to reduce bushfire risk (with five being the highest potential to reduce bushfire risk). Each of the three tranches outlined above had to achieve an aggregate value of points through the completion of REFCL protection for relevant ZSS. However, the DBs could choose which ZSS they would target and when, as long as they would meet their prescribed number of points by the specified completion date for each tranche.

Amendments to the Electricity Safety Act and enactment of the Electricity Safety (Bushfire Mitigation Duties) Regulations 2017

The *Electricity Safety (Bushfire Mitigation Duties) Regulations 2017* as well as amendments to the *Electricity Safety Act 1998* were introduced in 2017 to ensure that DBs delivered the enhanced bushfire safety obligations specified above on time and to the correct standard. They gave the Minister for Energy, Environment and Climate Change or ESV the power to seek significant civil penalties against the DBs as a measure of last resort if the target dates and associated operational standards were not being met.

If DBs fail to meet the prescribed requirements without obtaining an exemption or time extension from ESV, they face significant financial penalties (in the millions of dollars). The penalties increase further for each additional day the DBs fail to comply with the obligations.

4.4 Network Assets Project

Summary of key points

- Extensive reviews and consultation, assisted by advanced bushfire modelling, revealed that 90 per cent of relative bushfire risk reduction from REFCL deployment can be achieved by targeting 45 selected ZSS.
- The installation of new generation ACRs was extended from deployment in extreme and very high fire loss consequence areas to cover Victoria's entire SWER network.

4.4.1 Overview of the Network Assets Project

The Network Assets Project included the deployment of network safety devices that reduce bushfire risk through the detection of faults on powerlines within milliseconds. Following an analysis of relevant protection devices, the Taskforce recommended the deployment of two technologies across the rural electricity network:

- REFCLs at all ZSSs with 22kV powerlines. REFCLs had been used in Europe to improve supply reliability, but utilising REFCLs for bushfire safety purposes was a new concept introduced by PBSP.
- New generation ACRs on SWER powerlines in extreme and very high fire loss consequence areas. Sensitivity settings on these devices could be adjusted remotely to respond to heightened bushfire risk conditions.

4.4.2 Project delivery

SWER ACR deployment

SWER ACR deployment was focussed on installing remotely controlled ACRs on Powercor's and AusNet's networks. AusNet received separate funding (approval to pass on costs to consumers) as part of the 2011-15 Electricity Distribution Price Review (EDPR) period prior to the PBSP announcement to install ACRs on its SWER network by 2015. The PBSP funding commitment was thus directed at the deployment of ACRs on Powercor's network, which was split into two stages:

- Priority deployment of 178 ACRs in areas of highest fire risk consequence as directed by ESV in April 2012; and
- Deployment of additional ACRs between 2016 and 2020 to ensure the remainder of the SWER network was protected.

The priority deployment of ACRs by Powercor targeted SWER powerlines in the highest fire loss consequence areas. Installation of the remaining ACRs to fully protect Powercor's SWER ACR network started in 2016 and finished in April 2020, several months ahead of schedule.

REFCL deployment

The original plan to install REFCLs at all of the 108 ZSSs with powerlines extending into rural Victoria was based on the following assumptions:

- The average cost of protecting a ZSS with a REFCL and associated works is approximately $4 million (Powerline Bushfire Safety Taskforce, 2011, p. 68); and
- The protection of each ZSS would provide an equal risk benefit to Victorians.

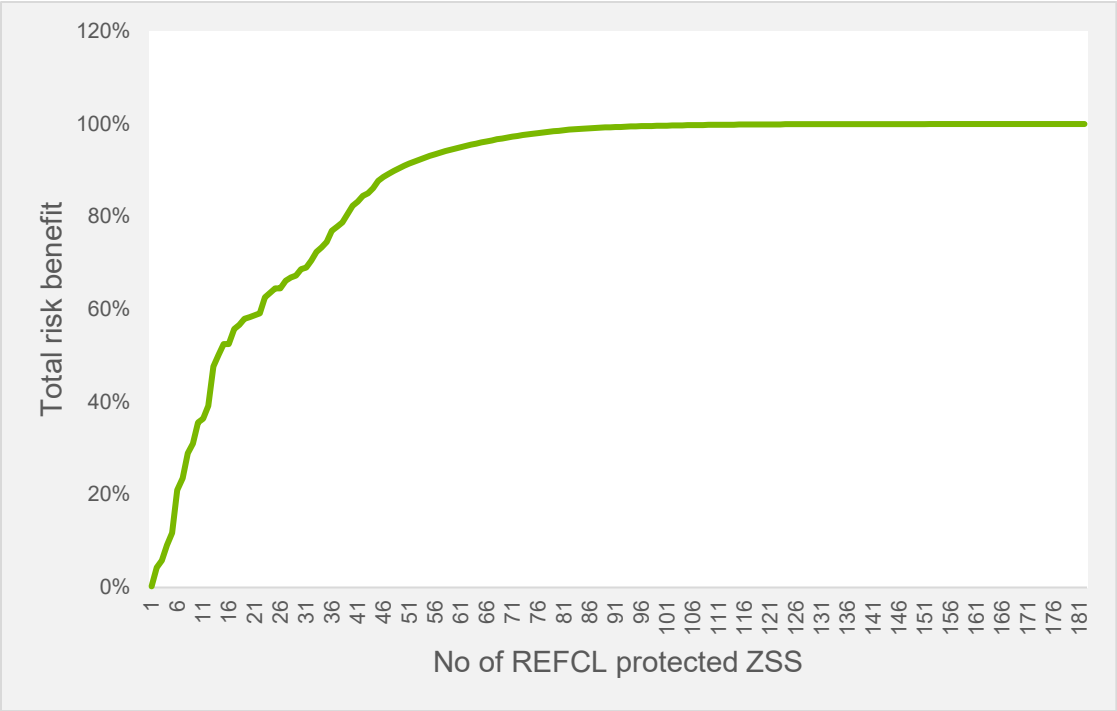
Following a thorough review of the REFCL rollout progress in 2014-15 and analysis of additional data collected on REFCL function and deployment, PBSP concluded that:

- Costs for the installation of REFCLs at the proposed ZSS would be higher than originally thought; and
- Some of the 108 ZSSs were of lower priority than others because:
  - The corresponding powerlines are in low bushfire risk areas; or
  - The length of powerline to be protected is too short to justify the investment.

Risk benefit calculations were carried out by PBSP for the 108 ZSSs based on CSIRO's RRM. The calculations found that the risk reduction resulting from REFCL protection of a relatively small number of ZSS located in the highest consequence bushfire risk areas is significant. These calculations also found that 90 per cent of possible relative risk reduction due to REFCLs can be achieved by protecting only 45 selected ZSSs (see Figure 3).[10]

[10] Achieving the full risk benefit would require the protection of an additional 50 Victorian ZSSs.

Figure 3: Diminishing returns of REFCL deployment



Source: DELWP

Based on these calculations and new cost estimates it was concluded that the installation of REFCLs at 45 ZSSs with the highest risk benefit could be achieved within the available funds and in three milestone tranches, which was subsequently codified in the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* (refer Section 4.3.2).

Of the 45 ZSSs requiring mandated REFCL protection 22 are operated by AusNet, 22 are operated by Powercor and one is operated by Jemena.

4.5 Powerline Replacement Fund

Summary of key points

- The PRF was established to facilitate the replacement of bare-wire powerlines with undergrounded conductors, insulated overhead powerlines, or new conductor technologies in targeted high-risk areas in Victoria within a 10-year timeframe.
- Extensive fire loss consequence and ignition likelihood modelling was utilised in combination with operational knowledge to determine locations that should be targeted for powerline replacement in the areas of highest bushfire risk.

4.5.1 Overview of the Powerline Replacement Fund

The PRF involved the replacement of bare-wire powerlines with undergrounded or insulated powerlines in targeted areas across the State. Up to $200 million of Victorian Government funds was made available over a 10-year timeframe to fund the project to avoid imposing additional costs on electricity consumers. The PRF targeted only the highest bushfire risk locations to ensure the investment would provide the best value-for-money outcome.

4.5.2 Project delivery

Targeting of powerlines

To determine the locations to be targeted for powerline replacement, fire loss consequence and ignition likelihood modelling was used in combination with operational knowledge to identify the areas of highest bushfire risk. This process informed the selection of 33 ELCAs, with a total length of high voltage (HV) bare-wire powerlines of 3,477km.

PBSP in consultation with the Fire Services Commissioner, now the Emergency Management Commissioner, recommended 11 of these ELCAs to be targeted under the PRF as detailed below:

- Three high bushfire risk locations (Dandenong Ranges, Otway Ranges and Warburton District) were selected for initial powerline replacement in 2013, which was informed by risk reduction maps and models available at the time.
- 30 additional areas for HV powerline replacement were identified in 2015, following further refinement of PBSP's RRM and mapping capability. This was based on:
  - Fire loss consequence estimates under different conditions;
  - Fire carrying capacity of the environment;
  - Likelihood of ignition;
  - Proximity of population to ignition point;
  - Fire suppression capability; and
  - Quality of access / egress routes.
- Of these 30 additional areas, eight were classified as high priority areas, which together with the three initial areas were selected as the 11 target areas to be treated under the PRF.

Within the 11 priority areas, work under the PRF targeted 734km of HV powerlines owned by DBs. In addition, a smaller portion of the PRF investment was utilised to underground low voltage (LV) private overhead electric lines (POELs) in 33 Local Government Areas (LGAs)[11], with at least one POEL in a high fire loss consequence location.

Funding and delivery

The ownership of electricity assets and the regulatory framework in Victoria meant that DBs were ultimately responsible for undertaking the capital works under the PRF. For the HV powerline replacements within the 11 priority areas, AusNet and Powercor were invited to identify and cost individual projects. These projects were based on the risk reduction and operational considerations of the DBs. There was no requirement for DBs to undertake projects in all priority areas or to apportion funds to each geographic area.

Following the nomination of projects by the DBs, the Assessment Advisory Panel (AAP) of the PRF reviewed the project proposals against established criteria and recommend projects for funding. Once the funding recommendation had been accepted, DBs would receive a 'third party capital contribution' as defined in the *National Electricity Rules* to undertake the works.

To receive funding for the replacement of POELs, households and small businesses with uninsulated POELs located in the 33 LGAs with heightened bushfire risk exposure were considered eligible. POEL owners were invited to apply for a PRF grant to fund the undergrounding of their POELs.

[11] These are different to the 33 ELCAs.

5 PBSP benefits realisation assessment

This chapter examines the extent to which the anticipated program objectives have been achieved to date or are on track to be achieved by the end of the PBSP. The objectives include a program level objective and separate objectives for each of the five individual PBSP initiatives.

5.1 Evaluation criteria

Summary of key points

Separate program objectives and benefits were defined for the PBSP that could have been utilised as evaluation criteria to underpin the benefits realisation review. The PBSP objectives were viewed as being more appropriate for this purpose as they are:

- better aligned with the overall structure of the program, and
- incorporate all PBSP initiatives into the evaluation.

5.1.1 Program objectives

Six overarching program objectives were identified for PBSP (Powerline Bushfire Safety Program, 2013), which align with the program structure and include a program level objective (Objective 1) and separate objectives for each of the five individual initiatives (Objectives 2 to 6). Principal measures and key performance indicators (KPIs) were identified by PBSP for each objective to evaluate the extent to which the objectives were being met (Table 4).

Table 4: PBSP objectives and associated principal measures and KPIs

Objective	Principal Measure	KPI	Additional assessment criteria
Objective 1: Reduce the harm to human life and property from bushfires started by powerlines, within the parameters of: ▪ a $750 million program of works; ▪ 10 years duration ▪ no material reduction in electricity supply reliability.	Change in the relative risk (likelihood x consequence) of bushfires initiated by electricity distribution assets.	**KPI 1:** Relative reduction in state-wide powerline related bushfire risk.	Annual powerline related ignitions data. Performance against budget, timelines and supply reliability.
	Cost to consumers.	**KPI 7:** Economic impact of regulatory obligations ($) on consumers.	
Objective 2: Operate network assets so as to prevent bushfire starts at the times and locations of greatest risk, whilst minimising disruptions to customer supply.	Impacts on supply reliability.	**KPI 2:** Proportion of customers affected by outages on TFB and Code Red days due to altered safety settings.	Enhancing network operational practice.
		KPI 3: Average duration of outages.	
Objective 3: Ensure businesses invest in those	Number of network assets installed.	**KPI 4:** Number of ACRs installed since 1 Jan 2012.	

Objective	Principal Measure	KPI	Additional assessment criteria
new and replacement assets needed to achieve a heightened bushfire risk standard at least cost.		**KPI 5:** Number of additional devices (e.g. REFCLs) installed since 1 Jan 2012.	Risk reduction outcomes linked to network protection technologies.
Objective 4: Bring forward the replacement of those Powerlines which currently pose the most severe bushfire hazard without imposing additional costs on consumers.	Number of powerlines replaced.	**KPI 6:** Total kilometres of powerlines replaced.	Risk reduction outcomes linked to powerline replacement.
Objective 5: Mitigate the risks caused by program-related power outages for people who are dependent on power for their health and wellbeing	Number of vulnerable people provided with backup electricity supply.	**KPI 8:** Number of facilities provided with backup electricity capacity.	Not applicable
		KPI 9: Number of people using the facilities provided with backup generation.	
Objective 6: Improve the cost effectiveness of the broader Program, and reduce unintended negative consequences, by obtaining new and better information.	Research and development effectiveness.	**KPI 10:** Use of R&D findings/outcomes by PBSP projects (qualitative measure).	Not applicable
		KPI 11: Use of R&D findings/outcomes beyond PBSP delivery (qualitative measure).	

