# FireSafe SWER EFD Trial

# Final Report

November 2024

This report adds new data from the final year of the Trial to 30 June 2024 to build upon and complement two earlier Trial reports: *FireSafe SWER EFD Trial Report 20220815 in August 2022*, and *FireSafe SWER EFD 12-month Update Report 20230707 in July 2023*.

This report has been prepared by IND.T Pty Ltd, considering comments provided by AusNet Services and Powercor Australia at a draft stage.

**SWER:** Single Wire Earth Return – a powerline technology that uses a single high-voltage wire to carry current to remote customers, the current returning to the source through the Earth.

**EFD:** Early Fault Detection – a patented powerline monitoring technology that detects incipient powerline faults before they occur, manufactured by IND Technology Pty Ltd in Melbourne Australia.

IND Technology Pty Ltd

# Disclaimer

This report describes a project to trial a new powerline bushfire safety technology at various locations in rural Victoria. The Victorian Government sponsored the Trial under its Powerline Bushfire Safety Program. IND Technology Pty Ltd and the Victorian Department of Environment Land Water and Planning executed a Funding Agreement dated 17$^{th}$ February 2021.

This report has observations, analysis, commentary, interpretation, findings, and recommendations.

Subject to the Funding Agreement, IND.T can offer no warranty to third parties for:

- The application of anything in this report for any purpose other than those required by the specific Trial objectives outlined in the body of this report.
- The direct application of anything contained in this report to any situation other than the specific Trial situations recorded in this report.

Readers should note the following qualifications:

- Readers should form their own judgement on the level of confidence they should have in the observations and findings set out in this report.
- The information in this report relates to 12.7kV SWER powerlines. Readers who wish to use information contained in this report to derive conclusions for other types of networks or networks in other locations or environments should rely on their own investigations.
- IND.T has taken reasonable care to outline the rationale and evidence for the findings set out in this report. Readers should make their own judgements of the merits of any such findings before relying on them.
- IND.T has used assumptions to generate insights, derive findings, and interpret data obtained from the Trial. It has taken reasonable care to explicitly document these assumptions and explain the rationale in each case. IND.T offers no warranty that such documentation is complete or accurate or that any assumptions used are valid.
- Where IND.T has used mathematical theory to derive insights set out in this report, it has taken reasonable care to identify the theory and outline its application. IND.T offers no warranty that the theory employed is valid or correctly applied.

Readers should rely on their own analysis if they wish to use this report for any purpose other than the specific objectives of the Trial project outlined in this report.

# Funding Agreement requirements of Final Report

Schedule 5 of the 17th of February 2021 Funding Agreement between IND.T and the Government of Victoria states the following requirements for the Trial final report:

> Details and responses will be required on:
>
> • *The Objectives:* The degree to which the Project has achieved its objectives as stated in Schedule 2 – Project Plan;
> • *The Deliverables:* The degree to which the Project has delivered the agreed outputs as stated in Schedule 2– Project Plan;
> • *The Intended Outcomes:* The extent to which Recipient's performance of the Project has achieved the intended outcomes as stated in Schedule 2 – Project Plan;
> • *Future Outlook:* Details of the future outlook for the Project; and
> • *Appropriateness:* The Final Report must cover the entire Grant Period and describe the benefits and outcomes of the Project as a whole (including a summary of the major activities undertaken by the Recipient).
>
> The Recipient must also include in the Final Report a discussion of any other matters relating to the evaluation of the Project, which the Department specifies to be included in the Final Report.

# Contents

# 1 Executive Summary

The two-year Trial of FireSafe SWER EFD has successfully demonstrated the new technology works, is affordable, and is practical[1,2]. Full-scale rollout is recommended to protect Victoria's rural communities from catastrophic powerline fires.

The Trial was fifty per cent funded by the Government of Victorian and carried out by IND Technology Pty Ltd, AusNet Services, and Powercor Australia. It ended on the 30th of June 2024.

FireSafe SWER EFD systems directly monitored 800 kilometres (and indirectly monitored a further 300 kilometres) of SWER powerlines in a wide variety of environments across Victoria for two years, including in locations with extreme fire loss consequence[3].

Key findings and outcomes of the Trial were:

1. The FireSafe SWER EFD product was proven, refined, and is now exported globally.
2. Reduction in deployment cost was sixty-four per cent, beating the Trial target.
3. FireSafe SWER EFD technology is effective, affordable and practicable.
4. FireSafe SWER EFD systems located multiple network defects, some high-risk.
5. Economic regulation of utilities does not directly support rollout of FireSafe SWER EFD.
6. Both utilities are now considering whether to keep the Trial equipment in service or not[4].

# 2 Next steps

Based on the Trial's powerline monitoring results and other insights set out in this report, IND.T recommends rollout of FireSafe SWER EFD across Victoria to protect all its rural communities from catastrophic bushfires. Towards that end, the following next steps are suggested:

1. Victoria's utilities should review plans to include requests to the AER for funding of EFD rollouts as part of the coming Electricity Distribution Price Review process. The AER's policy settings and its history of decisions on utility investments not directly required by the NEO or justified by market benefits show there may be little value in the usual approach.
2. The Government of Victoria should collaborate with the utilities to explore the feasibility of rollout funding options listed in Section 3 of this report and any others they identify[5].
3. The utilities should work with IND.T to identify the most suitable way to keep in service the FireSafe SWER EFD systems installed for the Trial. These valuable and saleable assets belong to IND.T, which has no budget for their operation beyond the 30th of June 2024.
4. If the Trial EFD units are maintained in service, or a wider rollout takes place, the following recommendations apply:

---

[1] See Section 9.5 on practicality of EFD for protection of rural communities from catastrophic fires.
[2] In accordance with normal practice in Trials, every anomaly located by the EFD technology was regarded as warranting inspection and about fifty sites were inspected. In a wider rollout, the automated tools described in Section 9.4 would be used by utilities to prioritise inspection and remediation to cut costs.
[3] Forty-five Trial SWER networks had powerlines in Electric Line Construction Areas defined by legislation.
[4] AusNet Services has committed to the purchase of their share of the Trial units with a view to keeping them in service. Powercor has not yet advised IND.T of their decision. Absent this decision, IND.T plans to temporarily underwrite operation of Powercor's units through this fire season until the end of March 2025 to maintain the protection provided by the Trial for rural communities in the West of the State.
[5] IND.T would note that the federal government's Future Power Grid initiative may be relevant to the option of government funding of the FireSafe SWER EFD rollout should the parties wish to pursue that option.

a) The utilities should enhance site inspection skills, tools and techniques to improve their cause-identification ('hit rate') in site inspections to best practice levels.
b) The utilities should work with IND.T to transition to 'business-as-usual' EFD monitoring by adopting IND.T's automated EFD results processing: aggregation, summarisation, and analysis software tools.
c) The utilities should review their business processes in network operations, asset management, and network planning to identify adjustments required to get maximum value from EFD systems monitoring their powerlines, including the FireSafe SWER EFD systems installed for this Trial.

A successful trial is not sufficient in itself to produce action that benefits the wider community. Action requires implementation funds and the path to a funding solution can be challenging.

# 3 Editorial – funding the powerline fire-safety of rural communities

NB: This editorial section is solely IND.T's opinions derived from its exploration of stakeholder roles and positions. These views may or may not be supported by AusNet, Powercor, the Australian Energy Regulator, Energy Safe Victoria, or the Government of Victoria. Comments here were not written with expert legal advice; they attempt to reflect the views of educated reasonable persons. They have not been vetted by any of the stakeholders named below.

A target outcome of this Trial was increased powerline fire-safety for Victoria's rural communities. The Trial was successful, but achievement of this outcome requires funds for implementation of the Trial recommendations.

This was the eighth EFD trial in Victoria[6] in nine years, all of which delivered the same findings: EFD works, it cuts powerline fire-risk. This FireSafe SWER EFD Trial has delivered the technology it was tasked to deliver, and it has cut the cost of EFD deployment to monitor Victoria's 27,400 kilometres of SWER powerlines by a factor of three. FireSafe SWER EFD is effective, affordable, and practical.

