Line down detection

Innovation allowance findings report

December 2025

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1. Introduction

1.1 Purpose of this report

This is Powerco Limited's ("**Powerco**", "**we**") close out report for the Innovation Project Allowance, for the Line down detection project. This report is submitted to the Commerce Commission (**the Commission**) to meet the requirements of the DPP3 Determination Schedule 5.3 clause 5[1]. Clause 5(a) requires that following completion of the innovation project, the EDB must 'submit a report to the Commission that outlines the key findings of that project'. Section 3 of this report outlines the key findings of the project. The report is also published on the Powerco website as required by clause 5(b).[2]

1.2 Powerco's innovation allowance application, approval and completion

Under the DPP3 Determination, Electricity Distribution Businesses (**EDB**s) may make an application to the Commission for approval of drawdown of the allowance under Schedule 5.3 of the Determination. An 'innovation project' is one which is focused on the creation, development, or application of a new or improved technology, process, or approach in respect of the provision of electricity lines services[3].

The Powerco application for the innovation allowance was submitted in June 2024 (application for FY24 and Commission approval). Stage 2 of the project was planned to progress following successful completion of Stage 1. To date, this has not progressed due to other priorities and as outlined further in the next steps section below. This report is therefore published to complete the DPP3 Schedule 5.3 requirements and should the next stage be implemented, this would be under DPP4 provisions.

1.3 Sharing project learnings

This report shares information about this project and our learnings for the benefit of other electricity distributors and the wider electricity sector. Activities we have, or will, undertake to share information include:

- Publishing the application
- Publishing this completion report
- Project update and video in the industry insights section of our website[4]
- Presentation at the 2025 EEA conference
- Briefings with individual EDBs with an interest in the technology.

[1] The 2020 DPP Determination was updated to include Powerco's transition in November 2022: 5B20225D-NZCC-25-PowercoE28099s-transition-to-the-2020-2025-DPP-Final-determination-30-November-2022.pdf (comcom.govt.nz) The Commission also updated Schedule 5.3 in November 2023 to update clause 5.3(2)(c) relating to the specialist report: Electricity-Distribution-Services-Default-Price-Quality-Path-Innovation-Project-Allowance-Approval-Criteria-Amendment-Determination-2023.pdf.

[2] Electricity disclosures

[3] Input Methodologies Determination, Interpretation section 1.1.4: electricity-distribution-services-input-methodologies-determination-2012-consolidated-as-of-23-april-2024.pdf (comcom.govt.nz)

[4] Live lines down detection testing project overview on Powerco website

2. Project outline

2.1 Project overview

Table 1 presents an overview of the project stages, cost and how the innovation allowance drawdown has contributed.

Table 1 Project overview

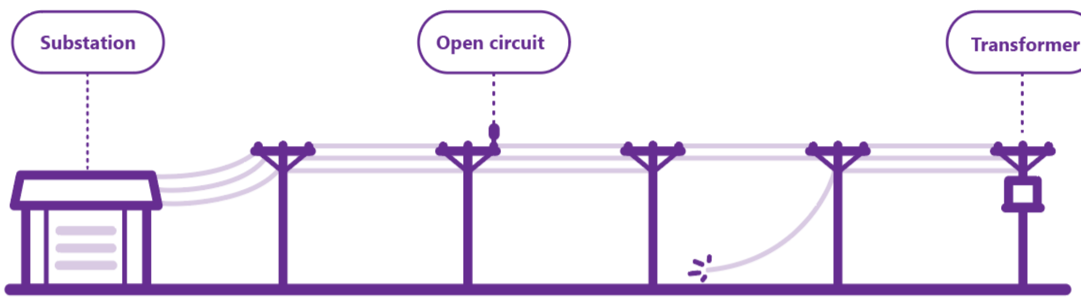
Project activity		Cost
Stage 1: Development and proof-of-concept (complete)	This stage developed and tested a new detection method for downed HV conductors using LV voltage phase and sequence analysis. Activities included PSCAD[5] simulations, building a safe test circuit, and conducting controlled field trials across multiple downed-line scenarios.	Cost: $178,168 Allowance drawdown: $89,084
Stage 2: Network trial and integration	*(Not yet commenced – subject to internal approval)* Looking to potentially partner with other EDBs to scale trial to test against real-world complexities	

2.2 Project drivers and purpose

Downed conductor events occur when an overhead high-voltage (**HV**) line becomes detached and falls to the ground or another surface. In many cases, the conductor remains energised because traditional protection schemes do not detect the fault, particularly under high-impedance or open-circuit conditions where current flow is minimal. This creates a significant public safety risk, as the hazard may persist until reported by a member of the public.