In addition, four program-level benefits were identified that would result from the realisation of the six objectives above (Powerline Bushfire Safety Program, 2013):

1. Reduce the potential for harm to people and property;
2. Maintain the reliability of power supply;
3. Reduce the impact of power disruptions on vulnerable Victorians; and
4. Add to the pool of knowledge that Victoria can use to improve power distribution and to manage bushfires.

Program objectives were utilised to give structure to the assessment as they incorporate whole-of-program achievements as well as efforts linked to the individual PBSP components into the evaluation. The KPIs set by the PBSP were used as primary assessment criteria.

Furthermore, a number of additional assessment criteria were identified by Aurecon to review the objectives and associated benefits of the program (Table 4). These either provide another means of assessing the relevant objective or bring the broader parameters that the program and its initiatives had to be considered within into play (e.g. budget, timeframes and supply reliability).

5.2 Achievement of the program objectives

This section evaluates the outcomes of the PBSP against the set of objectives and KPIs outlined in Section 5.1 above. Where applicable, we have distinguished between benefits realised to date (30 June 2020) and benefits expected to be realised at the end of the program in 2023.

5.2.1 Objective 1: Reducing harm to human life and property

Summary of key points

- **KPI 1: Relative reduction in state-wide powerline related bushfire risk**

  PBSP has already achieved a significant reduction in powerline related bushfire risk across Victoria (which will reach up to 50 per cent by June 2023), with REFCLs being the largest contributor to this risk reduction. This is expected to reduce the number of bushfires in the future thereby helping to avoid harm to human life and property.

- **Annual powerline related fire starts**

  Annual f-factor ignitions data has shown encouraging results with respect to operational bushfire safety enhancements, particularly since the risk weighted scheme was introduced in 2016. Since 2016-17, annual fire starts have consistently been below 650, which is significantly lower than the 2006-2010 historical average of 870. Annual fire starts in HBRAs have also been trending downwards in recent years. More data is however needed to draw definitive conclusions and account for the long-term seasonality of the weather.

- **Performance against budget, timelines and supply reliability**

- Key components of PBSP have been delivered within the allocated budgets and timeframes, with the PRF and LIAF delivered ahead of schedule. Costs for the deployment of REFCLs are anticipated to be significantly higher than the $500 million (2011 dollars) the Victorian Government originally estimated due to technical and cost uncertainties associated with the first-time use and implementation of this technology for bushfire safety purposes.

- Reduced reliability outcomes for a small number of customers have been observed on feeders of REFCL protected zone substations (ZSSs) for sustained faults where REFCLs may trip the entire line causing an outage for all customers supplied by the line. Compatibility issues between in-service REFCLs and some existing equipment are being addressed by DBs to achieve better fault detection.

- **KPI 7: Economic impact of regulatory obligations on consumers**

  The economic impact on consumers as a result of customer funded PBSP activities has surpassed initial forecasts by the Taskforce. While the Victorian Government cannot directly influence the amount of costs distribution businesses (DBs) are allowed to recover, it is committed to limiting the impact of the investment on consumers and continues to actively monitor funding requests and advocate for consumers in all major funding decisions for PBSP related investments in safety. Further, regulations in relation to the rollout of infrastructure upgrades are continuously reviewed to ensure the intended outcomes are achieved.

Relative bushfire risk reduction

PBSP uses CSIRO's RRM which combines fire loss consequence and ignition likelihood data to calculate the relative bushfire risk reduction associated with PBSP treatments. It compares the risk of electricity distribution assets starting a bushfire before and after PBSP measures have been implemented. Table 5 below shows the cumulative relative reduction in state-wide powerline related bushfire risk, which is the main criterion used to determine if the PBSP measures have been successful at reducing bushfire related harm to people and property.

Table 5: KPI results linked to Objective 1

KPI Description	Result FY14	Result FY15	Result FY16	Result FY17	Result FY18	Result FY19	Result FY20	Target FY23
Relative reduction in state-wide powerline related bushfire risk	3.5 – 5.0%	15.7%	16.0%	19.8%	22.9%	32.5%	36.6%	48.1%[12]

Source: Powerline Bushfire Safety Program Annual Performance Reports

PBSP has led to a 36.6 per cent reduction in relative powerline related bushfire risk in Victoria to date. The fall in risk exposure was particularly significant from financial year 2018 to financial year 2019, coinciding with the first tranche of REFCLs being operational. This trend is expected to continue over the next three years as tranches two and three of REFCLs are completed and the associated benefits realised.

The current bushfire risk reduction target for the end of the 2022-23 financial year when the REFCL rollout is scheduled to be finalised (concluding the works that were part of the original funding commitment of the PBSP) is 48.1 per cent.[13] For context, the original $750 million PBSP package, comprising the deployment of approximately 1,300 ACRs, 108 REFCLs and more than 845km of powerline replacement, was projected to facilitate a relative risk reduction of approximately 64 per cent based on Taskforce estimates (Ernst & Young, 2012, p. 6).

Despite differences between the relative bushfire risk reduction forecasts anticipated by the Taskforce and current estimates for the end of the PBSP, it is evident that the program is on track to achieve a significant reduction in powerline related bushfire risk across Victoria and is contributing to reducing harm to human life and property.

Powerline related ignitions data

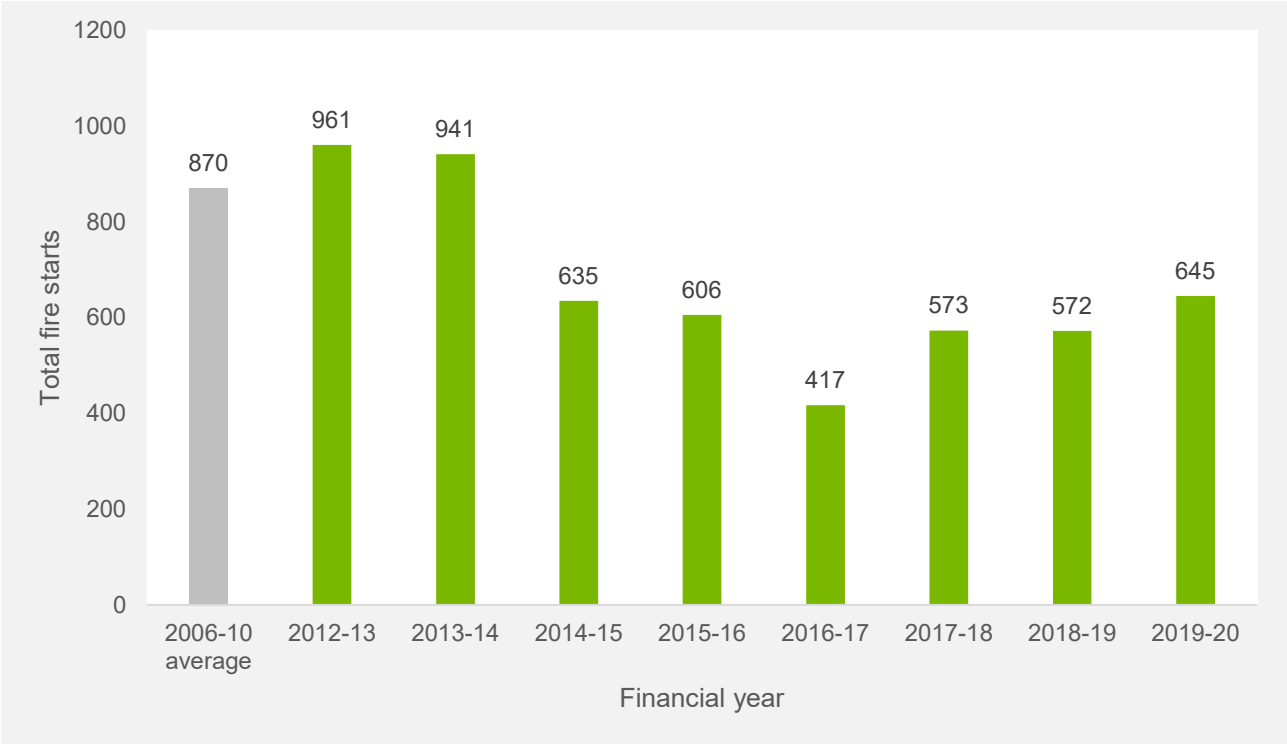
The introduction of the f-factor Scheme in January 2012 required DBs to report powerline ignitions data annually and compare it with historical benchmarks. The intention was that this would drive safety and operational improvements in high bushfire risk situations and encourage DBs to optimise operational settings for mandated protection technologies to obtain the full safety benefits.

Figure 4 shows the total reported powerline fire starts in Victoria for the financial years 2012-13 to 2019-20. The data collected to date suggests that overall powerline related fire starts are trending downwards. Annual fire starts for the years 2016-17 to 2019-20 were significantly lower than the historical average for the years 2006 to 2010.

[12] This is the current target for the end of the 2023 Financial Year when the REFCL rollout is scheduled to be finalised, concluding the works that were part of the original funding commitment of the PBSP.

[13] Further risk reduction is expected as a result of legislated powerline replacement within the 33 ELCAs. Current estimates predict a total relative risk reduction of 57.3 per cent once these additional steps have been completed. However, the timeframe for these activities is currently unclear and our consultations revealed that it could take up to 50 years until the full benefit can be realised.

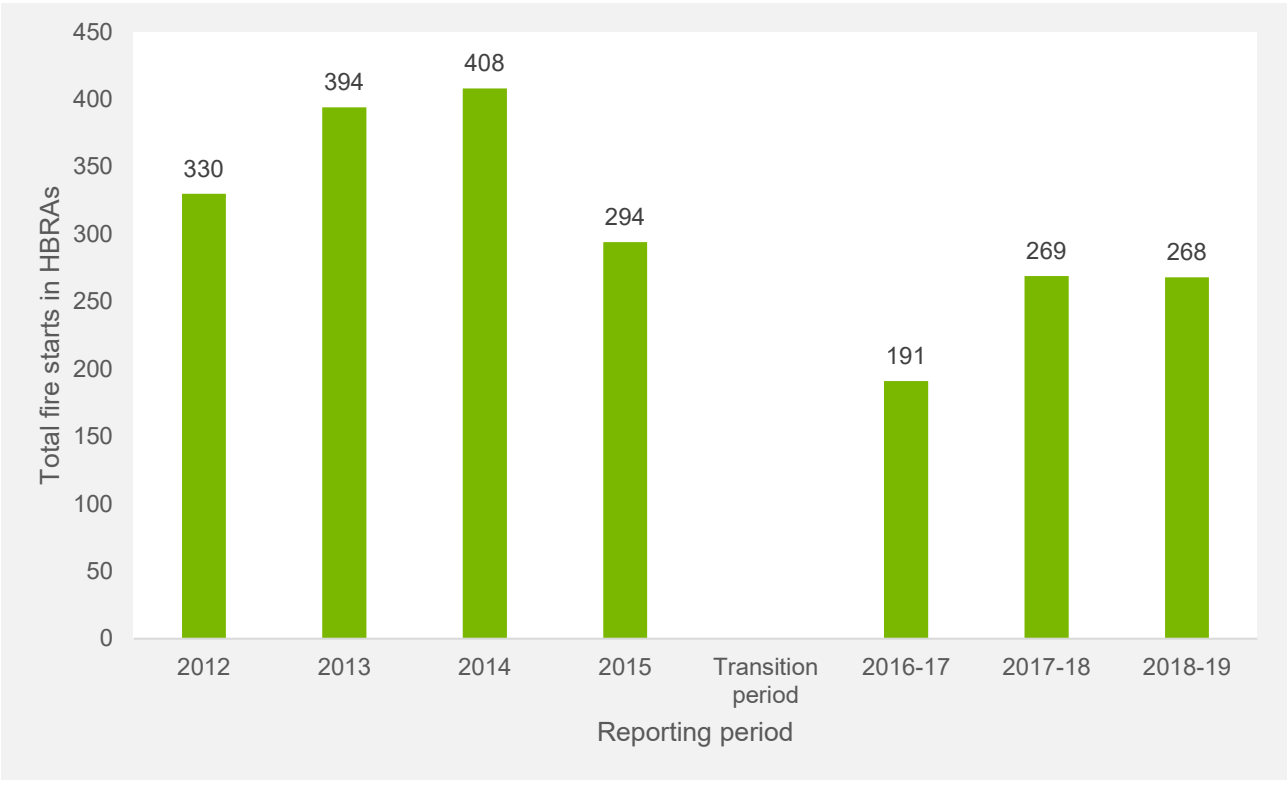
Figure 4: Reported powerline fire starts from 2012-13 to 2019-20



Source: AER.[14]

Figure 5 below shows the total number of fire starts in HBRAs since 2012 (fire starts for the six-month transition period between January 2016 to June 2016 are not shown). The average number of fire starts in HBRAs under the original f-factor Scheme (2012-15) is 356.5 compared with an average of 242.7 fire starts in HBRAs (including ELCAs and REFCL construction areas) under the revised scheme.[15]

Figure 5: Total number of fire starts in HBRAs



Source: AER – Victorian electricity distributors' fire start reports

[14] Validated fire starts data for 2019-20 was provided by ESV.
[15] Data for 2019-20 had not been provided at the time of writing.

The Figure above suggests that the revised f-factor Scheme may have helped to reduce the number of fire starts in HBRAs (noting that the deployment of new protection technologies and the replacement of bare-wire powerlines is also likely to have contributed to this reduction in fire starts). The Victorian Government has also agreed to undertake annual adjustments of benchmarks for the DBs to ensure that the DBs do not benefit financially (through incentive payments) from the rollout of new safety measures which are expected to continue to deliver reductions in fire starts in HBRAs over the coming years.