No trial to date has triggered action to deploy EFD technology in Victoria to fulfill its key purpose – protection of rural communities from catastrophic powerline fires like those on Black Saturday. The key recommendation from this Trial is a full-scale rollout of FireSafe SWER EFD systems on all SWER powerlines across Victoria. FireSafe SWER EFD exists for this purpose.

Rollout funding is necessary to implement this recommendation. For the benefit of wider public readership, this editorial explores the challenge of funding a full rollout of FireSafe SWER EFD.

Stakeholders that between them influence or control implementation funding include electricity customers, the national energy economic regulator (AER), state energy safety regulator (ESV), utilities with rural SWER powerlines (AusNet and Powercor), and Government of Victoria.

Relevant aspects of the role of each of these stakeholders are outlined as follows:

[6] There have been fifteen Australian EFD trials and a similar number of overseas EFD trials over the last nine years. All of them confirmed EFD technology worked and cut powerline fire-risk.

## 3.1 Victoria's electricity customers

AusNet and Powercor each have approximately 800,000 customers, making a total of 1.6 million. The key customer issue is how much they are prepared to pay to cut the risk of catastrophic fires from SWER powerlines. Victoria's Powerline Bushfire Taskforce in December 2010 surveyed 1,500 customers across Victoria to answer this question[7]. That survey found customers were willing to pay up to eight per cent more for electricity if the safety measure involved no reduction in supply reliability, falling to two per cent if supply reliability were somewhat reduced.

The survey indicated that improved bushfire safety was third on the list of customer priorities after cost and convenience, but ahead of supply reliability, environmental friendliness, and visual amenity. The two aspects they were most dissatisfied with were cost and fire-safety.

Section 5 of this report indicates that a full rollout of FireSafe SWER EFD might add thirty cents to a customers' monthly electricity bill. In 2011, the Taskforce estimated the average monthly bill at $105 and it is unlikely to have fallen since then. At that level, an increase of less than one half of one per cent in customer electricity bills would suffice to fund a rollout. This appears to be well within customer acceptance levels.

## 3.2 The Australian Energy Regulator (AER)

The AER is a national body that decides the revenue network businesses can collect from their customers. AER decisions must align with the National Electricity Objective (NEO[8]) defined by the collective governments of Australia in resolutions of the national Ministerial Council on Emergency Services and Energy.

The essential issue: an EFD rollout delivers benefits to the community and environment, but rollout costs go to powerline owners. This split seems to hamper funding decisions.

The AER will only approve increases in utility revenue if the utility submits a case demonstrating sufficient energy market benefits to justify it. Energy market benefits generally (but not always) include retail electricity price reductions or increased competition to create price reductions.

Utility revenue submissions to the AER must meet the RIT-D[9] test. Section 3.5.2 on Page 32 of the RIT-D guidelines in effect states the AER will not approve revenue to cover safety investment beyond a utility's legal obligations[10]. The guidelines do not bind the AER to approve revenue to meet such obligations, only that its approval will not include revenue to exceed them.

---

[7] Powerline Bushfire Safety Taskforce: Final Report, September 2011, Page 51. IND.T is not aware of any similar research published since 2011.

[8] The NEO mentions safety but does not elaborate on its treatment in utility proposals to include wider public protection from safety risks arising from the utility's powerlines.

[9] Regulatory Investment Test – Distribution, which compares the market benefits of a utility investment with its cost to electricity customers.

[10] In AER's words: "A RIT–D proponent must exclude from its analysis, the costs (or negative benefits) of a credible option's harm to the environment or to any party that is not expressly prohibited or penalised under the relevant laws, regulations or administrative requirements. This places the onus on policy makers to prohibit certain activities or to value various types of harm and impose financial penalties accordingly. The RIT–D has no role in prohibiting or penalising activities that policy does not prohibit or penalise." This is not easy to translate into plain English and it is possible IND.T has misunderstood it.

In other words, the AER views investments to protect rural communities and the environment from catastrophic powerline fires to any level beyond a utility's legal obligations as not eligible for cost recovery from electricity customers. The salient question then becomes: what are a utility's relevant legal obligations?

## 3.3 Energy Safe Victoria (ESV)

ESV is Victoria's energy safety regulator. It is bound by and administers functions set out in Victoria's Electricity Safety Act 1998 (as amended). There are two parts of the Act that are particularly relevant to the bushfire-safety obligations of AusNet and Powercor:

(a) **General Duty of Major Electricity Companies** (MECs)[11] set out in Clause 98(c) on Page 139 of the Act. A key phrase is "to minimise as far as is practicable". The Oxford dictionary defines practicable as "able to be done", but the Act uses a more qualified definition[12]. If the qualifications in the Act's definition are met, then Clause 98(c) may impose a clear legal obligation on the utility to deploy EFD on SWER powerlines and the AER would have grounds for including the rollout cost in its revenue decisions; and

(b) **Electricity Safety Management Scheme** (ESMS) procedures set out on Pages 140 to 152 of the Act. In short, utilities must submit an ESMS to ESV. ESV can accept, provisionally accept, not accept, or determine an ESMS for each utility. ESMSs include a Bushfire Mitigation Plan (BMP) covered by further procedures set out on Pages 153 to 159 of the Act. The powers given to ESV by the Act would allow it to include (by negotiation or otherwise) an EFD rollout in a utility's ESMS, most likely in its BMP. This would create a legal obligation, and the AER would have grounds for including the rollout cost in its revenue decisions.

The Act has been successfully used in judicial processes. For example, ESV took a Victorian utility to court and obtained a judgement in May 2024 that held the utility in breach of its legal obligations under the Act. Penalties were set at more than two million dollars. In 2024, the Government of Victoria gave ESV stronger powers and increased penalties for breaches.

An important consideration in any action to impose a legal responsibility for rollout of a fire-safety technology is competitive neutrality. One approach is to define a functional performance specification that a fire-safety technology must meet and allow the competitive marketplace to proffer solutions that meet that specification[13]. Alternatively, policy could use the North American approach: utilities run comparative field trials to select a technology which they then propose to the regulator as representing best value for money.

---

[11] "A major electricity company must design, construct, operate, maintain and decommission its supply network to minimise as far as practicable — (a) the hazards and risks to the safety of any person arising from the supply network; and (b) the hazards and risks of damage to the property of any person arising from the supply network; and (c) the bushfire danger arising from the supply network."

[12] "practicable" is defined in Part 1 of the Act as: "practicable, in section 83B or Part 10, means practicable having regard to (a) the severity of the hazard or risk in question; and (b) the state of knowledge about the hazard or risk and any ways of removing or mitigating the hazard or risk; and (c) the availability and suitability of ways to remove or mitigate the hazard or risk; and (d) the cost of removing or mitigating the hazard or risk".

[13] This approach was used for the REFCL rollout. At the start of the seven-year rollout program, only a single commercial product was available that met the specification. By the seventh year, there were two competitive products in the market, and each was selected by different utilities for the program.

## 3.4 The utilities: AusNet and Powercor

Utilities face a clear choice whether to deploy FireSafe SWER EFD systems to protect rural communities from catastrophic fires started by their SWER powerlines, or to take other action, or to take no action.

EFD deployment would be in line with the results of Victoria's eight EFD trials. It could be considered a contribution to the utility's corporate social responsibilities and environmental objectives, or it could be seen as a condition of the utility's social license to operate in rural communities. The utility directors' fiduciary responsibility to shareholders may not support deployment without clear cost-recovery. Funding a FireSafe SWER EFD rollout, whether by AER-approved cost-recovery or other means, would be an important consideration for utility boards.

## 3.5 Other funding options

IND.T has reviewed other options to fund a FireSafe SWER EFD rollout:

1. **Business case:** A utility business case that meets the RIT-D and shows the rollout will reduce customer electricity prices over the long term (i.e., deliver energy market benefits) would likely satisfy the AER guidelines. However, utility business cases to justify cost recovery fail because the benefits within the utility and to the energy market, taken together, are not sufficient to justify the cost. The FireSafe SWER EFD rollout would deliver major economic benefit to Victoria's rural communities and environmental assets. Without a clear legal obligation, these 'external' benefits may not be considered by the AER in its RIT-D assessment of recovery of the rollout cost from customers.
2. **National Electricity Objective:** The national Ministerial Council could modify the NEO to include protection of rural communities from catastrophic fires caused by powerlines. The NEO was recently modified to encompass climate goals. However, modifications to the NEO are exceedingly rare and are very unlikely in this matter.
3. **Government funding:** A government might fund the rollout. The tax treatment of such arrangements can be prohibitively complex. Nevertheless, early in 2024, IND.T made a pre-budget submission based on independent economic analysis[14] for the federal government to fund a national FireSafe SWER EFD rollout.

