

Date of Submission

May 2021

NIA Project Registration and PEA Document

Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

Project Registration

Project Title

Low Voltage Feeder Cable Open Circuit Detection

Project Reference

NIA_SSEN_0052

Project Licensee(s)

Scottish Hydro Electric Power Distribution and Southern Electric Power Distribution

Project Start Date

December 2020

Project Duration

1 year and 9 months

Nominated Project Contact(s)

Colin Mathieson

Project Budget

£408,169.00

Nominated Contact Email Address(es)

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Problem(s)

On the Low Voltage (LV) Distribution network, a common fault is an Open Circuit on a Feeder cable, either on a single phase or multiple phases. The Feeder cable being the cable connecting the local LV substation to a residential or commercial property. It is difficult to locate these faults as the cables are buried in the ground, with no visible indication of the location of the fault.

In order to minimise the amount of time the cable remains faulty and customers are off supply, the location of the fault on the cable must be identified accurately. Accurate identification prevents unnecessary additional excavations which result in an extended period of time where customers are off supply, potential increased customer complaints and additional costs to the Distribution Network Operator (DNO).

It is also imperative that accurate location of open circuit faults is possible where power has been restored to customers through a temporary back feed from another substation, but the open circuit remains on the network.

The purpose of the Low Voltage Feeder Cable Open Circuit Detection proposal is to develop the technology and equipment to a Technology Readiness Level (TRL) that will prove the application of locating Open Circuit faults accurately in the above scenarios.

DNOs currently identify open circuit faults location using equipment from a variety of manufacturers with a variety of accuracy results, which sometimes requires an excavation for the equipment to work. These devices are based upon the principle of Time Domain Reflectometry (TDR). The accuracy of TDR depends on a number of factors, all of which impact the reflected signal, including cable type, cable material, cable dimensions, cable length and cable joints. The proposed solution will use injected signals to generate electric fields to locate the position of the open circuit fault. This technology, if successful, will work on any cable type, cable material etc, hence eliminating sources of possible inaccuracies.

Method(s)

The Open Circuit Detector technology will consist of the following instruments:

The Open Circuit Injectors
The Open Circuit Detector.

The Open Circuit Injector will inject a current into the faulty cable at the substation end, using a high frequency, that will also contain a specific code. The injector will also communicate with satellites providing highly accurate timing and position information.

The Open Circuit Detector reads the signals the Injector sends down the faulty core, facilitating the Operator to walk/trace the faulty cable route with the goal of detecting the Open Circuit fault.

The Open Circuit Detector will be configurable to operate in one of two modes (A or B) for utilisation in the common scenarios below.

Mode A: Customers are on supply through the reconfiguration of the local LV network allowing customers to be Back Fed.

Mode B: Customers are off supply beyond the location of the Open Circuit Fault. Re-configuration of the local low voltage network to restore power supplies is not possible. Immediate action is required to locate and fix the fault.

Scope

The Scope of this project is to manufacture and test the proof of concept technology on the LV Network to detect Open Circuit Faults which will include as a minimum;

- Proof of Concept Models - prove the concept and confirm the theory of the Open Circuit Detector, to a level where factory testing can be undertaken
- Develop enhanced location accuracy using Global Position System (GPS) technology - Current GPS technology provides a positional accuracy of between 5m and 10m. Enhancement will provide a GPS accuracy of less than 2m. This increased accuracy will allow the remedial works to be carried out more efficiently
- Manufacture 'A' Model (Prototype) The 'A' Model (Prototype) units will be the first models used to locate 'real' open circuit faults on a 'real' low voltage Network.
- Trial 'A' Model (Prototype) - Trial to locate 'real' open circuit faults on a 'real' low voltage Network.
- Manufacture 'B' Model (Pre-Production) - From learnings captured in the trial of 'A' Model, manufacture 10 'B' Model units, to enable the DNO to perform trials.
- Trial 'B' Model (Pre-Production)- The final trial of the units to include thorough testing on real open circuit faults, diverse locations on an assortment of LV cable types.

Objectives(s)

The projects objectives are as follows;

1. To prove the concept and confirm the ability to accurately detect open circuit cable faults.
2. Production to a level of TRL 8 technology with the device enabling a Field Operative to accurately identify an open circuit cable fault, on an operational LV Network, reducing time Customers are off supply at time of fault or subsequent planned outages. This will including locating open circuit fault when power has been restored to the customer.

Success Criteria

- Open Circuit location accuracy. The achieving of the design goal of locating the open circuit fault with an accuracy of less than 2 metres. Including GPS coordinate accuracy of uploaded positions.
- Locating the open circuit fault on a variety of cables with varying shielding used in its construction, and understanding any limitations, if any.
- Acceptance of the units by the DNO. Ensuring that the user community is involved with the development from the beginning.
- Cost effective equipment.
- More efficient planning of remedial repairs.
- Greatly reduced Customer Minutes Lost (CMLs).

Technology Readiness Level at Start

TRL 2

Technology Readiness Level at Completion

TRL 8

Project Partners and External Funding

HAYSYS LTD is the project partner. No external funding is provided for this project.

Potential for New Learning

The project will provide an opportunity for new learning in the following areas: -

Accurate detection of open circuit cable faults.

Locating the open circuit faults accurately and efficiently without the need to carry out excavations will enable the DNO to manage the low voltage network more efficiently.