Representatives from AusNet, Powercor, ESV and DELWP that were interviewed for this Review agreed that the fire starts data collected since the beginning of the PBSP is encouraging particularly in the context of climate change and the apparent worsening of extreme weather events. However, participants were also mindful of the limited amount of data available to date and that the time span since accurate reporting of ignitions data started may not have been sufficient to have captured the long-term seasonality of the weather.

Performance against budget, timelines and supply reliability

The overarching program objective of reducing harm to human life and property was to be considered within the constraints of the $750 million funding commitment ($847.5 in nominal terms), 10-year duration and the goal to maintain the overall reliability in electricity supply.

Performance against budget and timelines

Table 6 below outlines the estimated costs and timelines for the four projects that received funding through the PBSP (see Appendix D for further details). Program management costs, which were included in the original funding commitment, are not displayed.

The three Victorian Government funded projects (LIAF, R&D Fund and PRF) were all completed on or under budget, with both the LIAF and PRF completed ahead of time, and the R&D fund completed on time. This is testament to the diligent management of PBSP and its commitment to maximise the value for money received by the Victorian community.

Table 6: PBSP's performance against budget and timelines (at August 2020)

Project	Budget ($million)[16]	Total cost ($million)	Performance against budget	Project status	Performance against timeline
LIAF	40.0	29.4	Under budget	Completed	Ahead
R&D Fund	10.0	8.3	Under budget	Completed	On time
PRF	188.5	186.2	On budget	Completed	Ahead
Network Assets Project	596.8	1,113	Over budget	Ongoing (targeted completion by May 2023)	On time[17]
Total	**835.3**	**1,336.9**			

Adapted from VAGO, 2020.

Performance against timelines

The delivery of the Network Assets Project is also expected to be finalised on time. The Rollout of ACRs was finalised in April 2020, several months ahead of the 1 January 2021 deadline specified in the *Electricity Safety Act 1998*. Similarly, the installation of REFCLs is on track with respect to the set dates for the three tranches of REFCL delivery, taking into account time extensions that were granted to AusNet for the compliance of their tranche 1 ZSSs in Kinglake and Woori Yallock.

At the start of the PBSP all associated infrastructure upgrades were expected to conclude by 2021-22 (Ernst & Young, 2012), so it could be argued that the Network Assets Project is actually expected to be finalised

[16] Nominal costs as outlined in the PBSP Business Case (Ernst & Young, 2012), excluding program management costs
[17] Based on the timeframes codified in the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016*

with a 10-month delay to its original 10-year delivery timeframe. However, much longer delays were prevented by PBSP through identification of market and regulatory failures that were discouraging DBs from proactively implementing bushfire protection measures and addressing them in the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016*.

In developing the amended legislation, the Victorian Government had to balance the risk of potentially experiencing another major bushfire if the REFCL rollout schedule was extended beyond May 2023 with the technical and cost uncertainties associated with a quick REFCL rollout.

Performance against budget

Total costs for PBSP are projected to be significantly higher than the original forecasts made by the Taskforce. This is solely driven by the Network Assets Project. All other projects were delivered within or under budget.

The cost of the Network Assets Project has been forecast to amount to $1.113 billion including $45 million spent on the deployment of SWER ACRs and $1.068 billion projected for the installation of all mandated REFCLs by May 2023 (Nous, 2020). This is significantly higher than the $500 million anticipated by the Taskforce in 2011 ($583 million in 2020 dollars)[18] and the direct cost of $349.9 million ($385 million in 2020 dollars)[18] forecast in the 2015 RIS (ACIL Allen Consulting, 2015) for the deployment of 45 REFCLs and 1,064 SWER ACRs.

The discrepancy is largely attributed to technical challenges faced by DBs while installing REFCLs as well as approximately $180 million of HV customer expenses to ensure REFCL compliance of their equipment, the scale of which was not anticipated at the outset of the project.

Some of the technical challenges associated with REFCL deployment that have contributed to the high installation costs are outlined below:

- Single source supply of REFCL technology that would meet the performance standards;
- Some ZSS requiring more than one REFCL;
- Lack of experience and know-how in relation to REFCL installations; and
- Ensuring compliance of the remaining network with the technology.

The tight timeframes for the rollout of REFCLs were further thought to have contributed to the high costs of the project. This transferred a large amount of risk to the DBs as they had to overcome technical and operational complexities ‘on-the-go’ as the rollout schedule did not allow for a review of procedures and potential adjustments between tranches. The timeline dictated that planning for Tranches 2 and 3 already had to commence before Tranche 1 was finalised.

Lower delivery costs might have been possible in a staged (i.e. slower) adaptive rollout, however this had to be balanced against the need to provide bushfire safety benefits to affected communities as soon as practicable to reduce the risk of future major bushfires.

R&D Fund expenses were under the $10 million originally committed by the Victorian Government. Consultations with DELWP revealed that some of the costs for the mapping and risk reduction modelling components are still tied up in contracts that DELWP will be using going forward. However, approximately $1.5 million of underspend from the R&D Fund was reallocated within PBSP to cover program management costs. This included funds to conduct other project evaluations or where other projects costs were slightly higher than anticipated.

Supply reliability

Overall supply reliability was not anticipated to be negatively affected by the rollout of the PBSP in the long run. Both ACRs and REFCLs were predicted to have a positive effect on supply reliability by limiting the number of “false alarms”, where a disruption to the electricity supply occurs when there was no need for it (Victorian Government, 2011, p. 4).

[18] Costs adjusted to 2020 dollars using the Consumer Price Index deflators for Melbourne as published at: https://www.dtf.vic.gov.au/state-financial-data-sets/macroeconomic-indicators

There is no evidence that the enhanced ACR safety settings have led to a significant deterioration in supply reliability when these settings are in operation. However, analysis and consultations revealed that a decline in supply reliability has been observed for a small number of customers, which has been attributed to the deployment of REFCLs. Initial evidence from ZSS that were REFCL protected prior to the 2019-20 bushfire season indicated that REFCLs have been able to limit the amount of interruptions in relation to temporary faults, but that supply interruptions associated with permanent or sustained faults have increased. This is because in some fault types REFCLs cause the feeder circuit breaker to trip the entire line instead of a single fuse operation that would isolate part of the line, which affects a larger number of customers.

DBs have identified compatibility issues between in-service REFCLs and some existing equipment, which may cause mal-operation or make it harder to locate faults when they occur (PSC, 2020). For example, AusNet's Distribution Feeder Automation system, used to isolate a faulted section of a feeder, is incompatible with in-service REFCLs. Similarly, traditional ACRs operating on REFCL protected networks are not able to differentiate between actual fault currents and increased current flows in healthy feeders due to REFCL operation.

The DBs are proactively exploring and implementing alternate technologies to achieve better integration of equipment and improved fault detection (PSC, 2020).

Economic impact of regulatory obligations on consumers

The economic impact of regulatory obligations on consumers is a measure for the total amount expended on PBSP activities that will be funded by consumers, such as expenses in relation to the Network Assets Project. By June 2019, this amount was $504.4 million (in 2011 dollars),[19] which was already higher than the $500 million projected by the Taskforce.

Customer research conducted by the Taskforce in 2011 found that on average, customers were willing to pay eight per cent more in electricity prices if there was no deterioration in supply reliability as a result of PBSP activities, and two per cent more if there was a noticeable deterioration in reliability. Subsequent modelling by the Taskforce estimated that the measures associated with the PBSP would lead to a maximum 0.9 per cent increase of average household electricity bills of all electricity customers (Powerline Bushfire Safety Taskforce, 2011, p. 8).

Revised modelling based on the total funding approved by the Australian Energy Regulator (AER) for the REFCL rollout found an average 2.5 per cent electricity bill increase for affected customers from 2017 to 2020 (Nous, 2020). Given that this analysis does not consider costs associated with ACR deployment, the average price increase for that period was likely slightly higher.

The Victorian Government and DELWP cannot directly influence the outcomes of funding proposals presented to the AER by DBs to cover their costs in relation to the deployment of REFCLs and ACRs. However, the Victorian Government is committed to limiting the impact of the investment on consumers and continues to actively monitor funding requests and approvals and review regulations in relation to the rollout of infrastructure upgrades.

5.2.2 Objective 2: Operate network assets to prevent bushfire starts at the times and locations of greatest risk

Summary of key points

- **KPI 2: Proportion of customers affected by outages on TFB and Code Red days due to altered safety settings**

  The proportion of customers affected by outages has not changed significantly since the start of the PBSP.

[19] Data for June 2020 was not available at the time of writing.

- **KPI 3: Average duration of outages**

  The average period for which supply was lost by customers who were affected by the PBSP's altered safety settings appears to be trending upwards. However, more data is needed to confirm these trends in future years and determine whether supply reliability has been adversely impacted by the enhanced ACR safety settings on days of extreme fire risk.

- **Enhancing network operational practice**

  Feedback from Powercor and AusNet suggests that the introduction of the f-factor Scheme has positively affected operational practice and associated safety outcomes. It initiated the collection of reliable data on bushfires and their causes, which has since been used to enhance operational settings and support efficient and targeted reduction of fire starts. The scheme has also raised the profile of bushfire risk within the organisations of the DBs and has helped shape their asset management strategies.

The KPIs outlined above relate to supply reliability information in relation to outages attributable to the enhanced safety settings prescribed for ACRs. This information will be discussed in the first part of this section. The second part of this section explores how the f-factor has contributed to enhance operational practice to achieve lower network ignitions in high bushfire risk settings across Victoria.

ACR Safety Settings

VBRC Recommendation 32 requires DBs to apply enhanced safety settings such as limiting the amount of reclose attempts on TFB and Code Red days in Victoria as outlined below.

Table 7: Safety settings and requirements

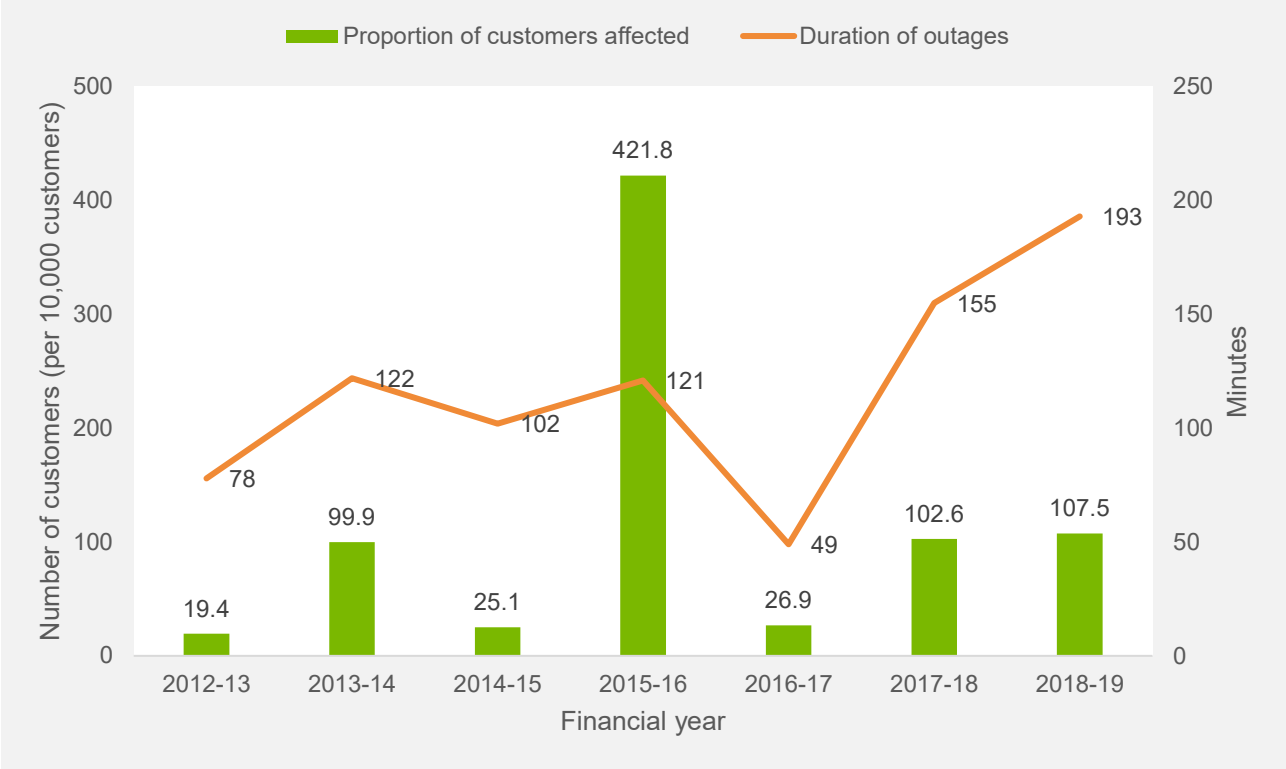
Area	TFB day	Code Red day
Rural powerlines in the worst areas (approx. 20% of rural powerlines)	Two fast protection operations	One fast protection operation
Rural powerlines in remaining areas (approx. 80% of rural powerlines)	One fast and one slow protection operation	One fast and one slow protection operation

Source: Victorian Government, 2011, p. 4

It was generally accepted that changing the operational settings of ACRs to minimise fire risk on high fire risk days could have an adverse impact on supply reliability for some electricity customers. The variations in the two KPI's utilised by PBSP to determine the impacts of the altered safety settings on supply reliability from 2012-13 until 2018-19 have been illustrated in Figure 6.[20]

[20] Data for 2019-20 was not available at the time of writing.