## 3.6 Context: other jurisdictions

Experience in other jurisdictions with different regulatory regimes provides thought-provoking context. For example, regulation in North America has produced a very different result than regulation in Australia.

During the Trial period, IND.T sold thirty-nine EFD systems in Victoria[15] (none were FireSafe SWER EFD systems). In the same period, sales to North America exceeded ten thousand EFD systems, including almost five thousand of the FireSafe SWER EFD systems developed in this Trial[16]. IND.T has progressively moved toward a specific hypothesis about the driver of this extreme disparity.

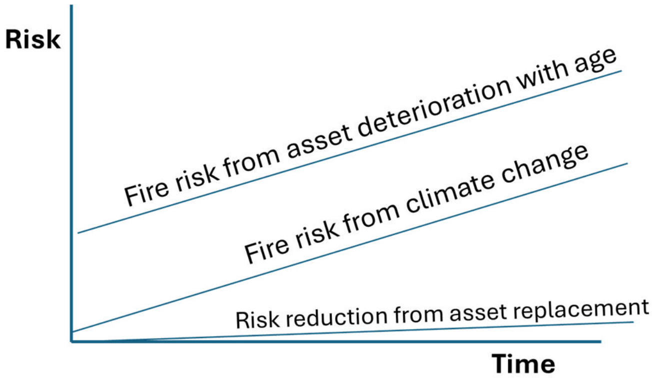
[14] Adept Economics, *Cost-benefit analysis: FireSafe SWER EFD rollout*, November 2023.
[15] Mandated on independent advice from CSIRO to ESV, to protect a specific rural powerline network in place of a REFCL.
[16] Branded in that market as EFD.Tap as utilities there refer to one-and two-wire powerlines as Tap lines.

In North America, EFD technology is widely accepted as a proven way to reduce the risk of catastrophic wildfire. Regulators support, and even informally promote it. North American regulatory regimes IND.T has encountered are state-based[17] and do not split economic regulation from public safety regulation as strictly as is done in Australia. Many regulators there face the challenge of balancing economic and public safety objectives in their utility revenue decisions. IND.T believes this may be the reason demand for EFD systems in North America is hundreds of times greater than demand in Australia.

# 4 The Trial's goal was rural community fire-safety

The challenge of fire-risk to rural communities with SWER powerline networks continues to grow. Risk reduction by replacement of aged assets[18] is not keeping up with increases in risk due to asset age and climate change. Innovative measures are required to manage this steady increase in fire-risk. Figure 1 illustrates in schematic form the drivers of this growing fire-risk.

*Figure 1: Increasing fire-risk from Victoria's SWER powerlines (illustrative only).*




SWER powerlines were adopted many decades ago as the lowest cost way to deliver electricity to comparatively small numbers of customers and facilities (water pumps, shearing sheds, phone towers, etc.) widely spread across remote rural areas. Even today, there is no competing powerline technology that approaches SWER cost-effectiveness in this role.

A technological solution to improve SWER powerline fire-safety is a priority for rural fire protection in Victoria. Victoria has 27,400 kilometres of SWER powerlines, most operating well beyond their originally envisaged service life. New fire-safety technology must have the lowest possible cost, in line with the inherent cost-efficiency of SWER powerlines.

When next Victoria experiences Code Red[19] weather conditions like Black Saturday, SWER powerlines may again cause catastrophic fires, as they did then. On Black Saturday, SWER powerlines caused multiple major fires, including the deadliest – the Kilmore East Kinglake fire

[17] Operating under national guidelines and standards, especially for major transmission lines.
[18] Accurate records are hard to find. Estimates total less than 100 kilometres per year in Victoria.
[19] The highest fire danger rating is now termed "Catastrophic". The previous nomenclature (Code Red) is used in this report to avoid confusion with the frequent use of the term "catastrophic fires", i.e., "catastrophic" is used in this report to describe a type of fire rather than a fire danger rating.

that killed 116 people[20]. SWER powerlines continue to cause thirty to forty fires in Victoria every year. CSIRO predicts[21] increasing occurrence of high fire-risk days as climate change continues.

Innovative new technology is urgently needed to fill the 'SWER gap' in Victoria's powerline bushfire safety strategy. Following the Black Saturday fires, Victoria's response[22] and utility initiatives provided a partial solution to the problem of SWER powerline fires. SWER powerlines have technical characteristics that prevent fire-risk reduction by methods such as REFCLs[23] that work well on polyphase powerlines. Fire-starting SWER powerline faults continue. Victoria's Bushfires Royal Commission noted SWER powerlines posed an inherent fire risk.

This context motivated IND.T, in collaboration with AusNet and Powercor, to bid for a grant under the competitive Round II of the Powerline Bushfire Safety Program R&D Fund. The purpose was to develop and trial a new lower-cost EFD technology designed to support fast[24] rollout with minimal or no disturbance to customers: FireSafe SWER EFD.

The best solution is predictive maintenance: detect and locate, in time to remedy, SWER powerline defects before the powerline fails and causes a fire. Following the Black Saturday disaster, IND.T invented, patented, and commercialised EFD technology that uses predictive maintenance to cut fire-risk on both SWER and non-SWER powerlines.

Until now, IND.T's customers have used EFD technology more for non-SWER powerlines than SWER powerlines. Prior to this Trial, the only EFD systems on SWER powerlines in Victoria were those installed for an earlier government-funded SWER EFD Trial five years ago. Those sixty-one EFD systems have recently been retired due to changes in Telstra's rural data services.

That early Trial proved EFD cut fire-risk from SWER powerlines[25]. It covered less than one per cent of Victoria's 27,400 kilometres of SWER powerlines. SWER EFD systems installed for that trial found two clear cases of gross powerline defects likely to start fires (live broken wire strands hanging from the powerline). The Trial reported here covered four per cent of Victoria's total SWER and found one further such powerline defect (a detached live conductor resting against a wooden pole). Serious undetected SWER powerline defects remain despite improved fire-safety measures since Black Saturday.

# 5 Estimated cost of a whole-of-Victoria rollout

The cost of a whole-of-Victoria rollout of FireSafe SWER EFD would add thirty cents to customers' monthly electricity bills over the 15-year EFD service life.

[20] Based on EFD experience since Black Saturday, it is highly likely an EFD system would have detected and located the incipient fault (strand break) prior to the high winds that caused the conductor to fall. In 2019, the SWER Trial EFD systems found two SWER conductor strand breaks. Many more have since been found by EFD systems on non-SWER powerlines in Australia and North America.
[21] 2021 CSIRO study published in *Nature Communications*
[22] Increased frequency of visual inspections (every three years), rollout of fast sensitive reclosers – switches that cut power if faults are detected – and dampers to inhibit conductor breakage from vibration.
[23] Rapid Earth Fault Current Limiters: devices that reduce (within a tenth of a second) current flow in a powerline earth fault to a level where it cannot start a fire, even under worst case conditions. REFCLs are technically incompatible with SWER powerlines.
[24] Full rollout within two or three years is a feasible objective based on North American experience.
[25] EFD SWER Trial final report 23 June 2019.

It would be a small increment on the cost of Victoria's powerline bushfire safety work completed so far. To deploy FireSafe SWER EFD systems on all 27,400 kilometres of Victoria's SWER powerlines and operate those systems for fifteen years is estimated to cost six to ten per cent of the cost of Victoria's REFCL rollout just completed.

The cost of a whole-of-Victoria rollout depends on three numbers:

1. The total kilometers of SWER powerlines in Victoria.
2. The average kilometres per FireSafe SWER EFD unit.
3. The per-unit deployment and operation cost of FireSafe SWER EFD units.

Each involves uncertainty, so the following estimates must be seen as indicative.