The detection challenge arises because conventional protection relies on current imbalance or earth fault magnitude, which is often insufficient for these scenarios. The line down detection technology leverages low-voltage (**LV**) monitoring at distribution transformers to identify changes in voltage phase relationships and sequence components (V2/V1 ratio) that occur when an HV conductor is down. These distortions are measurable even when current is negligible, enabling earlier hazard identification. This use of controls to detect the line down is illustrated in Figure 1 Illustration of network placement for line down detectionFigure 1.

Figure 1 Illustration of network placement for line down detection



[5] Power System Computer Aided Design software

The project tested this concept through electromagnetic transient simulations and controlled field trials. The trials replicated real-world conditions such as a conductor on the ground, on a vehicle, or against a fence—and confirmed that the algorithm could reliably detect downed-line conditions. This validation demonstrates the potential for a proactive engineering control that does not rely on public reporting.

The purpose of capturing this data and refining detection logic is to enable timely alarms and operational response, reducing exposure time for the public and improving safety outcomes. This approach also supports efficient resource deployment and could inform future integration into supervisory control and data acquisition (**SCADA**) and outage management systems.

2.3 Project delivery

The Phase 1 development and proof-of-concept trial confirmed that the proposed LV-based detection method can reliably identify downed HV conductors under a range of conditions. Controlled field tests replicated multiple real-world scenarios, including conductor contact with ground, vehicles, and fences, and the detection algorithm consistently generated alarms aligned with simulation predictions. This validates the technical feasibility of using LV voltage sequence analysis for early hazard identification.

The test circuit and PSCAD modelling approach, as described in our June 2024 application[6], remain appropriate for further refinement. The controlled trial also highlighted the influence of earth resistance and network configuration on detection sensitivity, which will inform any future deployment logic. For more detail regarding the relevant technology see the June 2024 Application to the Commerce Commission.[7]

Figure 2 Monitoring device in place

While Phase 1 achieved its objectives, further network trials are considered necessary to confirm performance across diverse feeder types and operating conditions, including areas with high solar (photovoltaic (**PV**)) penetration and harmonic distortion. These trials would also allow assessment of nuisance-alarm mitigation and integration into operational systems.

Phase 2 (network trial and integration) did not progress during 2025 due to competing priorities and the small team's focus on other activities. We intend to advance the line down detection project into a network trial in FY26 or FY27 and are currently scoping the next phase. An application under the DPP4 Innovation and Non-Traditional Solutions allowance may be submitted.

[6] Innovation allowance drawdown application to Commerce Commission June 2024
[7] As above at (5)

3. Project findings

3.1 Detection algorithm performance and field test correlation

The field trial involved the two technology providers testing the response to simulated incidents of a car v line, line on the ground, and line across a farm fence.

Figure 3 Field test

The LV voltage sequence analysis performed well in the controlled trials. The field tests validated the detection thresholds.

The PSCAD modelling outputs were proven with field test results, confirming accuracy and reliability of the technology.