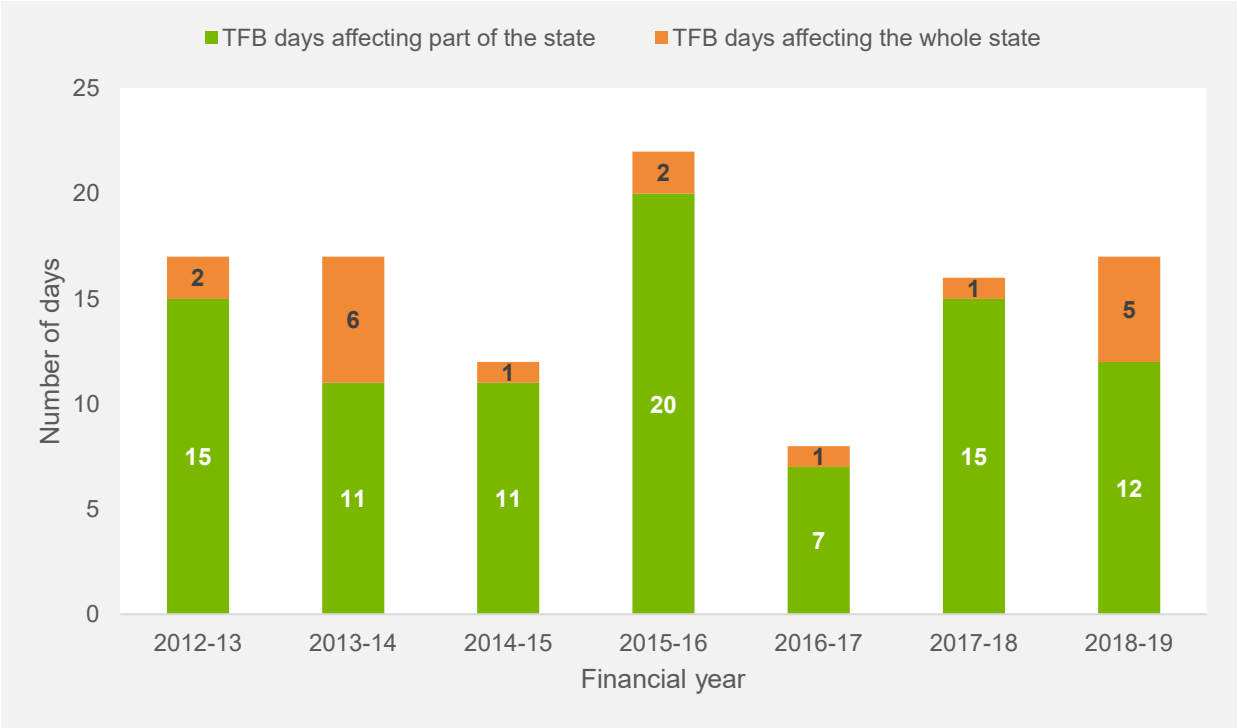
Figure 6: Proportion of customers affected by power outages and average duration of outages attributable to PBSP's enhanced safety settings



Source: Powerline Bushfire Safety Program, 2019

Figure 6 shows that the two indicators to measure supply reliability have varied considerably over the past seven years. This is partly because the number of outages linked to the enhanced safety measures of the PBSP and the number of people affected will be influenced by the number of TFB and Code Red days declared for a given bushfire season and the number of CFA Fire Districts covered by the declaration. For example, the 2015-16 season featured 22 TFB days as outlined in Figure 7, which is significantly higher than the average for the previous eight years and has likely contributed to the high proportion of customers affected by power outages in that year.

Figure 7: Number of TFB days declared for part of the state and the whole state per financial year



Source: Powerline Bushfire Safety Program, 2019

The duration of power outages in 2017-18 and 2018-19 (orange line in Figure 6) appears to have increased slightly in comparison with previous years without a similar trend being evident for the proportion of customers affected by power outages (green bars in Figure 6). Furthermore, the number of TFB days in 2017-18 and 2018-19 is comparable to the number of TFB days 2012-13 and 2013-14, which both featured a lower average duration in power outages.

The limited data available suggests thus that the average period for which supply was lost by those customers who were affected by the PBSP's altered safety settings is trending upwards whereas the proportion of customers affected has not changed significantly. However, it is worth remembering that heightened safety settings lead to location and isolation of more powerline faults, thereby preventing them from starting a fire. More data is needed to confirm these trends in future years and determine whether supply reliability has been adversely impacted by the enhanced ACR safety settings on days of extreme fire risk.

Enhancing network operational practice

While the DBs are obligated to install network protection devices as specified in the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016*, they are not required to operate them to achieve the greatest bushfire risk reduction. The desire to minimise supply disruptions and operational costs may act as opposing drivers for the DBs to seek maximum safety outcomes from the operation of REFCLs and ACRs. The revision of the f-factor Scheme to include risk-weighted ignitions targets has provided an opportunity to enhance operational practice to achieve the greatest safety benefit from protection technologies that have been rolled out across the network.

Feedback from Powercor and AusNet indicated that the revised f-factor has positively affected safety outcomes and influenced network operation and management strategies of the DBs. Other positive outcomes that have been observed in relation to the revised f-factor, include more detailed vegetation management and line maintenance in ELCAs. The DBs have further reported that the f-factor has raised the profile of bushfire risk within their organisations and has helped to shape their asset management strategies.

5.2.3 Objective 3: Investment in network assets to achieve a heightened bushfire risk standard at least cost

Summary of key points

- **KPI 4: Number of ACRs installed since 1 January 2012**

  1,288 SWER ACRs were installed under the PBSP commitment, which is in line with the 1,300 ACRs anticipated at the start of the program.

- **KPI 5: Number of additional devices (e.g. REFCLs) installed since 1 January 2012**

  Electricity distribution business are making good progress with the installation of REFCLs. By 30 June 2020, 20 REFCLs had been installed across the state, including 17 REFCLs at mandated zone substations which had achieved regulatory compliance. The delivery of tranche two REFCLs is well advanced and planning for tranche three is also underway.

- **Risk reduction outcomes linked to the Network Assets Project**

  During the 2019-20 summer at least four instances could be identified where REFCL technology prevented a fire start from a powerline fault on a TFB day, confirming that REFCLs are effective at preventing ignitions in high fire risk situations.

The Network Assets Project called on DBs to install new protection technologies in areas of heightened bushfire risk to detect and isolate powerline faults, thereby reducing the likelihood that faulty conductors lead to bushfires. The KPIs linked to this objective are thus the number of ACRs installed and the number of additional devices (e.g. REFCLs) installed.

Following a Victorian Government review of initial targets and timeframes for the deployment of protection devices the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016*, mandated the installation of REFCLs at 45 ZSSs by May 2023 and the deployment of remotely controlled ACRs to protect Victoria's entire SWER network by January 2021.

Number of ACRs installed

In total, 2,155 ACRs were installed between January 2012 and April 2020, including 1,288 SWER ACRs as part of the PBSP funding commitment, which is very close to the 1,300 ACRs anticipated at the start of the program. It was first thought that the PBSP funding would only cover SWER lines in extreme and very high fire loss consequence areas across the state. However, in combination with the installation of 525 SWER ACRs by AusNet as part of the 2011-15 EDPR period the deployment of 1,288 ACRs by Powercor actually completed the protection of Victoria's entire SWER network as required by the amended regulations.

Number of REFCLs installed

DBs are making good progress with the installation of REFCLs. By 30 June 2020, REFCLs had been installed at 20 ZSSs across the state, including REFCLs at 17 mandated zone substations which had achieved regulatory compliance. The delivery of tranche two REFCLs is well advanced and planning for tranche three is also underway. It is possible that the delivery of tranches two and three could be impacted by the timing of HV customers achieving REFCL compliance through hardening or isolation of their equipment, however, DBs are actively monitoring and managing these risks (PSC, 2020).

The development of the amended legislation was essential to ensuring timely REFCL delivery. Consultations with AusNet and Powercor confirmed that the DBs would not be on track to meet the intended timeframes for the installation of REFCLs without the amended legislation. Due to the high technical uncertainty associated with the use of REFCLs for bushfire safety purposes the DBs would have continued to test the technology within the 2016-20 regulatory period and not commenced installing additional REFCLs until they were satisfied that the technology was proven. The DBs felt unable to comment on how long it would have taken them to complete the rollout of REFCLs at 45 ZSS but agreed that the timeframes would have been much longer.

Risk reduction outcomes linked to network protection technologies

The rollout of ACRs and REFCLs has contributed significantly to the relative state-wide bushfire risk reduction of 36.6 per cent that has been achieved to date and with the planned installation of the remaining tranche two (May 2021) and three REFCLs by May 2023 a relative risk reduction of 48.1 per cent is anticipated. The majority of this risk reduction is attributable to REFCLs.

This demonstrates that the targeting of ZSS has been very effective. Most ZSS areas will reach a relative bushfire risk reduction that is higher than the state-wide average by the end of the PBSP in June 2023. Nine ZSSs are forecast to achieve slightly lower (3 per cent or less) risk benefit than the state-wide average, generally because a large proportion of powerlines in those areas are SWER lines, which are not protected by REFCL technology.

Furthermore, fault analysis data from the 2019-20 summer shows that at least four instances could be identified where REFCL technology prevented a fire start from a permanent powerline fault on a TFB day and it is possible that additional fire starts were prevented from the remaining 21 faults that the REFCLs detected on TFB days. This confirms that REFCLs are effective at preventing ignitions in high fire risk situations (PSC, 2020, p. 21).

5.2.4 Objective 4: Bring forward the replacement of powerlines in the most hazardous bushfire risk areas without imposing additional costs on consumers

Summary of key points

- **KPI 6: Total kilometres of powerlines replaced.**

  The Victorian Government-funded PRF facilitated the replacement of 733.6km of bare-wire powerlines without imposing additional costs on consumers. The total amount of powerlines replaced is slightly lower than what was originally anticipated, likely because a large proportion of powerlines were undergrounded rather than insulated, which is more expensive.

- **Risk reduction outcomes linked to the PRF**

  The PRF investment has expedited the relative bushfire risk reduction in areas of highest bushfire risk across Victoria. Furthermore, the level of risk reduction achieved in these areas is well above average and is expected to increase even further once all mandated ZSSs have been REFCL protected.

The *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* dictate that ultimately all 3,477km of bare-wire powerlines in the 33 ELCAs will be replaced in compliance with heightened powerline conductor standards. However, due to the high cost associated with this measure only a fraction of this amount was able to be targeted through the PRF and it was decided that only powerlines in the highest fire loss consequence areas, where deploying other protection technologies would not reduce the risk sufficiently, would receive funding.

The procedures to identify the target areas and secure funding are explained in detail in Chapter 4.

Total kilometres of powerlines replaced

Upon completion, the PRF had facilitated the replacement of 733.6km of powerlines, including 536.4km of HV bare-wire powerlines that were insulated or undergrounded, 192.8km of POELs that were undergrounded and 4.4km of HV lines that were retired due to the provision of standalone power systems (SAPS) to properties at the end of the line in dense bushland in the Colac Otway Ranges.

It was anticipated that the $200 million Victorian Government contribution would enable the replacement of 845km-3000km (Ernst & Young, 2012, p. 54) of powerlines in areas of greatest fire loss consequence. However, it was acknowledged that the ultimate amount of powerline replacement would depend on the technology used and the geography of the areas that were targeted. It was assumed that the preferred powerline replacement technology would be overhead insulated conductors in most instances (Ernst & Young, 2012, p. 54).

The total amount of powerlines replaced is thus slightly lower than what was originally anticipated, likely because a large proportion of powerlines were undergrounded rather than insulated, which is more expensive than the latter. A comparison of the unit costs projected by the Taskforce with the actual unit capital costs showed that they were within range (refer Appendix D).

Costs for the powerline replacement projects were paid by the Victorian Government via a third-party capital contribution to the DBs. Thus, the project did not impose additional costs on consumers.

Risk reduction outcomes linked to powerline replacement

All PRF target areas have achieved risk reduction estimates to June 2020 that are similar to or greater than the state-wide average. Furthermore, by June 2023 seven out of the 11 areas are expected to achieve a risk reduction of greater than 70 per cent, meaning that over 70 per cent of the bushfire risk associated with powerlines in these areas will have been retired.

Overall, these results show that the PRF investment has expedited the relative bushfire risk reduction in areas of highest fire loss consequence across Victoria and that targeting of powerlines to be replaced has been very effective.

5.2.5 Objective 5: Mitigate risks caused by program-related power outages for people who are dependent on power for their health and wellbeing

Summary of key points

- **KPI 8: Number of facilities provided with backup electricity capacity.**

  The LIAF delivered generators to 343 residential care facilities.

- **KPI 9: Number of people using the facilities provided with backup generation.**

  This provided backup power supply for 15,937 Victorians. These numbers have significantly exceeded earlier targets for the project.

Objective 5 relates directly to the delivery of the LIAF, which was excluded from the scope of this Review. For completeness, a short summary of the findings from the Benefits Realisation Report for the LIAF has been included, which was published following the completion of the project in March 2018 (Powerline Bushfire Safety Program, 2018a).

Early PBSP targets for the KPIs linked to the LIAF (2014-15) predicted that the program would enable the delivery of backup generators to 310 RCFs, thereby protecting 11,062 vulnerable Victorians (Powerline Bushfire Safety Program, 2015, p. 58).

These targets have been exceeded by the actual number of outputs delivered under the LIAF, with 343 generators installed at residential care facilities providing backup power supply for 15,937 vulnerable Victorians. This helps the average RCF and its residents to avoid close to two supply interruptions and 253 minutes of lost power supply each year.