**Total length of SWER powerlines in Victoria.** The 2010 Powerline Bushfire Safety Taskforce assumed a total of 30,000 kilometres of SWER powerlines in Victoria. At the start of the FireSafe SWER EFD Trial, the utilities advised the estimated total was 25,000 kilometres. Both utilities have since provided more accurate data that adds to a total of 27,400 kilometres. This figure has been used here as a basis for estimates of a whole-of-state rollout.

**Average SWER powerline length monitored per FireSafe SWER EFD unit**. This depends on the average degree of branching in the powerline network topology. The units can protect up to five or six kilometres of powerline if there is little or no branching. However, SWER networks are highly branched and the average length of powerline per EFD unit may drop below three kilometres. To estimate the whole-of-state rollout cost, a mid-range figure of 3.6 kilometers[26] has been assumed.

**Per-unit deployment and operation cost.** This is a combination of equipment purchase and the per-site installation cost. A 12-month SaaS[27] license is required and must be renewed each year of the 15-year service life. Each of these components exhibits significant economies of scale, i.e., the per unit cost is lower for total rollouts than for partial ones. Estimates used here are for per-unit deployment and operating costs derived from the Trial after scale efficiencies, and a full wall-to-wall rollout over two years that delivers maximum economies of scale.

Based on the above assumptions, the cost of a whole-of-Victoria FireSafe SWER EFD system over its 15-year service life would be $123 million in dollars of the day. Of this, $37 million would be capital cost over the first two years of deployment. The remainder would be for SaaS service, expensed annually.

Ignoring inflation and exchange rate variations, the indicative NPV cost of a whole-of-Victoria FireSafe SWER EFD rollout at an annual discount rate of seven per cent over a fifteen-year

[26] The 3.6 kilometres per EFD DCU is probably the least certain of these estimates. The 2019 SWER EFD Trial had 4.1 kilometres per EFD DCU. This Trial had 3.7 kilometres total route length per EFD DCU, of which 2.7 kilometres was directly monitored. A full rollout would increase the directly monitored proportion to more than 3.3 kilometres. It is assumed from experience that a major part of the indirectly monitored length was still effectively monitored. This rationale leads to the estimate of 3.6 kilometres per EFD DCU.

[27] Software as a service. Utility practice in North America is to capitalize EFD SaaS license cost since the license terms meet the criteria set out in the NERC-endorsed GAAP (Generally Accepted Accounting Principles) for capitalisation of software services. However, AusNet and Powercor have informed IND.T that this cannot be done by their organisations.

service life would be $91 million in 2024 dollars. If the discount rate were ten per cent, the NPV cost would reduce to $81 million.

This range of cost estimates would add between twenty-eight and thirty-one cents[28] (2024 dollars) to customers' monthly electricity bills over the EFD systems' fifteen-year service life.

Utilities making investment decisions can refine these preliminary indicative estimates with more precise data and more sophisticated modelling based on analysis of a larger sample of representative SWER networks.

# 6 Estimated benefit of a whole-of-Victoria rollout

The target benefit of a statewide rollout of FireSafe SWER EFD would be a reduction in the number of catastrophic bushfires caused by SWER powerlines on Code Red days.

On Black Saturday, SWER powerlines caused several major fires, including the deadliest. Victoria's Bushfires Royal Commission recommended replacement of all SWER powerlines or installation of new technology to reduce their fire risk.

Victoria's rollout of REFCL technology cut the fire-risk of polyphase (multi-wire) powerlines to a fraction of the previous level. There is no similar solution available for SWER powerlines. SWER fire-risk constitutes a gap in Victoria's efforts to ensure powerline bushfire safety. Rollout of FireSafe SWER EFD would go a long way to address this gap.

Independent economic modelling [(Footnote 14, Page 9)] shows the economic return to Victoria would be $4.70 for each dollar of EFD investment. For a rollout of FireSafe SWER EFD to monitor every SWER powerline in Victoria, the economic benefit to Victoria would be $404 million (2024 dollars) over the 15-year service life of the EFD systems through reduced economic loss from catastrophic powerline fires. This does not include the financial value of EFD side-benefits: improved reliability of supply, reductions in utility operating costs[29], and better targeted decisions on end-of-life asset replacement.

In 2025, the AER will decide five-year revenue for Victoria's powerline network businesses. IND.T understands the utilities have included (or are planning to include) investment in some degree of EFD rollout in their submissions to the AER. Without a new approach, the AER is almost certain to deny approval for utilities to recover full rollout costs from electricity customers, just as it has done in similar cases in the past. Section 3 above explains why this so.

# 7 Trial scope and objectives

The Trial's specific scope and budget were:

1. Deploy and operate three hundred new FireSafe SWER EFD systems for two years.
2. Deploy fifty local EFD weather stations.

[28] Given the narrow range of estimates for added cost, a figure of thirty cents is used in this document.
[29] It is much less costly to remedy powerline defects as part of scheduled maintenance than working in emergency conditions under pressure to restore customer supply.

Total Trial budget was $1.45 million, 50% funded by the grant, and 50% funded by IND.T, AusNet, and Powercor. Details are contained in the 17 June 2022 project report[30].

The specific objectives of the Trial were:

1. Prove an EFD solution for SWER networks that halves the cost of the previous one.
2. Reliably estimate fire-safety benefits and levelised cost of the new SWER EFD solution.
3. Assess operational and fire-safety benefits of local weather data for remote areas.

The first objective was achieved - in fact, it was bettered. The second was achieved within confidence limits set by the Trial. Work on the third is still underway[31].

The scope of the Trial is shown in Table 1:

*Table 1: Scope of Trial – Trial network details.*

| Supply Zone Substation | SWER Networks | Route km | Path km | Off-path km | Spurs | Subs | EFD DCUs | Weather Stations | Off-path |
|---|---|---|---|---|---|---|---|---|---|
| Ararat | 3 | 88 | 72 | 16 | 28 | 83 | 24 | 3 | 18% |
| Bairnsdale | 7 | 103 | 84 | 20 | 34 | 119 | 26 | 4 | 19% |
| Ballarat North | 1 | 27 | 23 | 4 | 7 | 27 | 8 | 1 | 14% |
| Ballarat South | 6 | 105 | 78 | 27 | 65 | 207 | 30 | 6 | 26% |
| Barnawartha | 4 | 40 | 27 | 13 | 20 | 60 | 12 | 3 | 33% |
| Bendigo | 1 | 20 | 3 | 18 | 23 | 49 | 2 | 0 | 88% |
| Charlton | 1 | 31 | 24 | 7 | 7 | 19 | 8 | 1 | 21% |
| Colac | 1 | 16 | 12 | 4 | 13 | 35 | 5 | 1 | 23% |
| Eaglehawk | 1 | 30 | 29 | 0 | 1 | 18 | 9 | 1 | 1% |
| Gisborne | 1 | 7 | 4 | 3 | 9 | 23 | 2 | 1 | 39% |
| Hamilton | 4 | 116 | 92 | 24 | 33 | 126 | 30 | 4 | 20% |
| Kilmore South | 4 | 51 | 28 | 23 | 37 | 122 | 12 | 3 | 45% |
| Kinglake | 4 | 76 | 46 | 30 | 52 | 134 | 19 | 2 | 39% |
| Lilydale | 1 | 10 | 9 | 1 | 5 | 22 | 4 | 1 | 14% |
| Moe | 1 | 8 | 6 | 3 | 2 | 13 | 3 | 1 | 31% |
| Murrindindi | 1 | 21 | 15 | 7 | 14 | 39 | 6 | 0 | 31% |
| Myrtleford | 3 | 60 | 47 | 13 | 22 | 90 | 16 | 2 | 22% |
| Seymour | 8 | 101 | 65 | 36 | 60 | 205 | 28 | 4 | 35% |
| Stawell | 1 | 18 | 15 | 3 | 3 | 12 | 6 | 1 | 17% |
| Winchelsea | 1 | 11 | 6 | 5 | 8 | 23 | 3 | 1 | 46% |
| Wodonga | 6 | 63 | 41 | 22 | 47 | 160 | 19 | 4 | 35% |
| Wood End | 5 | 89 | 59 | 30 | 74 | 168 | 23 | 5 | 33% |
| Woori Yallock | 2 | 9 | 6 | 3 | 12 | 29 | 4 | 1 | 36% |
| Total | 67 | **1100** | **791** | **309** | 576 | 1783 | 299 | 50 | 28% |

Forty-five of the sixty-seven Trial networks included powerlines in codified Electric Line Construction Areas – the most extreme fire loss consequence areas of the State.