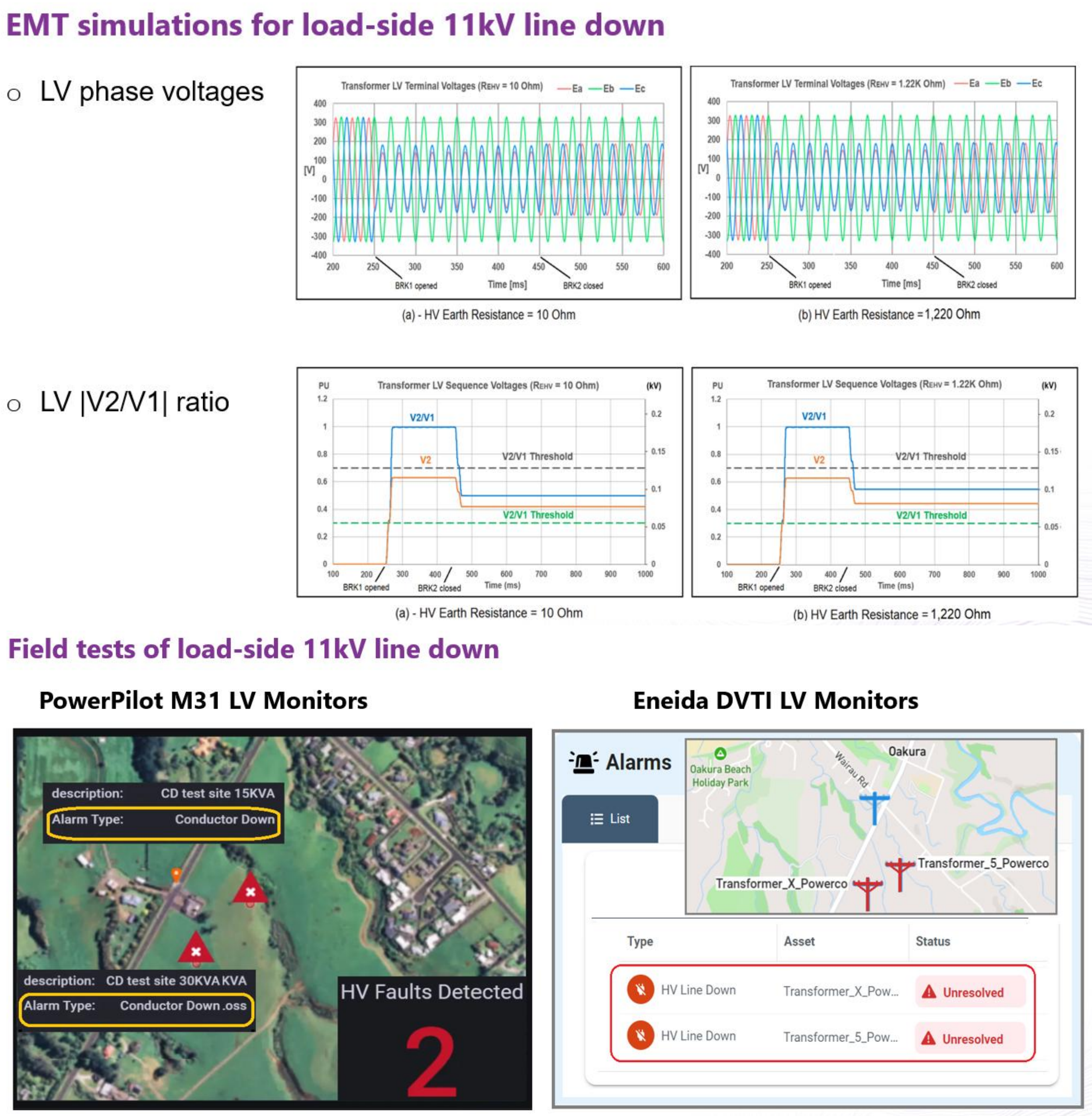
Learning from the field tests allowing us to add the following detection thresholds to enhance the detection algorithm:

1. HV Phase Loss threshold. This will prevent HV Line Down from triggering in borderline cases and classify them as HV Phase Loss instead
2. Add resolution threshold. This will avoid repeated clearing and retriggering and result in a single HV Phase Loss alarm rather than multiple alarms.
3. Set confirmation period to improve the validity of real line down events.

However, there are complexities with real world application which were not tested in our field test as it was limited to a scenario in a controlled open area (refer **Error! Reference source not found.**). Further trial at scale is required to test these real-world challenges, for example, where there are non-conventional loads/generation like PV and EV installations.