The project was also delivered three years ahead of schedule and more than $10 million under budget, allowing the excess funds to be redirected towards the HV customer assistance program (HCAP). A cost benefit analysis found that the Victorian Government's investment in the LIAF produced a net present benefit of $19.552 million (2012 dollars), of which $2.857 million could be directly attributed to the expedited delivery of the project.

Feedback on the LIAF

The General Manager of four RCFs located in Terang confirmed that the LIAF-funded generators at these facilities were invaluable during power outages caused by bushfires in March 2018. He described that all of the generators operated for about 20 hours to cover the complete duration of the outages and provided light, facilities to feed and bathe people and charge phones (Powerline Bushfire Safety Program, 2018a).

5.2.6 Objective 6: Improve the cost effectiveness of the broader Program, and reduce unintended negative consequences, by obtaining new and better information.

Summary of key points

- **KPI 10: Use of R&D findings/outcomes by PBSP projects (qualitative measure).**

  R&D outcomes were critical to the success of the entire PBSP. REFCL trials provided a world-first proof of concept for the use of this technology for bushfire mitigation purposes, paving the way for their widespread deployment. The trials also helped identify the necessary performance standards to achieve the desired bushfire risk reduction. Improvements to the fire loss consequence mapping capability in combination with the development of the RRM ensured that infrastructure upgrades targeted areas of highest risk and with the highest return on investment.

- **KPI 11: Use of R&D findings/outcomes beyond PBSP delivery (qualitative measure).**

  REFCL and EFD technology have received attention outside the scope of the PBSP and are now being applied in international markets such as the United States and Asia. The PBSP and the research conducted with the help of the R&D Fund have positioned Victoria at the forefront of bushfire expertise, creating a pool of knowledge and experience which are expected to continue to bring benefits to Victorians and other jurisdictions beyond the duration of the program.

The R&D fund facilitated research, testing and prototype development focussing on seven priority areas that had been identified by PBSP. The KPIs linked to this objective were the use of R&D findings and outcomes by PBSP projects and the use of R&D findings and outcomes in other areas of government. Both were qualitative in nature and had no set targets, but it was stated that the R&D fund was established to identify cost-effective risk reduction technologies and procedures (Victorian Government, 2011, p. 6) and improve the efficiency and effectiveness of PBSP (Ernst & Young, 2012, p. 42).

Use of R&D findings/outcomes by PBSP projects

Many PBSP activities have produced learnings that have helped improve the efficiency and effectiveness of the PBSP and can be utilised to improve bushfire and power distribution management in the future.

Bushfire risk modelling was crucial for the delivery of the PBSP and ensured that infrastructure upgrades could target the highest risk areas. REFCL trials provided valuable proof of concept while the covered conductor and EFD projects produced viable prototypes to improve powerline safety in the future. The actual installation of protection technologies by DBs further contributed to gain a better understanding of their operation, required settings to meet performance criteria and integration into the existing distribution system. These projects are discussed in further detail below.

Bushfire mapping and risk reduction modelling

The bushfire mapping and risk reduction modelling components of the R&D Fund have enhanced knowledge of bushfires caused by powerlines. The RRM developed by CSIRO was mainly designed to determine bushfire risk levels to prioritise areas for asset deployment and enable the quantification of relative risk reduction enabling PBSP to track its progress. However, through integration of the RRM data with other information such as geo-spatial mapping, the capability of the RRM was further expanded and has facilitated the delivery of several other program activities, including:

- Development of a risk profile for Victoria's entire electricity distribution network;
- Definition of 33 ELCAs in which heightened installation standards apply;
- Identification and selection of 45 ZSSs where the greatest risk benefit from installation of REFCLs will be achieved;
- Establishment of a benchmark for fire starts under the risk-weighted f-factor Scheme; and
- Informing the cost-benefit analysis for the Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016 RIS.

REFCL trials

Trialling of REFCL technology was another important activity that received appropriations through the R&D Fund. The trials were crucial in establishing proof of concept for the utilisation of REFCLs to reduce the risk of powerlines starting bushfires and identified a set of performance standards for effective bushfire mitigation. These results have helped DBs facilitate the rollout of REFCLs in Victoria, noting that a large degree of technical uncertainty remained even after the trials were finalised, which had to be addressed and resolved by the DBs as they were installing REFCLs.

Prototype development and testing

The identification of risk reduction technologies was further progressed through the EFD project and covered conductor grant program. EFD technology was developed with the aim to identify emerging faults on SWER powerlines while the covered conductor program investigated cost-effective conductor solutions as alternatives to undergrounding powerlines or using conventional insulated wires such as aerial bundled conductor (ABC).

These activities led to the development of prototypes that were tested on the Victorian distribution network. Consultation sessions with AusNet and Powercor revealed that the covered conductor and EFD technologies are still in operation on small sections of their networks and are being considered for a more widespread rollout in the future.

Other activities contributing to an improved knowledge base

Remaining technical uncertainty associated with the deployment and operation of network protection technologies required the DBs to “learn-by-doing”. This approach forced the DBs to learn and innovate at a rapid pace but also ensured that they gained a lot of their knowledge first-hand, which has enabled them to apply learnings from the initial deployment of protection technologies to similar works and installations down the track. For example, the first tranche of REFCL installations at ZSS provided some valuable learnings that have since been applied to subsequent works, including:

- A much wider application of fuse savers to protect the network when faults occur; and
- The need for isolating transformers to avoid capacitance issues.

Use of R&D findings/outcomes beyond PBSP delivery

While the primary aim of the R&D Fund was to assist with PBSP delivery and monitoring, selected R&D funded projects have also been utilised outside the scope of PBSP, as summarised below:

- Consultations with the DBs and ESV revealed that they have adopted the RRM for their own bushfire mitigation and maintenance planning.
- The utilisation of REFCL technology and EFD devices for bushfire safety purposes has created interest from other jurisdictions (see box below).

Use of PBSP research outcomes in international markets

Technology trialled and developed through funding by the Powerline Bushfire Safety Program (PBSP) is being rolled out in international markets. Pacific Gas and Electric (PG&E) in California has included REFCLs as a key part of its Electric Emerging Technology Programs. After two years of laboratory testing, PG&E are installing a REFCL at a zone substation in the Napa Valley, which will be operational in 2021.

EFDs are also being tested and applied in international markets. Electricity distributors in the United States, Malaysia and China are rolling EFDs out on their networks to balance fire risk reduction and supply reliability. These devices were developed under PBSP’s Research and Development Grants.

The PBSP and the R&D funded projects in particular have positioned Victoria at the forefront of bushfire expertise worldwide, creating a pool of knowledge and experience which are expected to continue to bring benefits to Victorians and other jurisdictions beyond the duration of the program.

An independent review of Victoria’s Electricity and Gas Network Safety Framework chaired by Dr Paul Grimes recommended that the research should be maintained into the future beyond the delivery of the PBSP (Victorian Government, 2017, p. 175).

6 Broader impacts of the PBSP initiatives

This chapter aims to illustrate the potential scale of benefits associated with the anticipated reduction in relative powerline bushfire risk as well as some of the broader impacts stemming from the bushfire safety initiatives reviewed above.

6.1 Benefits and avoided costs of reducing relative bushfire risk

Key Findings

- A relative bushfire risk of up to 50 per cent was estimated in the PBSP Business Case to lead to avoided economic costs over the next 50 years of over $1 billion in net present value terms.
- The real economic benefits are now expected to be at least double that anticipated in the PBSP business case when a broader range of social impacts, such as mental health, are considered.

6.1.1 The prevalence of powerline-related major bushfires

While powerlines have been identified as starting a relatively small proportion of bushfires (around 1–4 per cent), recent inquiries that have followed major bushfires have concluded that a disproportionate number of catastrophic bushfires, with major loss of life and property, have been caused by powerlines. In particular, powerlines are thought to have started:

- Nine of the 16 major fires on 12 February 1977;
- Four of the eight major fires on Ash Wednesday (16 February 1983); and
- Five of the 15 major fires on Black Saturday (7 February 2009) that were considered by the Royal Commission (Powerline Bushfire Safety Taskforce, 2011).[21]

6.1.2 Social, economic and environmental impacts of major bushfires

The reduction in relative powerline related bushfire risk of up to 50 per cent across Victoria due to PBSP is expected to help avoid harm to human life, residential and commercial property, as well as a broader range of social, economic and environmental impacts as outlined in Table 8. The damage or loss of the infrastructure outlined below in many cases can take a significant period of time to repair or remediate and lead to substantial economic hardship for local communities.

Table 8: General impacts of major bushfires

Benefit/Impact category	Description(s)
Loss of agriculture assets	Crops, pastures, plantations, livestock, fencing that is damaged or lost due to bushfires.
Infrastructure assets	Roads, utility networks that are damaged or lost due to bushfires.
Health and wellbeing	Mental health (trauma, anxiety and depression), family violence, alcohol and drug misuse, relationship breakdown
Business disruption	Business disruptions due to road closures, property damage absenteeism or lower productivity of affected workers
Tourism declines	Decline in tourism due to bushfire outcomes, damage or loss of national parks, camping areas and shelters

[21] Following the 7 February 2009 Black Saturday bushfires, the Victorian Bushfires Royal Commission (VBRC) identified powerlines as being the cause of five of the major fires that day, and responsible for 119 deaths. A sixth fire (Murrindindi) was not investigated by the VBRC as it was then under investigation by Victoria Police on suspicion of arson. Victoria Police subsequently concluded that arson was not the cause and referred the matter to the Coroners Court for inquiry. On 27 November 2015, the Coroners Court found that this fire was also caused by electricity distribution assets, adding the loss of a further 40 lives to the total attributable to electricity distribution assets (DELWP, 2016. *f-factor Incentive Scheme: Regulatory Impact Statement).*

Environmental damage	Threatening fauna and flora due to loss of habitat, direct injury and/or loss of life; pollution of waterways
Cultural heritage	Loss of artefacts, places of worship and cultural material of our ancestors and indigenous population.
Loss of timber assets	Reducing timber yield and quality due to bushfires.
Emergency and relief authorities	Time and resources required by emergency and relief agencies to respond to and manage bushfires.
Education and employment	Disruption to education and/or employment due to school closures and business disruption as a result of bushfires
Community connectedness	Community dislocation, breakdown of social networks and/or crime (e.g. loitering) in the wake of bushfires.

6.1.3 The estimated scale of the impacts of major bushfires

The expected avoided economic costs due to PBSP is outside the scope of this Review, the reduction in relative bushfire risk in Victoria of up to 50 per cent, together with the estimated scale of economic costs associated with significant or catastrophic bushfires, suggests that the benefits to the community will be substantial.

A 2016 Report prepared by Deloitte Access Economics on behalf of the Australian Business Roundtable for Disaster Resilience and Safer Communities examined the economic costs of natural disasters in Australia (Deloitte, 2016). The report used the 2009 Victorian Black Saturday Bushfires as a case study and estimated that the bushfires generated close to $1.3 billion (2011 dollars) in insurance costs (Insurance Council of Australia, accessed 2015) and led to tangible costs associated with the damage and/or loss to the economic, social and environmental infrastructure outlined above of around $2.6 billion (2011 dollars) or $3.1 billion (in 2015 dollars).

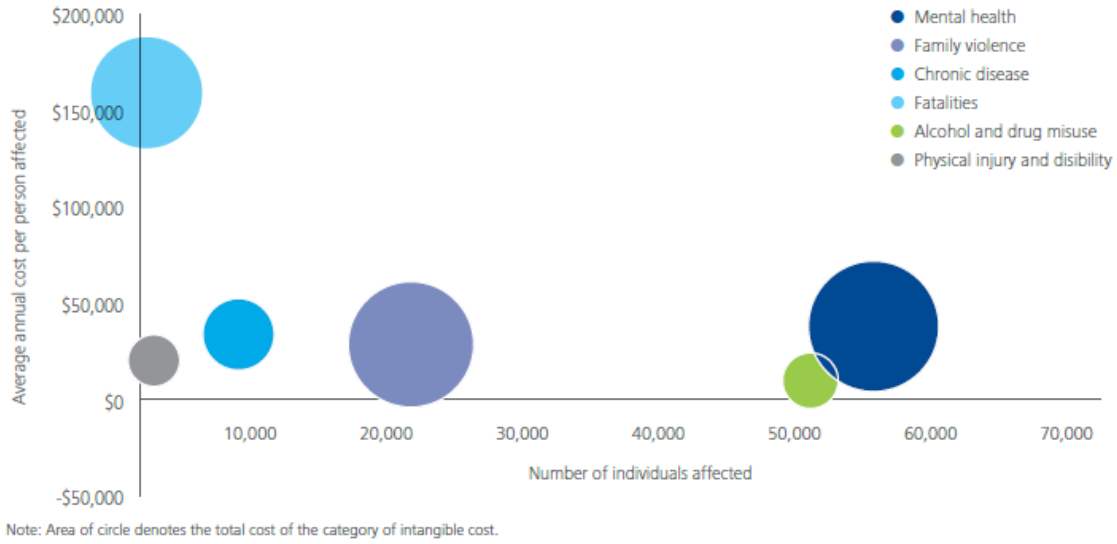
Table 9: Tangible cost estimates of the 2009 Black Saturday Bushfires

Impact category	Percentage of total	$m (2011)
Insured	41.7	$1,266
Uninsured	32.8	$593
Category B	23.0	$696
Agricultural production lost	0	$0.04
Evacuated	0	$0.09
Homeless	0	$16
Homes – damaged	0.3	$6
Commercial – damaged	0.1	$1
Emergency response costs	2.1	$65
Total	**100**	**$2,644**

Source: Deloitte, 2016.