[30] Table 3 in the 2022 Trial report contains calculation errors - corrected here in Table 1.
[31] The ongoing work on the use of local weather data for network operations on high-risk days is not covered by this report. The installed weather stations continue to function as designed but conclusions on their value must await Victoria's experience of extended periods of high-risk weather.

The ultimate target outcomes of the Trial were:

1. Increased powerline fire safety in remote rural areas of Victoria, Australia, and the world.
2. A major new smart technology export for Victoria.

The second has been achieved. The first requires a funding solution.

# 8 Trial milestones

The FireSafe SWER EFD Trial project encompassed the following activities and milestones:

1. IND.T, AusNet Services, and Powercor Australia formally agreed roles for a Trial.
2. IND.T applied for a Powerline Bushfire Safety Program grant.
3. The Victorian government signed a Funding Agreement with IND.T.
4. IND.T completed laboratory tests of the new EFD design concept.
5. IND.T deployed four prototypes in proof-of-concept tests on two SWER powerlines.
6. IND.T completed technical and physical design of the new FireSafe SWER EFD units.
7. IND.T manufactured 330 FireSafe SWER EFD units.
8. AusNet and Powercor installed 299 FireSafe SWER EFD units on SWER networks.
9. IND.T published the report on the Trial implementation phase (June 2022).
10. IND.T monitored the Trial networks for 12 months with regular firmware upgrades.
11. IND.T published the 12-month Trial update report (June 2023).
12. IND.T, AusNet, and Powercor inspected sites identified in the first 12 months.
13. IND.T, AusNet and Powercor monitored and inspected sites for a further 12 months.
14. IND.T carried out hardware upgrades of forty units to remove LF interference.
15. IND.T published this Final Report in consultation with AusNet and Powercor.

# 9 FireSafe SWER EFD network monitoring results

Discussions following the Trial's 2023 update report showed the value of reader guidance on how to interpret EFD data and site inspection results. The following subsections address this.

## 9.1 Extrapolation of the Trial EFD monitoring results

Trial results indicate (90 per cent probability) there may be high fire-risk powerline defects in up to 161 of Victoria's estimated 1,675 SWER networks.

Extrapolation of EFD results requires an understanding of direct versus indirect monitoring[32]. Although the Trial nominally covered 1,100 kilometres of SWER powerlines, different portions of this total were monitored to different standards: 790 kilometres were directly monitored EFD network paths, and 310 kilometres were indirectly monitored EFD network paths.

An anomaly on a directly monitored network path was almost certain to be detected and located by the Trial's FireSafe SWER EFD systems, whereas an anomaly on an indirectly monitored network path might or might not have been detected depending on a range of factors. The great majority of anomalies detected in the Trial were located on directly monitored paths.

[32] A directly monitored network path is a segment of powerline between two FireSafe SWER EFD units. An indirectly monitored path is a powerline branch off the directly monitored path that does not have a FireSafe SWER EFD unit at the end of it.

A full rollout of FireSafe SWER EFD to monitor all SWER powerlines in Victoria would transform many indirectly monitored paths in the Trial into directly monitored paths as each network is fully populated with EFD data collection units (DCUs) in accordance with EFD system concept design rules.

The proportion of directly monitored powerline-kilometres varied widely across the 67 SWER networks in the Trial (see Table 1), ranging from twelve per cent to one hundred per cent of the network's total powerline route-length. The average proportion was seventy-two per cent. This reflected the challenge of spreading Trial coverage over the full range of environments in Victoria within a hard constraint on the total number of EFD DCUs available for deployment, viz., three hundred. Some networks had only two FireSafe SWER EFD DCUs installed.

Extrapolations outlined here use the conservative option of total Trial network route length rather than the smaller total length of directly monitored powerline segments. The Trial's total route-length of SWER powerlines in its 67 SWER networks comprised four per cent of Victoria's 27,400 kilometres. Extrapolation of Trial results to yield a central estimate of Victoria's total results can be derived by simply multiplying Trial results by twenty-five[33].

Confidence limits can be calculated[34]. If the network with a detached conductor is viewed as the single positive experimental result in tests on sixty-seven networks, it is ninety-five per cent probable that the number of SWER networks containing a detached conductor lies in the range between 0.07 and 6.82 per cent of the total population of SWER networks in Victoria, i.e. between one and seventy-six (95% confidence limits) of Victoria's SWER networks may have this defect. The central estimate of this defect across Victoria is twenty-five networks.

If the 2019 SWER EFD Trial's eleven networks and two[35] critical powerline faults are included, three positive results in seventy-eight networks gives confidence limits of 1.35 and 9.63 per cent of SWER networks across the State, i.e., between 23 and 161 networks (95% confidence), with a central estimate of sixty-four networks, may have undetected critical fire-risk defects of those types[36]. Further analysis of confidence limits was not required by Trial objectives.

## 9.2 The role of site inspections in Trials

In a Trial, every EFD-detected anomaly must be considered a valid candidate for site inspection. The objective was to quickly build up knowledge of how EFD monitoring results correspond to different physical causes, including defects, on Victoria's SWER networks. Automated aggregation and analysis tools were not used to prioritise sites for inspection in the Trial.

FireSafe SWER EFD monitoring of SWER powerlines in the Trial found many anomalies that were candidates for potential powerline defects. Site inspection was the only means to confirm the physical cause of an anomaly detected by EFD monitoring. Four rounds of targeted site

---

[33] 27,400 km divided by 1,100 km is 25, times 67 networks in the Trial is an estimated 1,675 SWER networks in Victoria.
[34] *Accurate confidence intervals for binomial proportion and Poisson rate estimation*, T D Ross, 2003. The methods outlined in this text suit small test populations with very small numbers of positive results as occurred in this Trial.
[35] One of the two cases of a live hanging broken strand was detected after that trial had officially ended.
[36] Since 2019, the utilities may have adopted additional fire-safety measures, the benefits of which may not be reflected in the 2019 figures. If so, perhaps one of the two broken strands may not have existed, and the extrapolation confidence limits would be 12 and 131 networks.

inspection were conducted during the Trial. Some were performed by IND.T, some by the two utilities, and some by specialist contractors engaged by the utilities.

If the physical cause of an EFD-detected anomaly was identified by site inspection, the site could then be rated for priority of remediation and assigned to scheduled maintenance using existing utility work practices. If no physical cause were found, this indicated the cause of the RF signals was hidden in a network asset, was inactive during site inspection, was transient, or a combination of these.

## 9.3 The challenges of site inspection

FireSafe SWER EFD monitors powerline assets continuously for defects, regardless of time of occurrence, type, location (pole or span), and whether the cause is visible or not.

Powerline defects found by EFD monitoring are not always visually apparent, and sophisticated tools may be required to find them. These tools include ultrasonic cameras, corona cameras, high-resolution cameras on drones, and high-quality digital cameras with long-focus lenses for ground-based photography. IND.T experience shows the 'hit rate' (identification of a physical cause) with such tools can reach 80-85 per cent, whereas without such tools it is lower.

The Trial provided valuable experience of working with modern hi-tech inspection tools:

1. The corona camera offered limited value at distribution voltage levels.
2. The ultrasonic camera provided useful value at some sites, especially when used at times of the day when humidity was high, e.g., early morning and late afternoon.
3. At its best, the ultrasonic camera provided less value in SWER site inspections than in inspections of sites on higher voltage networks: 22,000-volt distribution powerlines, 66,000-volt sub-transmission, or transmission at 115,000 volts or more[37].

IND.T experience is that traditional line inspection methods have a 'hit rate' of at best about thirty per cent on EFD-detected sites. The role of traditional inspections is to define the work required to ensure there is no risk of a network fault before the next inspection in three years' time. Minor issues are not seen as material and may not be recorded. Inspectors cannot see defects within network assets such as failing lightning arrestors, fuses, switches, and transformers. Experience indicates inspection of pole-mounted hardware is much easier than assessment of conductor integrity, especially on long spans over deep gullies. SWER powerline conductor condition is notoriously difficult to accurately assess by ground-based inspection.