Pinpoint location of concealed Link Boxes.

The system will also be able to be used to locate the position and configuration of link boxes on the network as these behave like open circuits. This will then allow the operator to accurately locate link boxes that have been concealed (by asphalt replacement). Once known, the operator can act to reveal the link box.

Understanding the Operational Environment.

This project will also provide an insight into the challenges of using equipment of this nature in a variety of operational environments, including high streets that are densely populated. Challenges include size of the equipment, noise emitted from the device etc.

Website development.

Activity required to bring the TRL to level 8, will include development of a website, to provide additional functionality and analytics, including Geographical Information System (GIS) functionality.

Scale of Project

This project will take the solution from TRL2 to TRL8 over a period of 21 months, achieving a conclusion before the end of ED1. The project will consist of the following: -

Stage 1 – A-Model Prototype developments in the factory environment. Followed by B-Model development in the production and DNO user environment

Stage 2 – Field trials on the DNO low voltage network using the B-Model prototypes

A smaller scale project would not allow for both types of prototypes to be developed and the field trials to be carried out which are essential to achieve the readiness level of the technology appropriate for adoption to business as usual.

Geographical Area

Trials will take place on selected SEPD and SHEPD networks.

Revenue Allowed for in the RIIO Settlement

There was no revenue allowed in the RIIO settlement for investigating innovative ways of locating and pin-pointing open circuit faults.

Indicative Total NIA Project Expenditure

The total expenditure is £408,169, of which 90% (£367,352) is allowable NIA expenditure.

Project Eligibility Assessment

Specific Requirements 1

1a. A NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

A specific piece of new (i.e. unproven in GB, or where a Method has been trialled outside the GB the Network Licensee must justify repeating it as part of a Project) equipment (including control and communications systems and software)

A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

A specific novel operational practice directly related to the operation of the Network Licensee's System

A specific novel commercial arrangement

Specific Requirements 2

2a. Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

Please explain how the learning that will be generated could be used by relevant Network Licenses.

The learning from this project will be about a new method of proactively locating and pin-pointing open circuit cable faults on the low voltage network. This will be of value to all Network Licensees, as locating open circuit cable faults is an issue affecting each one.

Please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the Project.

N/A

2b. Is the default IPR position being applied?

Yes

2c. Has the Potential to Deliver Net Financial Benefits to Customers?

Yes

Please provide an estimate of the saving if the Problem is solved.

The project will reduce the number of customers affected by open circuit faults. We will do this by using open circuit detection equipment to accurately locate the position of the fault, thereby allowing us to affect fewer customers when repairing the fault.

Over a 5-year period we expect to achieve savings of around £368,166 from reduced IIS activities.

Please provide a calculation of the expected financial benefits of a Development or Demonstration Project (not required for Research Projects). (Base Cost - Method Cost, Against Agreed Baseline).

Base Cost - Method Costs over 5 years

Benefits/Savings because of fewer customers affected and more effective fault location techniques on open circuit faults.

Method Cost = £696,815

Base Cost = £1,064,981

Base Cost (£1,064,981) – Method Cost (£696,815) = Total Saving of £368,166 over 5 years

Please provide an estimate of how replicable the Method is across GB in terms of the number of sites, the sort of site the method could be applied to, or the percentage of the Network Licensees system where it could be rolled-out.

The proposed method could be adopted by all DNOs as they all face LV open circuit faults. Open circuit faults are the most common type of fault across all DNOs.

Please provide an outline of the costs of rolling out the Method across GB.

Costs and the associated benefits can be extrapolated out to include other GB networks if the technology is taken up. These will depend on the region-specific requirements, i.e. number of units required, number of low voltage feeders on the network etc.

2d. Does not Lead to Unnecessary Duplication

Yes

X

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

There is no replication or duplication on this project as it is utilising a different type of technology that has not been used in any other low voltage fault project.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

N/A

Additional Governance Requirements

Please identify

that the project is innovative (ie not business as usual) and has an unproven business case where the risk warrants a limited Research and Development or Demonstration Project to demonstrate its effectiveness

X

i) Please identify why the project is innovative and has not been tried before

This type of fault location technology has not been explored before.

ii) Please identify why the Network Licensee will not fund such a Project as part of its business as usual activities

The project is still at a low TRL level and there are a number of issues and risks to overcome before the technology is mature enough for it to be used as part of business as usual activity.

iii) Please identify why the Project can only be undertaken with the support of the NIA, including reference to the specific risks (eg commercial, technical, operational or regulatory) associated with the Project

The project can only be undertaken as an innovation project given the operational risks associated with the deployment of an unproven solution in network operations. The technology has been tested in a laboratory environment but requires a true network test to prove its viability. The proposed approach to low voltage fault finding also has an unproven business case, and the range of potential benefits should be tested before the tool can be deployed. As noted in the NIA guidance, certain projects are speculative in nature and yield uncertain commercial returns. This is the case with this project. There is a commercial risk that the solution trialed in the project is not adopted by the stakeholders involved following the trial period. This could be due to the fact that the solution has not reached the level of TRL 8 required for business-as-usual application. If the project is successful, it will have proven a technical solution which will improve network performance. The specific details regarding the benefits are captured under section 2b of this document.

This project has been approved by a senior member of staff