Summary of the results for the simulations and field tests are shown in Figure 4.

Figure 4 Summary of results



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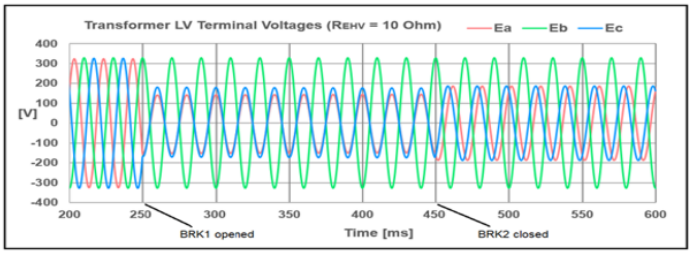
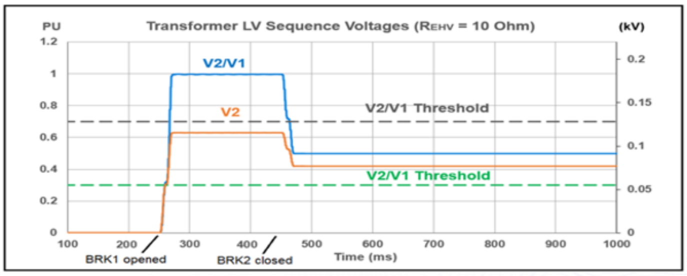
Summary

Scenario	Eneida	PowerPilot	|V2/V1|
Line down on car but not touching ground	✓	✓	0.54
Line down on car and ground	✓	✓	0.52
Line down on carpet tiles on car	✓	✓	1.00
Line down on ground	✓	✓	0.55
Line down on fence and wooden pole	✓	✓	0.91





3.2 Integration Challenges

A key challenge is integration with systems and workflows. This is critical for the success of the technology and our confidence of its long-term use. In particular, integration of alarms with SCADA.

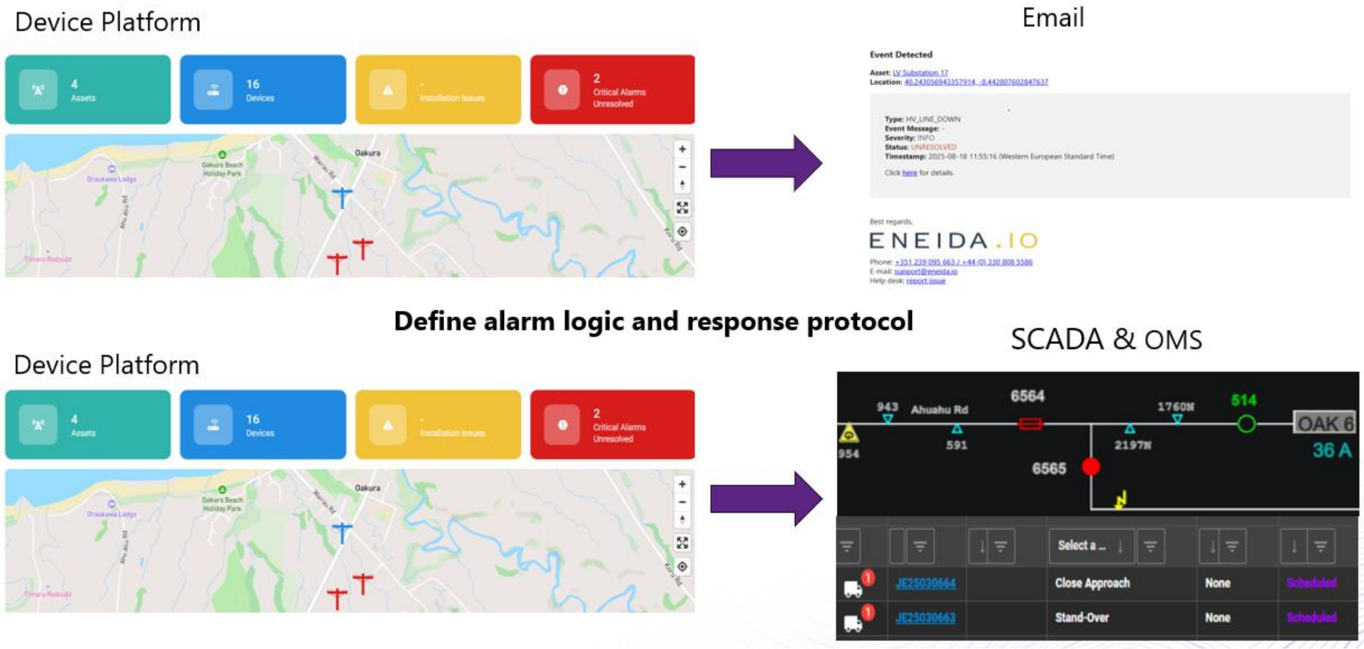
The trial aimed to define the integration and workflow interfaces. Figure 5 illustrates the key interfaces between the device platform and workflow systems.