## 9.4 Automated aggregation, summation, analysis, and workflow

Anomalies found by EFD monitoring of SWER powerline networks have four key attributes: Location, Energy, Activity, and Intermittency.

For 'business as usual' operation of mature EFD powerline monitoring systems, IND.T provides automated aggregation, summarisation, and analysis tools that process these attributes to create higher-level data (site scores, burst alerts, and alert management workflow) to assist network owners in decisions on site inspections and remediation. The highest priority for inspection is a continuously active RF signal source with a clear location, high signal energy,

[37] Electric field strength (the driver of RF emission) is stronger on higher-voltage powerlines than on SWER. The manufacturer has just released a new ultrasonic camera with enhanced sensitivity, suited to distribution networks. IND.T is acquiring one of these to evaluate its performance in site inspections.

and high activity. The priority of site inspection diminishes as the key attributes fade towards background noise levels.

## 9.5 EFD fire protection of SWER networks is practicable

If the sole purpose of an EFD rollout is protection of rural communities from catastrophic fires, a simple annual four-step activity performed prior to the start of the fire season should suffice to exploit the fire-safety benefits of FireSafe SWER EFD. The same steps could also be taken after severe storms to confirm SWER powerlines remain fire-safe.

The four steps are:

1. Scan recent EFD results for all the utility's SWER powerlines using automated analysis.
2. Select sites for inspection visits.
3. Inspect selected sites.
4. Carry out any remedial work required to make safe all powerline fire-risk defects.

These steps are not particularly onerous or costly.

Some North American utilities use automated tools to perform this sequence of tasks on a continuous basis. Those utilities also aim to integrate EFD monitoring results into their business processes to obtain maximum return on their EFD investment. EFD results can support many different utility functions: asset management, network planning, supply reliability, fire protection (including vegetation management), end-of-life asset replacement, etc. Adjustment of each of these business processes can deliver additional value from EFD monitoring.

There are advantages to continuous analysis of EFD results, but a pre-fire-season review of the last three months of EFD results using the four-step process above would be easy, low cost, and sufficient to find most SWER network sites that pose a high fire risk.

## 9.6 Results of Trial site inspections

Table 2 summarises the powerline anomalies found by EFD monitoring during the Trial.

*Table 2: High-level summary of EFD monitoring results in the Trial – counts of powerline anomalies.*

| Measure | mid-2023 | | mid-2024 | |
|---|---|---|---|---|
| | Count | % | Count | % |
| **No of direct monitored paths** | 260 | 100 | 260 | 100 |
| **No of 'clean' paths** | 228 | 87.7 | 206 | 79.2 |
| **No of paths with anomalies** | 32 | 12.3 | 54 | 20.8 |

During the Trial, 50 sites were inspected at different times, using a variety of methods:

1. IND.T inspections:
    a. Inspection tour 1: Pre-June 2023:13 sites inspected[38], nine likely causes found – 70% 'hit rate'
    b. Inspection tour 2: 4 Feb 2024: 15 sites inspected; seven likely causes found (30 per cent of the 15 were masked by LF interference) – 70% 'hit rate' on sites without LF interference. Acoustic camera used.
    c. Inspection tour 3: 28 June 2024: one site inspected; likely cause identified – 'hit rate' not applicable.
2. Traditional asset inspection[39]: 19 sites inspected, nothing assessed as warranting remedial work – 'hit rate' unclear[40].
3. External specialist contractor[39]: eight sites inspected; seven likely causes found – 90% hit rate'. A full range of visual and ultrasonic tools were used.

## 9.7 Powerline defects found by site inspection

The new FireSafe SWER EFD technology proved to be more sensitive than previous EFD designs, and some detections were low-energy, low-activity 'benign' anomalies, e.g. strands of cobweb hanging from live conductors, an example of which is shown in Figure 2.

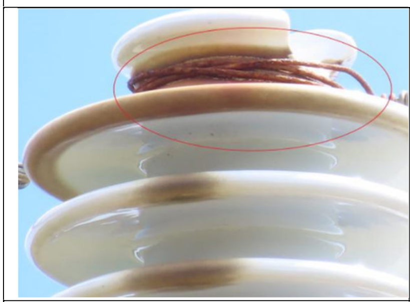
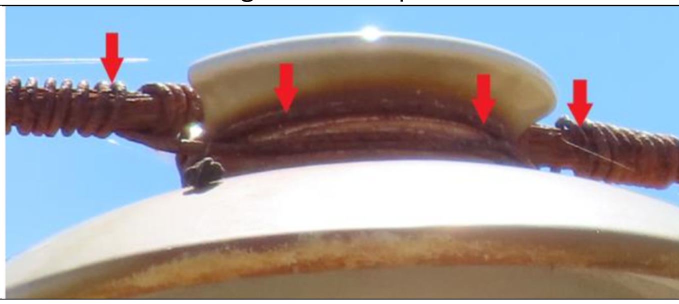
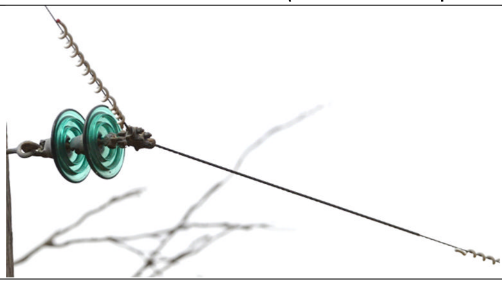
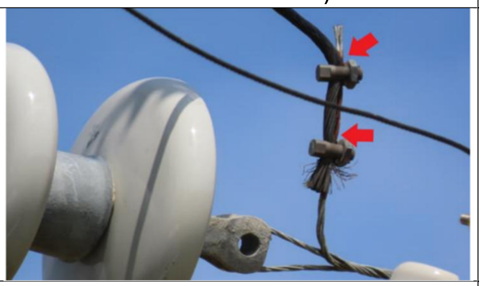
*Figure 2: Cobweb on powerline detected by FireSafe SWER EFD system.*

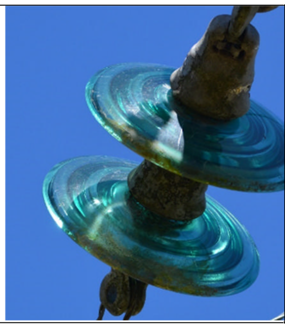
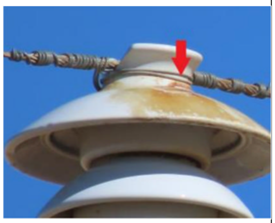
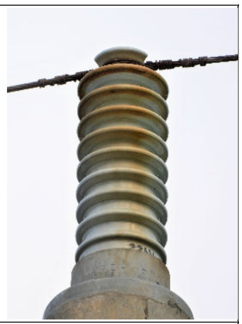
Utilities using EFD systems should not consider strands of hay and other vegetation benign if wind can blow them along the conductor to a pole-mounted insulator where they may cause a flashover. However, such debris usually blows off the conductor before site inspection.

---

[38] This tour of 13 sites with anomalies was conducted early in the Trial and results were reported in the Trial's June 2023 12-month update report.
[39] Carried out at the request of Energy Safe Victoria following the June 2023 report.
[40] The asset inspector reported at all nineteen sites: "No defects identified. All fittings serviceable. Conductor in good condition." However, site inspection notes recorded the presence of bird damage of polymer insulators at four sites, nearby splices (including McIntyre sleeves) at six sites, tie wire corrosion at one site, and a fog type insulator at one site. All of these can be causes of RF emissions.

*Table 3: Typical powerline asset defects found in EFD-prompted site inspections (representative sample)*

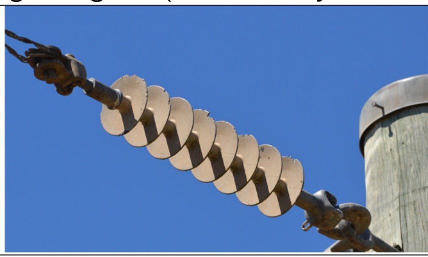
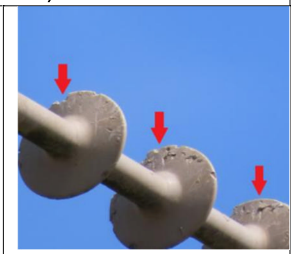
| | |
|---|---|
|  | |
| Detached live conductor against wood pole. | |
|  |  |
| Corroded tie-wires (with consequential insulator surface contamination) | |
|  |  |
| Loose conductor clamps (NB: conductor slippage in first example) | |

Insulators with surface contamination (mould and tie-wire corrosion products)



Splices emitting RF signals (three McIntyre sleeves shown)

Damaged insulators (from cockatoos and flashovers)

LV service faults (audible noise coming from Steel LV service shield on the pole)



Old ‘fog-type’ insulators (In Victoria, the youngest of this type is now 45 years old.)