In addition to the tangible costs of the bushfires, the social costs to the community from the Black Saturday Bushfires, including mental health and disease, were estimated to be close to $3.9 billion (Figure 8). The report noted that this is likely to be a conservative estimate as some social impacts could not be quantified and that the economic cost of the social impacts of bushfires is as high, if not higher, than the tangible costs.

Figure 8: A breakdown of the tangible and intangible costs of the Black Saturday bushfires ($ millions)[22]



Note: Area of circle denotes the total cost of the category of intangible cost.

Source: Deloitte, The economic cost of the social impact of natural disasters, 2016.

6.2 Broader impacts of the fire safety initiatives

Summary of key points

- The indirect benefits of the PBSP have included, but are not limited to, putting Victoria at the forefront of bushfire safety expertise worldwide, creating a legacy of initiatives which continue to bring benefits to Victoria beyond the duration of the program, and reducing the risk of electrocution.
- The indirect costs identified in this report, whilst having a significant impact for some customers, have largely been contained to 'one-off' costs for a small subset of electricity customers. DELWP has acted to minimise negative impacts through listening to feedback and adapting within the constraints of the program.

It is important to consider any broader impacts of PBSP that may not have been anticipated prior to implementation of the program as part of a benefits realisation review as they may provide further benefits to the Victorian community (or other jurisdictions) or offset the realisation of expected benefits for the program.

A high-level qualitative analysis of the broader impacts linked to the delivery of PBSP based on the insights gleaned from stakeholder consultation. Each of these impacts is discussed in further detail below.

6.2.1 Costs

- **HV customer expenses:** The scale of costs associated with modification of HV customer assets to make them REFCL compliant (see Section 5.2.1) were not anticipated at the outset of the program, despite early consultations with DBs on the number of affected HV customers and anticipated costs.

  HV customers directly connected to a REFCL network require hardening or isolation of their electrical assets to be protected from over-voltages. During Tranche 1 of the REFCL rollout, costs to harden or isolate HV customers' assets were funded by the DBs, who received AER approval to recover these costs through revenue determinations from consumers. An amendment to the *Electricity Distribution Code* in 2018 which applies to Tranche 2 and 3, pushes these costs onto HV customers. The HCAP has since been established to provide financial assistance to HV customers.

  In a recent REFCL cost-benefit analysis report, HV customer expenses for the REFCL rollout were estimated to be in the order of $180 million (Nous, 2020) and it was thought that a large proportion these

[22] Tangible and intangible costs are measured in 2011 dollars.

costs, particularly those by public sector organisations, will not be covered by HCAP and will have to be self-funded.

DELWP calculates HV Customer costs to be closer to $132 million. There are two key reasons to explain the difference between DELWP's estimate and Nous' projections:

1. DEWLP uses more finalised estimates from HV Customers.
2. DELWP does not include HV customer REFCL readiness costs prior to 2018, which fall within Tranche 1 of the REFCL rollout, as these works were funded by the DBs (refer above).

- **Disruption to property access and electricity supply during construction:** Networks have acknowledged that there have been instances of disruption to property access and electricity supply during construction. However, DBs sought to minimise these impacts as much as possible and would give customers and property owners plenty of notice before undertaking any works.

6.2.2 Benefits

- **Reduced risk of electrocution:** The first indirect benefit in relation to PBSP is linked to a reduced risk of electrocution when conducting works within the vicinity of powerlines due to the installation of REFCLs. REFCLs can quickly reduce the voltage in a conductor following certain types of faults and thereby reduce the risk of shocks and electrocution. It should be noted that electrocution of people as a result of powerlines is generally very rare.

Instances of REFCL protection saving lives

ESV described an example where a maintenance crew hit a powerline but were unaware that they had done so until a tool became stuck under the line. It was mentioned that without REFCL protection this would have likely led to the electrocution of two people.

- **Local industry development and job creation:** R&D funding through the PBSP was critical to creating and facilitating growth in local industry development and job creation. The R&D Fund not only created direct benefit throughout PBSP but has also enabled the creation of start-ups which continue to provide industry and economic benefits beyond the duration of the program. Furthermore, some of the research outcomes have since led to the development of commercial products and associated job creation. For example, IND Technology who developed the EFD device are determined to keep manufacturing the devices in Melbourne.
- **World-leading bushfire expertise:** PBSP activities and delivery have put Victoria at the forefront of bushfire safety expertise and product development. This is evidenced by the fact that other national and international jurisdictions look towards Victoria when seeking to identify measures and technologies to lower network related bushfire risk. Particularly, the R&D Fund was instrumental in developing this expertise. It was reported that the research activities and prototype development that were funded in this way would likely not have happened otherwise or at least not to the same degree. The amended legislation is also thought to have played a big part in the development of world-leading expertise as it forced DBs to innovate and adapt to meet tight timeframes and performance targets for the deployment of protection technologies.
- **Increased robustness of the network:** The installation of REFCLs and the associated change from solidly earthed networks to resonant earthing necessitated changes to and improvements of equipment and control systems to allow for the increased voltages experienced during REFCL operation. To facilitate these changes the DBs have implemented innovative engineering solutions, undertaken product development and progressive network integration activities, all of which have contributed to increasing the robustness of the network and developing a new best practice to treat earth faults.
- **Reduced fire risk for complex faults:** The primary aim of the installation and operation of REFCLs is to reduce the fire risk of phase-to-earth faults. They are generally not able to detect pure phase-to-phase faults. However, analysis of fault data from the 2019-20 summer, the first bushfire season that had all Tranche 1 REFCLs in operation, showed that they can also provide benefits regarding the treatment of complex faults if the resulting network dissymmetry exceeds the REFCL settings. This happened in one instance on Powercor's network, where a fault started off as a phase-to-phase fault but was picked up by

the REFCL due to an imbalance of the network caused by capacitance issues downstream. Since the conductors had made contact with the ground the limiting of fault current by the REFCL reduced the risk of a fire start (PSC, 2020, p. 24).

- **Improved fire starts data collection:** The introduction of the f-factor Scheme initiated the collection of reliable data on bushfires and their causes. Prior to 2012, DBs were not required to collect detailed data on fire starts, which made it difficult to even identify an appropriate benchmark target for the scheme. With the f-factor Scheme, network related fire starts have become measurable and tangible with data now available to drive targeted reduction in ignitions and assess outcomes from safety initiatives and operational changes.
- **Greater focus on reducing fire risk:** Consultations with the DBs revealed that PBSP measures and associated activities have led to an increased focus on proactively managing and reducing fire risk on their networks. For example, AusNet outlined that they have started to proactively replace bare-wire powerlines in the 33 ELCAs that were outside the scope of the PRF. Similarly, Powercor have reported that the PBSP has contributed significantly towards moving away from business as usual activities and looking for ways to proactively manage the network.

7 Conclusion

This report extends on existing performance and delivery reviews of PBSP[23] by providing a broader assessment of program-wide benefits through incorporation of direct, indirect, and wider impacts.

This Review finds that the PBSP initiatives are on track to achieve a significant reduction in powerline related bushfire risk across Victoria (up to 50 per cent by June 2023), with REFCLs being the largest contributor to this risk reduction. This is expected to reduce the number of bushfires in the future, thereby helping to avoid harm to human life and property. In addition to the direct benefits resulting from a reduction in the number of catastrophic bushfires, the indirect benefits of the program have resulted in new knowledge, innovations and work practices which place Victoria at the forefront of bushfire safety.

It is important to consider the degree to which the observed and expected benefits have both achieved the original goals of the PBSP and have been delivered to the fullest extent withing the constraints of the program.

Using KPI targets alone to assess the benefits realised has proven to be problematic due to the evolving nature of the PBSP resulting in shifting targets over time. To paint a fuller picture of the benefits, this report considers not only the KPIs, but the delivery timeframes and costs, the indirect benefits as well as a broader set of outcomes resulting from the interrelated activities.

This Review finds that the program objectives and benefits anticipated by the Taskforce and the Victorian Government are on track to be broadly realised by the conclusion of the PBSP based on:

- The rigorous bushfire modelling and analysis that underpinned the delivery of the network safety upgrades;
- The fact that most projects were delivered on time and within the allocated budget; and
- The scope and scale of the direct and indirect benefits observed to date.

The benefits of this program are becoming increasingly important and necessary given the worsening fire conditions resulting from climate change and will leave a positive legacy for Victorians and future generations. As such, this Review supports the ongoing delivery of the program to meet its stated objectives by 2023.

[23] Victorian Government, 2017. *Independent Review of Victoria's Electricity and Gas Network Safety Framework*. Victorian Government, 2019. *Gateway Review Process – Powerline Bushfire Safety Program Review*. PSC, 2020. *REFCL Functional Performance Review*. VAGO, 2020. *Reducing Bushfire Risks*.

8 References

2009 Victorian Bushfires Royal Commission, 2010. *Final Report: Summary*.

AER, 2010. *Final decision - Victorian electricity distribution network service providers: Distribution determination 2011-2015*.

ACIL Allen Consulting, 2015. *Regulatory Impact Statement: Bushfire Mitigation Regulations Amendment*.

Deloitte, 2016. *The economic cost of the social impact of natural disasters*.

Department of Environment, Land, Water and Planning, 2016. *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016: Statement of Reasons for Decision to Make Regulations*.

Dunstall S, Towns G, Huston C and Stephenson A (CSIRO Data61, Australia), 2016. *PBSP Risk Reduction Mode: Overview and Technical Details*.

Ernst & Young, 2012. *The Powerline Bushfire Safety Program: Full Business Case.*

Jaguar Consulting, 2013. *Regulatory Impact Statement: Electricity Safety (Bushfire Mitigation) Regulations 2013*.

Nous, 2020. *REFCL cost-benefit analysis Draft Report*.

Powerline Bushfire Safety Program, 2013, *PBSP Benefits Realisation Plan*.

Powerline Bushfire Safety Program, 2015. *2014-15 Annual Performance Report*.

Powerline Bushfire Safety Program, 2016. *f-factor Incentive Scheme: Regulatory Impact Statement*.

Powerline Bushfire Safety Program, 2018. *Local Infrastructure Assistance Fund Project – Benefits Realisation Report*.

Powerline Bushfire Safety Program, 2018. *Regulatory Costs – Implementation of VBRC Recommendations 27 & 32.*

Powerline Bushfire Safety Program, 2019. *2018-19 Annual Performance Report*.

Powerline Bushfire Safety Taskforce, 2011. *Final Report*.

PSC, 2020. *REFCL Functional Performance Review*.

Power Systems Consulting (PSC), 2020. *REFCL Functional Performance Review*.

VAGO, 2020. *Reducing Bushfire Risks*.

Victorian Government, 2011. *Power Line Bushfire Safety: Victorian Government Response to the Victorian Bushfires Royal Commission Recommendations 27 and 32*.

Victorian Government, 2017. *Independent Review of Victoria's Electricity and Gas Network Safety Framework.*

Appendix A: Detailed approach to the benefits realisation review

Analytical framework

Aurecon agreed with DELWP on an analytical framework for the benefits realisation assessment that was based on three evaluation components:

- A baseline assessment:
  - To establish the existing conditions, state of knowledge and legislation at the start of the PBSP; and
  - Identify the anticipated activities, costs and benefits for the different PBSP components.
- Analysis of PBSP measures and activities:
  - Examination of the actual PBSP initiatives and measures outlining the costs, activities and outputs associated with each of the key PBSP components.
- PBSP benefits realisation assessment:
  - Evaluation of the six overarching program objectives; and
  - Investigation of the broader impacts of the PBSP.

Literature review

Aurecon drew on a range of qualitative and quantitative information and data to conduct this benefits realisation assessment. Assessment inputs included, but were not limited to, the following:

- Documentation provided by DELWP, about the history of PBSP, the planned implementation strategy, projected benefits, prioritisation of high bushfire risk areas, changes to the legislation as a result of the PBSP and annual performance statistics.
- Publicly available information such as the PBSP Progress Report 2012-1019, final reports for the different projects that received appropriations though the R&D Fund, ESV's annual safety performance reports on the Victorian electricity network and annual fire start reports of the Victorian electricity distributors.
- Information from DELWP and the DBs on the incurred costs for the different PBSP initiatives.
- The distribution businesses' Bushfire Mitigation Plans.
- The REFCL cost-benefits analysis report prepared by Nous on behalf of ESV and the Functional Performance Review.
- Several reports by Deloitte Access Economics prepared on behalf of the Australian Business Roundtable for Disaster Resilience & Safer Communities.

Stakeholder consultation

Following the initial literature review, Aurecon conducted a stakeholder consultation process with representatives from different stakeholder groups affected by or involved in the PBSP delivery to:

- Understand the baseline parameters and constraints that DELWP and the PBSP had to operate within;
- Test and confirm the actual activities and costs of the different PBSP components;
- Identify key benefits and impacts to the DBs, the community and other affected parties as a result of the PBSP;
- Clarify any other queries in relation to the PBSP.

Aurecon recognises that many stakeholder groups have an interest in the PBSP, its delivery and associated benefits to the community and proposed to consult a broad range of stakeholders as part of this Review. The organisations that were agreed with DELWP given the timeframe, budget and scope of works included:

- DELWP;
- ESV;
- AusNet Services; and
- Powercor.

A number of customer impacts of PBSP, such as REFCL costs and changes to supply reliability, were gleaned from reports provided by other consultants, which were based on a more extensive consultation program. The availability of the information outlined above reduced the need for a broader stakeholder consultation process for this Review.

Analysis of data and insights

Within the parameters outlined directly above, Aurecon's assessment of the anticipated benefits of the PBSP was based on a desktop review of previous quantitative estimates of the:

- Expected relative bushfire risk reduction for the program as a result of network asset installations and bare-wire powerline replacement;
- Forecasts and targets for the key performance indicators linked to the six program objectives;
- Avoided costs linked to the broader benefits associated with a reduction in the number of bushfires.