To ensure project success, alarms must be managed in a consistent manner with clear, reliable messaging. Any discrepancies or untrustworthy outputs are likely to undermine operational confidence and hinder acceptance at the operational level. We found that as alarms are integrated, it is critical that they drive clear and simple actions and that the information provided is trusted by users. Reacting to misinterpreted or false alarms would have the potential to impact trust and unnecessarily increase SAIDI, creating a conflict between safety-driven responses and the operational imperative to minimise SAIDI.

To be successful, Powerco must work collaboratively with stakeholders to align expectations and operating practices, minimising conflict and maximising trust in the alarm framework. Rules will be needed that clearly outline actions required, and in particular are clear about escalation.

Theses integration challenges require further investigation and trial.

Figure 5 System integration



3.3 Cost–benefit and efficiency assessment

The monitoring devices could provide a cost-effective method for EDBs to detect HV connection failure and lines down, improving the safety and reliability on networks across the country. An engineering control for system alerts of lines down offers a significant benefit compared to current reliance on someone reporting a line down to Powerco or emergency services.

Each of the monitors are $2300 to $3300 capex (depending on configuration) which provides for multi-purpose monitoring with additional costs for systems and software. This success of the field trial detecting lines down 100% of the time demonstrated the potentially high cost-benefit of the technology.

Operational benefit is achieved through the ability to selectively determine the location of faults within the network. This requires sufficient density of measurement to accurately identify the outage area and provide reliable, selective indication of network faults.

Once operational rules are established, Powerco will have a clear mechanism to respond immediately to safety incidents. Where a credible “lines down” alarm is received from trusted equipment, the network can be de-energised without delay. While this response will result in SAIDI due to the initiation of an outage, the selective nature of the indication enables rapid restoration of supply to areas not affected.

This represents a necessary shift in operational culture toward proactive de-energisation in the interest of public and staff safety. The safety benefits of this approach significantly outweigh the temporary increase in outage duration incurred through selective switching.

When compared with the current operating model—where response is often reliant on field staff or public notification of lines down—this approach delivers a significantly enhanced safety response. It also enables immediate mobilisation to the precise location of the incident, rather than waiting for external notification, improving both response time and operational effectiveness.

4. Conclusion and next steps

The trial successfully demonstrated the potential of the technology to provide efficiency and benefits compared to traditional lines down response. However, prior to achieving full confidence in adopting this type of technology, its accuracy and reliability needs to be tested in more real-world scenarios.

Given the risks of increased SAIDI and incentive to avoid this, it is essential to demonstrate the value, consistency, and reliability of alarms and the expected operational responses. This must be achieved through a structured programme of real-world testing, enabling confidence to be built through demonstrated performance rather than theory alone. Proceeding to phase 2 of this project is a key step in achieving this.

Phase 2, to trial the technology on our 10 worst performing feeders, will need to be completed prior to determining if the technology should be integrated into our operations. This phase will also provide for fuller testing the integration with our systems in a real-world scenario.

Continuing to phase 2 of this trial has been delayed due to other priorities but we are actively looking for partners in order to progress the project and realise the potential benefits for consumers.