Utilities assessed most such defects as not requiring urgent remedy. They scheduled many as P2 (remedy within 32 weeks) or P3 (remedy within 3 years) or ‘remedy not warranted before next inspection’. The images set out in Table 3 show a sample of the asset defects found in EFD-prompted site inspections during the Trial.

## 9.8 EFD-detected asset defects that failed before site inspection

In addition to the example defects shown in Table 3, FireSafe SWER EFD systems detected some pending asset failures, but the asset failed before a site inspection could be done. The utility had already completed urgent remedial work to restore customer supply and detailed pre-failure site inspection records were not available. Fuse candling[41], a known fire-starter that regularly appears in fire records, was of particular interest. Table 4 outlines two examples.

*Table 4: examples of fuse candling foreshadowed by prior EFD defect detection.*

| No | Details (from operator's logs) |
|---|---|
| 1 | Fuse candling[42]. A fuse opened at 11:19pm during a storm. The EFD system monitoring the network path with the failed fuse showed the utility restored supply at 2:05am the next morning and restoration (by replacement of the failed fuse) was immediately followed by a very-high-energy disturbance for twenty-seven minutes, followed by intermittent low-energy signal bursts for two weeks. The fuse failed nine days after these bursts ceased, again during a storm. The utility replaced the fuse to restore supply after three and a half hours, this time with no unusual EFD results recorded. |
| 2 | Fuse candling. The EFD system monitoring the network path containing the failed fuse showed a continuous moderately-high-activity disturbance for two hours and forty-five minutes before the fuse failed, i.e., candled. |

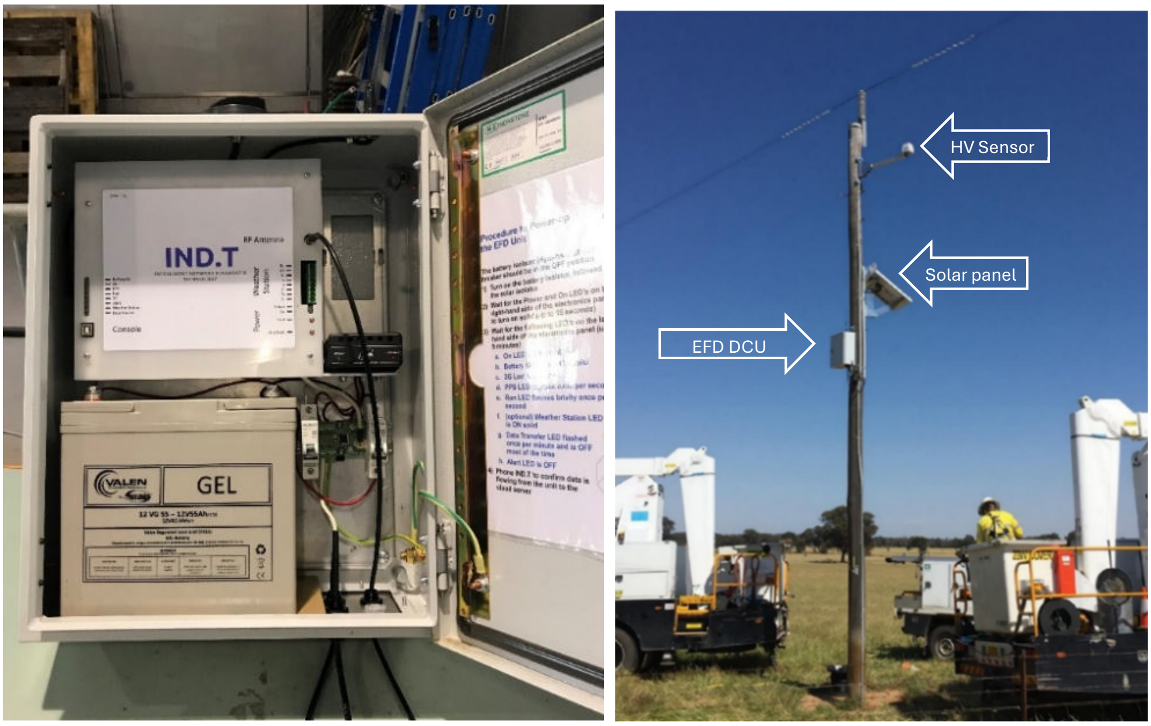
These two examples indicate a possibility of using EFD monitoring systems to detect and locate fuse candling events. The challenge will be to deliver near-real-time results suited to operational decisions in network control rooms.

# 10 Cost savings in the new EFD hardware design

The Trial cut the deployment cost of EFD monitoring of SWER powerlines by a factor of three. FireSafe SWER EFD hardware was a radical redesign of past EFD systems. The new design used a patented innovative concept: RF signal capture from low-voltage wiring instead of from high-voltage conductors. The following extracts from the June 2022 Trial report are repeated here to show the cost reduction. Figure 3 shows the 2019 SWER EFD design used as the cost baseline.

[41] Failure of high-voltage fuse: the fuse overheats, physically distorts, and does not open correctly.
[42] In the Trial's June 2023 12-month update report this case was incorrectly described as a vegetation fault. Further investigation revealed a candled fuse located less than one span from the vegetation.

*Figure 3: 2019 SWER EFD Trial equipment (baseline for comparisons).*




Cost analysis of the 2019 EFD trial units pushed design of the FireSafe SWER EFD hardware toward three specific objectives:

1. Eliminate the solar power supply – to save cost and have one less item on the pole.
2. Eliminate the HV capacitive sensor – to allow installation on customer substation poles.
3. Optimise the EFD Control Box – cut cost, weight, size, and ease of installation.

Figure 4 shows the result. The innovative design is small, light, and easy to install without a customer supply outage. Because FireSafe SWER EFD units are usually installed on customer substation poles, i.e., close to buildings, work crews do not have to travel deep into paddocks and can usually operate from, or close to, a driveway.

The Trial cut the deployment cost (i.e., cost to procure and install) of SWER EFD systems by an estimated sixty-four per cent, exceeding the project target of fifty per cent reduction. The innovative design beat the target fifty per cent reduction in unit manufacturing cost and delivered a seventy-seven per cent reduction in installation cost.

Table 5 compares the old and new SWER EFD units in each facet of their design. Figure 5 illustrates the resulting changes in cost structures.

*Figure 4: The final SWER EFD data collection unit and an installation with weather station.*

