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.

NIA Project Registration and PEA Document

Date of Submission

Apr 2018

Project Reference Number

NIA_SPEN_031

Project Registration

Project Title

Portable Radiometric Arc Fault Locator using battery powered field deployable equipment (RAFL2)

Project Reference Number

NIA_SPEN_031

Project Licensee(s)

SP Energy Networks Distribution

Project Start

April 2018

Project Duration

3 years and 10 months

Nominated Project Contact(s)

Watson Peat & David Ruthven SPEN, Kelvin Lee UKPN

Project Budget

£410,000.00

Summary

Radiometric Arc Fault Location (RAFL) utilises radio frequency waves generated in arc faults to assist the identification of fault location for intermittent faults on the distribution network.

Nominated Contact Email Address(es)

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Problem Being Solved

Transient faults on the overhead line (OHL) distribution network can be costly to repair, impact on customer service and quality of supply and contribute to an increase in Customer Interruptions (CIs) and Customer Minutes Lost (CML) penalties. DNO capabilities generally centre on sufficient detection and protection capability but, but have room for improvement in fault location capability. Certain transient, intermittent faults are not easily detected through a line patrol, and can be onerous to narrow down using fault passage indicators on a network with numerous branches. When the circuit repeatedly trips, field staff manually reset and re-energise, but this does not address the root cause. These faults are frustrating to customers and staff and are time consuming and costly to locate. Accumulated CIs and CML and the associated penalties they incur are real consequences of an inability to establish the root cause of relatively minor, but frequent incidents.

Method(s)

This project builds on earlier proof of concept projects (IFI 1413 and NIA_SPEN005) which SPEN undertook to investigate the feasibility of a Radiometric Arc Fault Locator (RAFL) based on fixed hardware to detect transient faults. These earlier projects culminated in a field trial of the RAFL system which were permanently mounted to wooden poles supporting transformers on an 11 kV OHL circuit.

Despite this circuit being chosen due to its historical poor performance, no faults were recorded during the trial period. Nevertheless,

the trial demonstrated that the hardware was reliable and suited to the purpose of detecting impulsive radio frequency emissions from power system arcing. Additionally, the process of uploading recorded data to the server was refined for greater availability.

This project, with SPEN as lead DNO, now proposes to expand on this learning and develop a low cost, portable, battery powered version of the RAFL system field deployable unit (FDU) that can be rapidly redeployed in service. It is estimated that 10% of permanent faults related to wind-borne or tree damage start off as transient arcing faults. Of these, 10% are estimated to be locatable using the RAFL devices.

Scope

The project will develop RAFL system hardware and software suitable for locating faults on DNO OHL networks. The hardware will be economic and suited for utility field use. The work will be divided into the following stages:

Initial system design, to be informed by
- Experience from previous project
- Discussions with DNOs focussing on reaction to faults, field practices
- Staged 11 kV switching tests to establish signal capture range and optimal receiving antenna
- GPS timing tests to establish best-case timing accuracy and appropriate use of GPS hardware

Development phase
- Detailed design work involving field unit electronic and enclosure design
- Software development of Field Deployable Unit (FDU) code, server code and web and mobile applications
- Construction, debugging and factory testing of first 4 FDUs.

Evaluation phase
- Location accuracy testing by repeating 11 kV switching tests
- Design review
- Manufacture and factory testing of remaining 20 FDUs
- Up to 12 month field trial

Objective(s)

For each stage of the project the following objectives have been identified –

Initial system design –

Identify the electronic specification for the recording hardware of the FDU based on current understanding of the (radio frequency)RF receiving constraints for arcing faults, GPS receiver accuracy and latest battery technology. Similarly, identify the housing for the FDUs considering DNO field practices.

Development phase –

Convert the initial system design specification into hardware suitable for field use; develop software to fulfil the system software specification.

Evaluation Phase –

Validate location accuracy. Review design and establish fitness for purpose. Success will measured by the device’s location accuracy, and the field teams’ feedback on its fitness on purpose

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Successful completion of this project will provide a system that will provide the following benefits:

- The developed system is easily used by DNO field staff.
- The location of faults is sufficiently accurate.

- The system is sufficiently reliable.
- The overall system can be integrated as ‘business as usual’ (BAU) in DNO operations.