The degree to which the (net) benefits of the PBSP have been or will be realised was based on an assessment of whether:

- The outputs of the PBSP have been in line with what was initially expected;
- The costs to deliver and administer the PBSP were in line with what was initially expected; and
- The regulatory changes achieved the outcomes they intended and facilitated improvements to network safety.

Aurecon has distinguished between benefits and outcomes realised to date (30 June 2020) and benefits expected to be realised by 30 June 2023, which was chosen as the end date for the PBSP given that all activities included in the original funding commitment are expected to be finalised by that date.

Furthermore, additional outcomes and impacts have been identified that were not considered in the initial forecasts of the costs and benefits associated with the PBSP. These outcomes and impacts have been addressed qualitatively in the benefits realisation review based on the findings and outcomes of the stakeholder consultation process.

Boundaries of analysis

The following tasks and activities were agreed with DELWP to be outside the scope of the Review in consideration of the available time, budget and resources:

- A review and evaluation of the design of the various program elements. This is consistent with the fact that the PBSP was subject to independent DTF Gateway Reviews that considered the design and delivery of the various program elements every second year between 2012 and 2019;
- An assessment of whether the program maximised the value to Victorians given the mandate and the constraints;
- Identification of whether decisions or processes could or should have been done / made differently with the benefit of hindsight;
- A traditional cost benefit analysis to justify the investments made as part of PBSP; and
- Modification or revision of the current set of metrics and modelling around fire risk reduction from the various initiatives that make up the PBSP.

Appendix B: Analysis and findings of the Taskforce

Recommendation 27: progressive replacement of 22kV and SWER powerlines

Based on extensive research and analysis, the Taskforce identified five potential approaches to address Recommendation 27 from the VBRC including:

- Underground powerlines;
- Insulate overhead powerlines;
- Deploy protection technologies;
- Deliberately turn off powerlines temporarily[24]; and
- Install standalone power systems (SAPS) and permanently turn off powerlines.

The five approaches outlined above were found to be associated with trade-offs in terms of the effectiveness in reducing bushfire risk, cost of implementation, and the impact on electricity supply to the community.

For example, while bare-wire powerline replacement was deemed to be the most effective safety measure available to PBSP to reduce bushfire risk stemming from powerlines with an estimated relative risk reduction of 90 per cent or above, it was also estimated to be the most expensive course of action. The Taskforce estimated that undergrounding all Victorian high-voltage (HV) powerlines in non-urban areas would cost approximately $40 billion and insulating them would cost around $20 billion (Powerline Bushfire Safety Taskforce, 2011, p. 5).

The Taskforce concluded that the most cost-effective solution to reduce the likelihood of bushfires starting by powerlines is the widespread deployment of new protection network technologies (REFCLs and new generation SWER ACRs), with the targeted replacement of powerlines with underground or insulated cable in the highest fire loss consequence areas.

Recommendation 32: disabling or adjustment of powerline reclose functions

The likelihood of powerlines starting bushfires is reduced significantly if protection systems that automatically turn off powerlines when faults occur are operate with increased sensitivity and faster response times. Operating protection systems in this manner, however, has the potential to adversely affect the reliability of electricity supplied to the community and impact:

- The welfare of the elderly and sick;
- The ability to monitor and communicate fire activity;
- The ability to pump water and fuel; and
- Animal welfare.

Following careful consideration of the appropriate balance between bushfire safety and reliability of supply, the Taskforce recommended that electricity distributors implement the VBRC's recommendation 32 by adjusting the protection systems for 22kV and SWER powerlines based on the severity of the day and the fire loss consequence of the area.

The Powerline Bushfire Safety Program

The Taskforce's Final Report provided six formal recommendations to the Victorian Government that addressed Recommendation 27 and Recommendation 32 from the VBRC. This included the provision of funding to establish an ongoing R&D program to underpin the deployment of new network protection technologies and the targeted replacement of powerlines with underground or insulated cable in the highest fire loss consequence areas.

[24] The Taskforce considered that the adverse impact on the community by deliberately turning off powerlines on a temporary basis generally outweighs the risk of powerlines starting bushfires.

Recommendation 1

Electricity distributors implement the 2009 Victorian Bushfires Royal Commission's recommendation 27 by:

(a) installing new generation protection devices to instantaneously detect and turn off power at a fault on high fire risk days:

- on SWER powerlines in the next five years (new generation SWER ACRs)
- on 22kV powerlines17 in the next 10 years (rapid earth fault current limiters)

(b) targeted replacement of SWER and 22kV powerlines18 with underground or insulated overhead cable, or conversion of SWER to multi-wire powerlines, in the next 10 years

to the level of between $500 million and $3 billion, consistent with the package of measures selected by the Victorian Government. These should be implemented in the highest fire loss consequence areas first.

Any new powerlines that are built in the areas targeted for powerline replacement should also be built with underground or insulated overhead cable.

Recommendation 2

Electricity distributors implement the 2009 Victorian Bushfires Royal Commission's recommendation 32 by adjusting the protection systems for 22kV and SWER powerlines based on the severity of the day and the fire loss consequence of the area so that at a fault there are:

Area	Total Fire Ban day	Code Red day
Rural powerlines in the worst areas (approximately 20 per cent of rural powerlines)	Two fast protection operations	One fast protection operation
Rural powerlines in remaining areas (approximately 80 per cent of rural powerlines)	One fast and one slow protection operation	One fast and one slow protection operation

For the 2011/12 fire season, to the extent practicable and possible, the electricity distributors change the protection systems at 10am or when the fire danger index20 exceeds 30, whichever occurs earlier, until the fire danger index falls below 30.

Until the old-style SWER ACRs are replaced, they should be manually changed in the highest fire loss consequence areas of the state during the worst bushfire period as declared by the Fire Services Commissioner.

Recommendation 3

To ensure the greatest benefits are achieved from the Taskforce's recommendations 1 and 2:

(a) The electricity distributors act to minimise the potential for recommendation 2 to adversely affect customers' reliability of supply.

(b) Victorians should continue to be advised, as part of the state's regular fire-preparedness communication program, that they may experience reduced levels of supply reliability on high fire risk days and should take appropriate precautions, including consideration of a back-up power supply if they are highly reliant on a reliable electricity supply.

(c) The Victorian Government nominate the body responsible for the inputs to, and assumptions for, state-wide fire loss consequence modelling.

By 31 October 2011, the Fire Services Commissioner ensure there is effective liaison between the electricity distributors and the State Control Centre (including through an industry liaison officer) in the lead up to, and on, high fire risk days, to inform the operation of protection systems.

(e) Energy Safe Victoria (ESV) seek funding to commission research and analysis on the detailed operation of protection systems on high fire risk days, and issue the framework to be used to make decisions, in the lead up to and on high fire risk days, on the operation of the protection systems.

(f) The electricity distributors systematically develop a rationale for the circumstances under which a powerline should or should not be patrolled (and to what extent) before it is turned back on after a period of time. The rationale must include consultation with the emergency services to ensure no evidence has been detected of a fire or other dangerous situation.

(g) Subject to a Victorian Government decision on the Powerline Bushfire Safety Taskforce's recommendations by the end of November 2011, the electricity distributors submit a revised Bushfire Mitigation Plan, which demonstrates how the required outcomes will be achieved, to ESV by the end of March 2012.

(h) By 30 June 2012, the electricity distributors submit a plan to ESV to reduce the fire risk associated with low voltage lines and service lines where it is cost-effective to do so.

Recommendation 4

The Victorian Government should improve the capacity for ongoing research and development to further reduce the likelihood that powerlines start bushfires and assist Energy Safe Victoria (ESV) to effectively and appropriately regulate the electricity distributors.

(a) Funding of not less than $2 million per annum for five years should be provided for research and development.

(b) Appropriate independent governance arrangements should be established to oversee the allocation of the funding.

(c) ESV, electricity distributors and other parties should be able to apply for the funding.

(d) The funding should be provided contingent on the results of the research and development being made publicly available.

(e) Priority should be given to improved fire loss consequence modelling, research and analysis to optimise the operation of network reclose devices, and developing new protection technologies to reduce bushfire risk and minimise impacts on supply reliability.

Recommendation 5

The Safer Electricity Assets Fund should be used to fund, in priority order:

1. Research, development and demonstration ($2 million per annum over five years) – fund research and development projects that will further reduce the likelihood that powerlines will start bushfires.

2. Private costs that are imposed on individuals by the Taskforce's recommendations to address equity and financial hardship concerns ($40 million) – contribute to the cost of service lines and private overhead lines, or alternative supply options.

Recommendation 6

a) Energy Safe Victoria (ESV) implement a reporting and compliance framework to ensure that the recommendations that are accepted by the Victorian Government are implemented by the electricity distributors.

b) ESV publish the outcomes of the reporting and compliance function and report on the status of the implementation of each recommendation accepted by the Victorian Government in its annual Comparative Safety Performance report.

c) A review be undertaken by ESV or an independent body at the end of five years to assess whether the Taskforce's recommendations continue to be the most cost-effective means to reduce the likelihood of powerlines starting bushfires, and to assess the effectiveness of the implementation of the Taskforce's recommendations.

In line with the Taskforce's Terms of Reference, six packages of measures were identified to reduce the likelihood of powerlines starting bushfires for consideration by the Victorian Government with a capital cost ranging from $200 million to $10 billion (Table 10). The Taskforce recommended an investment between $500 million and $3 billion but concluded that the most appropriate package should be determined by the Victorian Government, balancing the anticipated risk reduction and costs with any adverse impacts to customers.

The Victorian Government accepted the recommendations included in the Taskforce's Report and committed to a program of initiatives with a total estimated cost of $750 million (2011 dollars) (Victorian Government, 2011).[25]

Table 10: Packages of measures proposed by the Taskforce

Measure	Package 1	Package 2	Package 3	Package 4	Package 5	Package 6
Number of ACRs	1,300	1,300	1,300	1,300	1,300	1,300
Number of REFCLs	39	108	108	108	108	108
Powerlines to be replaced	Nil	110km	2,400km	7,300km	12,100km	40,000km
Capital cost (2011 dollars)	$199 million	$500 million	$1 billion	$2 billion	$3 billion	$10 billion
Relative risk reduction	48%	60%	67%	77%	83%	91%

Source: Powerline Bushfire Safety Taskforce: Final Report September 2011

[25] The Victorian Government further requested an additional $250 million of funding from the Federal Government to increase the overall value of the program to $1 billion in line with Taskforce Package 3. However, the Federal Government did not commit any funding to the program of works, meaning that the ultimate outcome was a hybrid between Taskforce Package 2 and 3.

Appendix C: Selection of projects supported through the R&D Fund

The main research projects that received funding via the R&D Fund and the outcomes associated with these projects are outlined below.

Table 11: Projects that received funding from the R&D Fund

Bushfire mapping & risk modelling

Bushfire risk modelling and mapping capabilities have been significantly enhanced and have helped to support analysis, planning and reporting across the PBSP. A risk reduction model (RRM) was developed by the CSIRO in partnership with FACIO Pty Ltd, taking into account:

- The location of network assets;
- The type of protection available at each location;
- The likelihood of an ignition occurring under relevant conditions; and
- The estimated consequences of ignitions under worst case bushfire conditions.

Through combination of the calculated ignition likelihood with bushfire consequence data the RRM is able to calculate the bushfire risk for a given location at a given point in time. This can then be used to quantify the relative bushfire risk reduction achieved at a particular location through the implementation of bushfire safety technology and infrastructure upgrades. The RRM has been utilised to determine the state-wide reduction in relative powerline related bushfire risk resulting from PBSP measures since 2015-16.

Arc ignition research

In 2011-12 ESV received funding to study arc-ignition, specifically metal-metal arcs near dry grass. The aim was to determine how arcs behave, how they ignite fuel and the performance required to prevent fires under these circumstances.

It was found that the for electric arcs to cause ignition, actual contact with fuel is necessary and that sustained ignition required to start a bushfire results from a chain reaction involving hot fuel, pyrolysis, gases and flames. Preventing ignition via electric arcs is achievable if the arc energy is low, the arc misses the fuel or air movement cools the fuel.

REFCL trials

Trials of Rapid Earth Fault Current Limiters have been conducted at two different ZSS to determine their potential to detect and contain faults on 22 kV lines and thereby assess their effectiveness for bushfire mitigation purposes.

REFCL trials on isolated systems conducted at Frankston South ZSS, which was configured for bushfire safety purposes in 2012, showed that the devices have the ability to detect faults at very low current levels and turn off the affected powerlines in milliseconds before arcing occurs, thereby establishing proof of concept.

Subsequent trials at Kilmore South ZSS tested REFCLs and their performance on a small section of the real network. The tests established a set of performance standards for bushfire mitigation using REFCLs and confirmed that there was a technology capable of meeting these standards.

Vegetation conduction & fault signature testing

A testing program was conducted at Springvale ZSS where different types of vegetation were brought into contact with electrical equipment under conditions that exist on days of high bushfire risk. The tests identified Willow and Desert Ash as the species with the worst fire risk and led to a database of fault signatures and fire probability for different plant species to assist in decision making regarding vegetation management around powerlines. The testing also demonstrated that unique electronic signatures exist for plants of different species, providing a basis for future technology development to detect faults and the species of plant involved, bringing a further level of enhanced sensitivity and discrimination to risk assessments and the mitigation response provided.

Early fault detection project

Funding was provided to IND Technology to progress and trial their Early Fault Detection (EFD) technology to determine whether the system is capable of correctly identifying faults on SWER lines. EFD trials on parts of the Powercor and AusNet networks indicated that the technology could cut fire-risk on rural SWER lines and support pre-emptive asset replacement and maintenance.