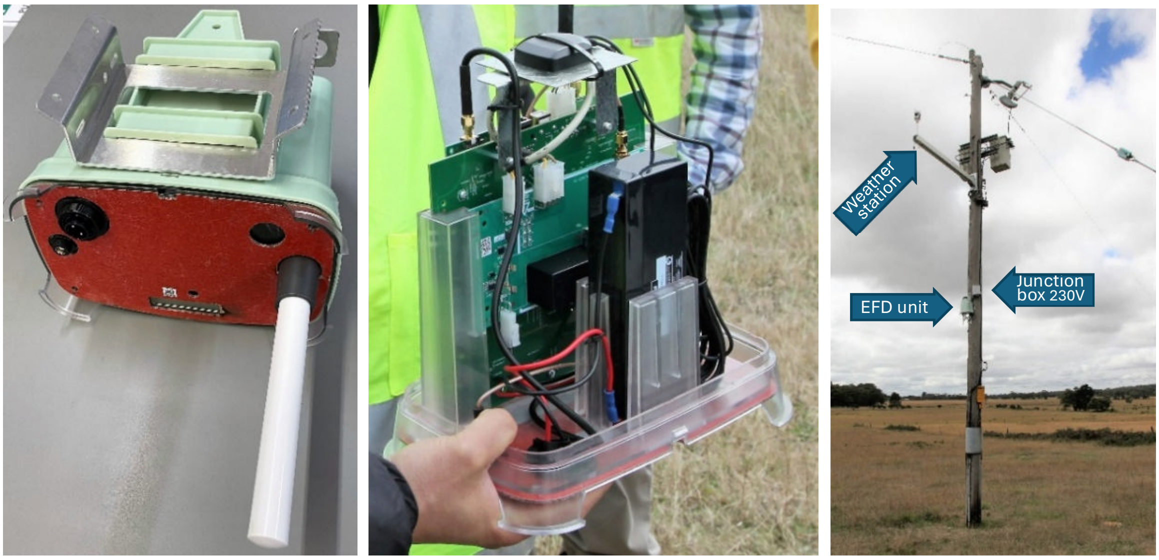
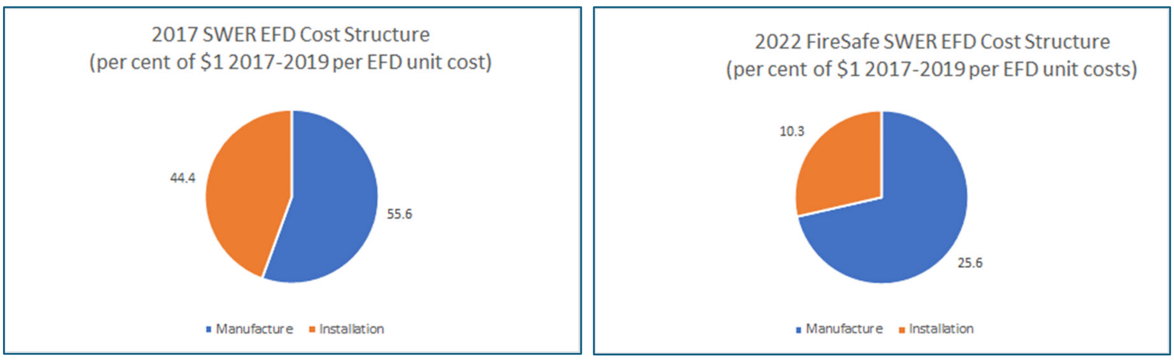



*Table 5: Summary of design changes in the FireSafe SWER EFD data collection unit.*

| ***Design facet*** | **2017 SWER EFD** | **2021 FireSafe SWER EFD** |
|---|---|---|
| *RF signal acquisition* | HV capacitive coupler | Internal LV power supply tap |
| *Power supply* | Solar panel | 90-264V mains |
| *Enclosure* | Powder-coat Zinc-plate Steel | UL94v0 Plastic |
| *GPS signal acquisition* | External 'puck' antenna | Internal antenna, ground plane |
| *Back-up battery* | Four days (12V55Ah) | Two hours (12V2.2Ah) |
| *Electronics assembly* | Metal chassis with PCBs | Integrated multi-PCB stack |
| *4G/3G antenna* | Whip on top of enclosure | Short stub on base of enclosure |
| *Interface* | Multiple LEDs | One LED |
| *Earthing* | Heavy-duty Q-lug | No safety earth required |
| *Circuit breakers* | Two: solar, battery | None, internal fuses only |
| *Cables* | Two: sensor, solar panel | One: mains power |
| *Serviceability* | Field serviceable | Field swappable |
| *Maintenance* | New battery each five years | Swap/refurbish every ten years |
| *Field access* | Lockable door | Sealed, no internal field access |
| *Weight* | 33kg | 4kg |
| *Size (DCU)* | 500Hx400Wx290D (inc. bracket) | 263Hx267Wx228D (inc. bracket) |

*Figure 5: Cost structure of 2022 FireSafe SWER EFD deployment compared to 2017 SWER EFD (both in 2022 dollars).*

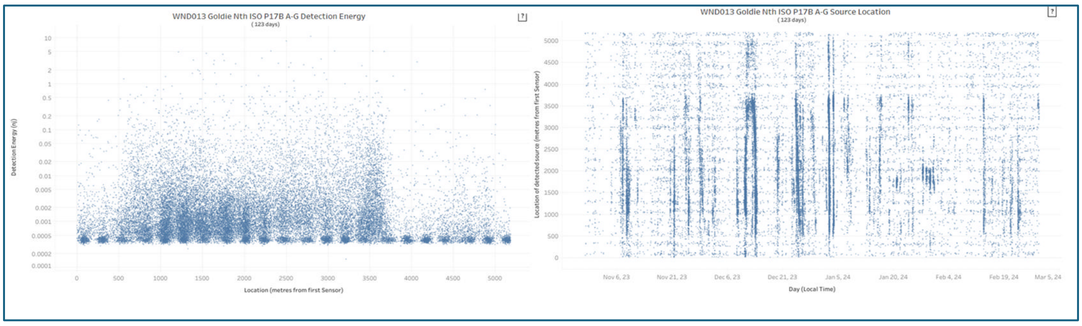


# 11 FireSafe SWER EFD design enhancement in the Trial

During the Trial, IND.T significantly enhanced the installed EFD systems, mostly by remote application of firmware upgrades[43]. Only one enhancement required hardware modification.

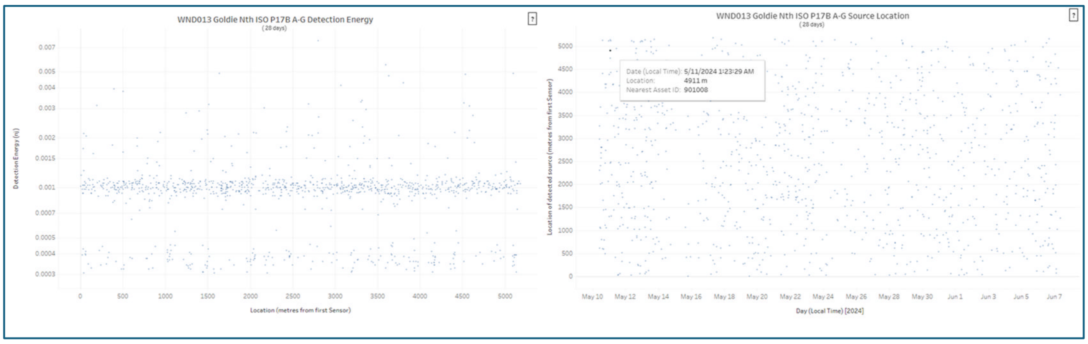
Early in the Trial implementation phase, IND.T saw several instances of low frequency (LF, less than one megahertz) interference in EFD monitoring results on a small number of the Trial's SWER powerlines. The identified sources were of two types: AM radio stations and local rooftop solar power systems. An example of a network path affected by both types is shown in Figure 6. The AM radio station signal had a 500-metre wavelength (corresponding to 600kHz) and though very low in energy, was constantly present. The solar interference was higher energy, more diffuse (spread over three kilometres of the path), and intermittent as shown in Figure 6.

*Figure 6: Low frequency interference (AM radio station and solar) before the hardware change.*




IND.T's review of solution options revealed a change to system hardware was the best short-term way to remove the distortion of EFD monitoring results caused by the interference. IND.T manufactured forty additional FireSafe SWER EFD units fitted with the hardware change and swapped these with the forty most interference-affected Trial units. 'Before and after' comparison confirmed the solution worked. Figure 7 shows interference had disappeared.

*Figure 7: After hardware change.*




Experience in this Trial and in North America confirmed the hardware change did not affect the EFD systems' core function – to detect and locate incipient powerline defects. IND.T integrated the modification into the standard EFD hardware design and incorporated it in all new units, including EFD.Tap units bound for North America.

[43] Enhancements done using firmware updates are listed in the June 2023 12-month update report.

# 12 Conclusion

The FireSafe SWER EFD Trial was successful: it showed (like each of the eight earlier Victorian trials over the last nine years) that EFD technology works and cuts powerline fire risk. It also demonstrated the technology's affordability and practicality.

IND.T greatly appreciates the Government of Victoria grant and the utility collaboration that made this Trial possible. None of the next steps listed in Section 2 requires another SWER EFD trial, so this is likely to be IND.T's final SWER EFD trial in Victoria.