Project Partners and External Funding

Elimpus

Potential for New Learning

The Project will provide potential learning by giving:

- Experience in the operation of a fault location system that uses radio frequencies, a fundamentally new principle compared to existing fault location technology, e.g. sensitivity, accuracy, reliability.
- Experience in the practicalities of operating a radiometric fault location, e.g. ease of deployment in the field, training required.

Scale of Project

The project will manufacture 24 FDU’s which will be utilised for field trials.

Technology Readiness at Start

TRL6 Large Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

SPEN will trial 12 of these units on areas of their 11kV network and UKPN will trial the other 12 units on their 11 kV network.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£354,181

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

n/a

How the Project has potential to benefit consumer in vulnerable situations:

n/a

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

Based on a UKPN cost benefit analysis (CBA), it is estimated that the financial benefit to be on the order of £168,000, if implemented in UKPN over 2020 to 2023 (the final 3 years of RIIO-ED1)

Please provide a calculation of the expected benefits the Solution

Project Cost = £354,181

Product Cost = 0 (covered by project cost)

Number of RAFL Sets = 6
Number of RAFL sets per operational area for trial = 1
Number of Operational Area = 6

Estimated pre-empted permanent faults, per site, per year = 1
Estimated Labour cost to rectify each fault in Base Case = £1500
Estimated Labour cost to rectify each fault in Method case = £750
Estimated CI benefit per site per year= £1100
Estimated CML benefit per site per year = £3660

Annual Base Cost = Number of Sites * permanent fault pre-empted per site * Labour cost per fault
= 6 * 1 * 1500 = £9000
Annual Method Cost = 6 * 1 * 750 = £4500
Annual CI/CML benefit = (1110 +3660) * 6 = £28620
Annual Financial Benefit = Annual Base Cost – Annual Method Cost + Annual CI/CML Benefit
= 9000 – 4500 + 28620 = £33120
Estimated device life = 10 years
Benefit Timescale = Estimated device life = 10 years
Total Financial Benefit over product life = Annual Financial Benefit * Benefit Timescale
= £33120 * 10 years = £331,200

Please provide an estimate of how replicable the Method is across GB

Every network operator with an OHL network experiences similar challenges when it comes to locating faults on the OHL that part of their network. As there are 14 DNOs, but just 13 DNOs with significant OHL networks, this can be applied to 13 out of 14 DNOS in GB.

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

Product cost = £4800 per set
Sets per site = 2 sets per site

Annual Upkeep (Staff Training, IT & device maintenance per site per year) = £2000
Number of sites in SPEN and UKPN = 12+18 = 30

Scale factor for SPEN & UKPN to GB =

13 license areas/4 licence areas = 3.33

Total Rollout cost for 10 years for 1 site = product cost * sets per site + annual Upkeep * product lifetime

= (4800 * 2) + (2000 * 10) = £29600

Total Rollout cost for GB = £29600 * (18 UKPN sites + 12 SPEN sites) * scale factor

= £29600 * 30 * 3.33 = £2,957,040

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 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 GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system 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 Licensees system

☐ A specific novel commercial arrangement

RIIO-2 Projects

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☐ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

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

n/a

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

This project is expected to provide all Network Licensees with an understanding whether this technology can successfully provide

accurate fault location of OHL networks

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

Is the default IPR position being applied?

☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

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

This project is a continuation of SPEN IFI 1413 and NIA_SPEN0005 RAFL projects, and to the best of our knowledge it does not duplicate any other work currently being carried out by any other Network Licensees.

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

n/a

Additional Governance And Document Upload

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

This project is innovative as it is a new way of locating OHL faults. Though a previous project (SPEN IFI 1413 & NIA_SPEN0005 RAFL) was conducted using the same technology, it was not able to detect faults on the OHL network. This project addresses the past issues encountered.

Relevant Foreground IPR

n/a

Data Access Details

n/a

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

As the technology is unproven in field trials, the Network Licensees are not able to deploy it on a BAU basis.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

Due to the heavy development costs associated with this project, commercially there is a risk that comes with an unproven technology. In addition, there are technical and operational risks as field trials have been limited.

This project has been approved by a senior member of staff

☑ Yes