Covered conductor grant program

A grant program was established to support and expedite the development of innovative and cost-effective conductor solutions that can be used on the Victorian network as an alternative to undergrounding powerlines or using conventional insulated wires such as ABC. Customisation and testing of three Amokable covered conductor products by Groundline Engineering Pty Ltd showed promising results, however PBSP in consultation with the DBs determined that the product was not market ready at the time.

Broken SWER conductor detection

United Energy and Victoria University received funding to investigate the potential of powerline carrier (PLC) communications-based technology to detect SWER conductor breakages and de-energise the powerline before the fault can start a fire. Prototype testing in the laboratory revealed that the concept works, and the development of a cost-effective product is feasible. Further development and testing of the system on a real network is recommended.

Appendix D: Costs for the program elements under review

Network Assets Project

Anticipated costs

The anticipated costs for the Network Assets Project are illustrated in Table 12.

Table 12:Split of estimated costs for the Network Assets Project

Component	Total cost ($million, 2011 dollars)	Total cost ($million, nominal)
New ACRs	39.0	43.9
REFCLs	432.0	517.9
Conductors	29.0	34.9
Total	500.0	596.8

Source: The Powerline Bushfire Safety Program Full Business Case, p. 52.

It was estimated that the costs of deploying 1,300 ACRs and 108 REFCLs would be around $39 million and $432 million (2011 dollars) respectively.[26] The Network Assets Project, which was also to include $29 million of conductor replacement was thus projected to cost $500 million (2011 dollars) or $596.8 million in nominal terms . This was to be funded by the major electricity companies and recovered from customers in the affected areas.

Revised cost estimates for the deployment of REFCLs and ACRs were presented in the 2015 Bushfire Mitigation Regulations Amendment Regulatory Impact Statement (RIS) (ACIL Allen, 2015) as part of a cost benefit analysis to determine the net benefits of installing network protection technologies. The forecasts were based on cost estimates provided by the DBs for the installation of REFCLs at each of the 45 ZSSs and deployment of 1,064 new generation SWER ACRs in lower consequence bushfire risk areas on Powercor's network[27]. ACIL Allen made one adjustment to the REFCL costs provided by DBs and assumed that only one in three lightning arrestors would need to be replaced, whereas the DBs had assumed that all lightning arrestors would need replacing.

Based on an average installation cost of $6.593 million, the RIS estimated that the deployment of REFCLs at 45 Victorian ZSSs would cost approximately $296.7 million (nominal). The costs of installing 1,064 SWER ACRs on Powercor's network were forecast to amount to $53.2 million (nominal) with a unit cost of $0.050 million per ACR. The total direct cost of the Network Assets Project excluding 178 SWER ACRs that had already been installed at the time the forecasts were produced was thus $349.9 million. Following indexation and taking into account avoided costs due to replacing equipment earlier than would otherwise have occurred, a present value cost of $178.6 million (2015 dollars)[28] was estimated for the Network Assets Project.

Actual cost of ACR deployment

AusNet proactively sought funding for the deployment of ACRs on its SWER network following the Black Saturday Bushfires prior to the finalisation of PBSP requirements. The funding was approved by the AER in October 2010 as part of the 2011-15 EDPR determination (AER, 2010), and AusNet received permission to pass up to $9.8 million (2010 dollars) on to consumers, allowing them to cover the capital costs of 525 ACR installations to protect their SWER network (Powerline Bushfire Safety Program, 2018b, p. 7). Thus, their costs were considered to be outside the scope of the PBSP funding commitment.

In 2012, Powercor sought the recovery of costs for the deployment of 178 SWER ACRs in the highest fire loss consequence areas to comply with a 2012 ESV direction. The AER did not grant Powercor the right to

[26] It is noted that the Taskforce estimates, which the PBSP Full Business Case adopted, had an error margin of ±20 per cent.
[27] Powercor had already installed 178 SWER ACRs in high fire loss consequence areas on their network at this stage.
[28] REFCL installations at four of the 45 ZSS were not included in this figure as it was assumed that these REFCLs would be installed regardless of whether the regulations were amended.

pass on costs in this instance, but it is assumed that Powercor redirected part of its general revenue allowance awarded through the 2011-15 EDPR period to fund the deployment of these SWER ACRs (Powerline Bushfire Safety Program, 2018b, p. 8).

In May 2016 the AER approved an allocation of $56.836 million for Powercor to pass on to consumers to facilitate the deployment of an additional 1,088 ACRs to cover its entire SWER network in line with its regulatory obligations. The number of ACRs required was later revised due to changing demands of the network and the availability of alternative technology such as fuse savers, which are cheaper.

Following completion of the project, Powercor advised that the total number of ACRs deployed under the PBSP funding commitment was 1,288 which cost approximately $45 million. This is in line with the Taskforce estimate of $43.9 million (nominal) for the deployment of 1,300 SWER ACRs.

Actual cost of REFCL deployment

A cost benefit analysis of the REFCL program was recently completed by Nous on behalf of ESV. Aurecon was provided with a draft of the REFCL cost-benefit analysis report and has incorporated the cost estimates below.

The total costs (in 2020 dollars) for the REFCL program are summarised in Table 13. For the DBs, this includes the cost of installing and maintaining REFCLs, accounting for avoided costs. For HV customers, this contains the cost of hardening or isolating their installations for REFCL operation.

The breakdown of costs for the DBs shows that Capex makes up most total costs. Avoided costs comprised the deferral of future replacement expenditure due to the early replacement of some assets as a result of the REFCL installations. These costs were estimated by Nous based on the average remaining asset life for the replaced parts and the associated deferral of the next replacement of those assets.

Table 13: Breakdown of DB and HV customer costs

Item	Costs ($million, 2020 dollars)			
Distribution Businesses				
	AusNet	Powercor	Jemena	Total
Capex	411	479	32	922
Opex	16	23	-	39
Avoided cost	32	38	2	72
Sub-Total Distribution Businesses	***395***	***464***	***29***	***888m***
HV Customers				
DB expenditure				45
HCAP				8
Private HV customer expenditure not covered by HCAP				11
Public sector organisations				115
Sub-Total HV Customers				***180***
Total Costs				**1,068**

Source: Nous, 2020

The total cost estimate of $1.068 billion (including HV customer expenses) for the delivery of all mandated REFCLs by 2023 is thus more than double the amount originally forecast by the Taskforce ($432 million in 2011 dollars or $504 million in 2020 dollars[29]).

It is noted that DELWP estimates incurred and projected REFCL costs for HV customers to be closer to $132 million, mainly because DB expenditure has not been included in their estimates as these costs fall into Tranche 1 of the REFCL rollout and would have been passed onto consumers (refer Section 6.2.1).

[29] Costs adjusted to 2020 dollars using the Consumer Price Index deflators for Melbourne as published at: https://www.dtf.vic.gov.au/state-financial-data-sets/macroeconomic-indicators

Powerline Replacement Fund

Anticipated costs

Table 14 outlines the anticipated costs for the PRF as detailed in the PBSP Business Case (Ernst & Young, 2012, p. 52). It shows that the $200 million Victorian Government contribution was also intended to cover all program management costs for the PBSP, which were described as material due to the complexity of the program.

Table 14: Estimated costs of the PRF and program management component of the PBSP

Items	Total costs ($m, real 2011)	Total costs ($m, nominal)
Powerline Replacement Fund	164.0	188.5
Program Management	11.0	12.2
Total	**175.0**	**200.7**

Source: The Powerline Bushfire Safety Program - Full Business Case

Actual PRF cost

High level costs for the PRF were provided by DELWP. These are detailed below.

Table 15: Powerline replacement costs (final net cost to customer)

PRF component	Length retired (km)	Length constructed (km)	Cost ($m, nominal)
HV powerlines replaced	536.4	635.9	167.1
POELs replaced	192.8	Not available	18.4
HV powerlines retired and SAPS installed	4.4	n/a	0.7
Total	**733.6**		**186.2**

Source: DELWP

The total cost for the powerline replacement component of the PRF was thus in line with the estimated nominal costs outlined in the business case. This is not surprising since the Victorian Government contribution was capped at $200 million.

A better understanding of whether the actual costs for the program were aligned with the anticipated costs can be gained by looking at the unit cost for powerline replacement per km. Table 16: Unit costs per km of HV powerline replacement below outlines the average unit cost per km for the replacement of HV powerlines (excluding powerlines that were retired due to SAPS installation) as well as the state-wide maximum and minimum. Both unit cost values for powerlines constructed and retired are presented as the length of powerlines constructed exceeds the length of powerlines retired by almost 100km.

Table 16: Unit costs per km of HV powerline replacement

Item	HV powerlines retired	HV powerlines constructed
State-wide average	$311,623	$262,864
State-wide maximum	$1,060,573	$817,863
State-wide minimum	$150,698	$90,981

Source: DELWP

For comparison, the Taskforce estimated the unit costs of replacing powerlines to range from $112,000 per km (low range estimate for overhead insulated conductor) to $650,000 per km (high range estimate for underground conductor). This suggests that either the majority of HV powerlines treated were undergrounded or that the unit cost estimates for insulated overhead conductors were significantly higher than anticipated.

Further analysis uncovered that the majority of powerlines constructed were indeed undergrounded (503.2km), which would have contributed to the relatively high average unit cost (noting that this is still well within the Taskforce unit capital cost estimates for undergrounding powerlines). It was also revealed that there were some cost inefficiencies in relation to some of the planned powerline replacements towards the end of the PRF where the works either took longer than anticipated or had to be descoped.

Research and Development Fund

Anticipated Costs

It was anticipated that R&D Fund appropriations would be allocated based on Taskforce recommendations as outlined below:

- A total of $10 million of Victorian Government funding to identify cost effective risk reduction technologies and improve knowledge and understanding of bushfires caused by electricity assets.
- Expenditures to be allocated to the first 5 years of the program, to ensure that the research can be utilised to improve the delivery and efficiency of the PBSP.
- Bushfire mapping and arc ignition research identified as funding priorities with $7 million to be spent on the bushfire mapping element over four years and $0.5 million to be spent on arc ignition research in the first two years of the program.
- The remaining funds to be allocated to additional research proposals with funding precedence to be given to those projects that were most likely to produce practical and timely outcomes that would enhance bushfire risk reduction efforts.

Additional research needs were to be identified by the Program Control Board (PCB), with some flexibility built into the process to ensure that potential recipients would be able to provide suggestions and feedback on the priorities identified by the PCB. Funding applicants would be determined through a public request for quote process (with exceptions) and would have to agree to the intellectual property being made public (Ernst & Young, 2012, p. 63).

Actual distribution of R&D funds

The breakdown of actual R&D Fund expenses was provided to Aurecon by DELWP and is summarised in Table 11. This includes both costs that have been expended to date as well as proposed expenditure for 2020-21 to cover the remainder of the contract with the CSIRO for the RRM and additional mapping and cartographic services.

Table 17: Breakdown of R&D Fund expenses (includes proposed expenses for 2020-21)

R&D Project	Total costs ($m, excl. GST)
Bushfire mapping & risk modelling	1.591
Arc ignition research	0.455
REFCL trials	3.314
Vegetation conduction & fault signature testing	1.395
Early fault detection project	0.650
Covered conductor grant program	0.359
Broken SWER conductor detection	0.179
Other (e.g. vegetation detection challenge, R&D roundtable, etc.)	0.339
Total	**8.282**

Source: DELWP

Table 17 shows that actual R&D Fund expenses were lower than the $10 million originally committed by the Victorian Government. Consultations with DELWP revealed that some of the costs for the mapping and risk reduction modelling components are still tied up in contracts that DELWP will be using going forward. However, approximately $1.5 million of funding that was first allocated to the R&D Fund was reallocated within PBSP to cover program management costs. This included funds to conduct other project evaluations or other projects costs that were slightly higher than anticipated.

It is also apparent that the breakdown of R&D expenses is different to the allocation of funds proposed in the PBSP business case. The largest contribution of funds was dispensed for the REFCL trials ($3.314 million), whereas the allocation for the bushfire mapping and risk modelling projects ($1.591 million) was significantly smaller than the $7 million originally suggested.

While Aurecon was not engaged to examine the reasons for the difference in funding allocation, our analysis showed that the R&D focus areas were re-evaluated following further consultation with representatives of Victorian Government, industry and the research community to ensure that all program activity was informed by the best knowledge and technology available. This is in line with general practice in the broader research community to continuously monitor key areas of interest to keep pace with new knowledge and technology and adjust research priorities accordingly.

It is noted that a new round of R&D funding opened on 10 August 2020. This round comprises a $2 million grant program to support emerging powerline bushfire safety technologies and systems and is not part of the original $10 million funding commitment for the R&D Fund. The Victorian Government is determined to continue to support research activities to further reduce powerline related bushfire risk and has been able to redirect funding that has become available through other parts of the program to facilitate the new grant program. Furthermore, additional funding will be sought in future budget cycles to enable an ongoing research program as first envisioned by the Taskforce.

F-Factor Scheme and legislative amendments

No information or data was available regarding the budget allocated for developing the f-factor Scheme and legislative amendments or the hours and costs associated with their development.

Document prepared by

Aurecon Australasia Pty Ltd
ABN 54 005 139 873
Aurecon Centre
Level 8, 850 Collins Street
Docklands, Melbourne VIC 3008
PO Box 23061
Docklands VIC 8012
Australia

T +61 3 9975 3000
F +61 3 9975 3444
E melbourne@aurecongroup.com
W aurecongroup.com

aurecon

Bringing ideas to life