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NIA Project Registration and PEA Document

Date of Submission

May 2016

Project Reference Number

NIA_UKPN0019

Project Registration

Project Title

OHL Fault Location Concept and Directional Earth Fault Passage Indication

Project Reference Number

NIA_UKPN0019

Project Licensee(s)

UK Power Networks

Project Start

May 2016

Project Duration

3 years and 1 month

Nominated Project Contact(s)

Peter Lang

Project Budget

£2,871,000.00

Summary

The scope of the project is to address time spent searching for overhead line faults; the duration of the outage; and the inability, currently, to detect developing faults. The scope of the project is 11kV overhead lines, which may or may not be fitted with existing visual Fault Passage Indicators (FPIs) and automatic sectionalising links (ASLs), but where fitted these devices do not report in via SCADA to our control room.

Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

Problem Being Solved

Faults on overhead lines are responsible for a significant proportion of all Customer Interruptions (CI) and Customer Minutes Lost (CML) in EPN and SPN. Such faults tie up resources, are time-consuming to locate and adversely impact customer service. It is evident therefore that if the overall number of faults on overhead lines could be reduced and if the restoration of supplies following an outage could be sped up, then substantial benefits to operational efficiency and quality of supply could be achieved. Even though we are increasing the number of points on our overhead lines where we can split up or sectionalise the network, significant search time is required to locate faults along the network between two sectionalisation points. Single faults can typically be repaired in 1-2hrs but they can take several hours (6-10hrs) to locate, especially if they are intermittent, are in a hostile environment or are at night. This problem becomes even more acute during storm periods when many incidents occur in a short space of time. Faults can occur on overhead lines for a wide variety of reasons such as contact with trees, bird strikes, insulation failure and high winds. Traditional methods of detecting developing or "incipient" fault location rely on foot patrols traversing the length of the line but these often fail to pick up internal failures such as cracked or pinholes in insulators, damaged conductors and surge arrestors. Difficulties in detecting both developing or "incipient" faults and permanent fault location are compounded by land access problems, a proliferation of "teed" circuits, a combination of overhead line and underground cable circuits, the accuracy of existing detection mechanisms and the inability to connect test equipment easily.

Method(s)

The project will develop functionality to detect faults, determine their direction whether upstream or downstream of the sensors, and estimate the location of the fault using the following equipment and techniques. It will be carried out in the following phases:

Phase 1a: Tollgrade's LightHouse Power Sensors and additional Fault Passage Indicators which report via SCADA into our control room will be installed. Where possible, existing items of equipment (existing remote terminal units (RTUs) which can be upgraded) will be modified to report estimates of distance to a fault.

Phase 1b: Tollgrade will enhance the LightHouse SMS software and LightHouse Power Sensor firmware to report directionality of fault events based on the phase angle of the captured faults. Software and firmware deployed during phase 1a will be remotely upgraded. As fault events are detected, the enhanced solution will demonstrate the reporting of the direction of fault current from each sensor location. The location of faults in the upstream or downstream direction will be confirmed by associated UK Power Networks records following outage resolution.

Phase 2: Fault Library and Fault Location

Tollgrade will enhance their LightHouse SMS software to calculate distance to fault based on the readings from the LightHouse Power Sensors.

In addition, the LightHouse Power Sensors will capture, time stamp and communicate critical measurements and event waveforms back to the LightHouse SMS software. This will allow UK Power Networks and Tollgrade to evaluate the reliability with which these are representative of developing or incipient faults, and to configure alarms via text or email to assigned personnel. The data will remain in the LightHouse SMS software as a repository, where it will also be used to understand whether it is possible to recognise the type of event or failure from the data captured.

Scope

The scope of the project is to address time spent searching for overhead line faults; the duration of the outage; and the inability, currently, to detect developing faults. The scope of the project is 11kV overhead lines, which may or may not be fitted with existing visual Fault Passage Indicators (FPIs) and automatic sectionalising links (ASLs), but where fitted these devices do not report in via SCADA to our control room.

Objective(s)

The project aims to further reduce search times by identifying that permanent faults as being down a particular spur, or locating them to a particular location between sectionalisation points on the main line. Secondly, it aims to demonstrate that developing or "incipient" faults can be reliably detected.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be deemed to have been successful when:

- at least one developing or "incipient" fault has been detected;
- the combination of Fault Passage Indicators, Tollgrade Lighthouse Power Sensors and existing equipment is successfully discriminating the correct spur which has faulted, or identifying that the fault is on the main line; and in the latter case, is providing a location estimate.

Project Partners and External Funding

Tollgrade has been selected as the supplier for the supply and development of the DEFPI and fault location algorithms using LightHouse sensors. Other elements of the project either use existing equipment or will be procured during the course of the project itself. Tollgrade have made a contribution to the project of £365k in the form of preferential pricing.

Potential for New Learning

The main learning that will be shared with other DNOs is expected to include:

- The reliability with which the equipment can distinguish the correct spur and estimate location of the fault;
- The reliability of detecting developing or "incipient" faults;
- Whether capturing the waveform can provide any further clues about the nature of the fault; and
- What policies needed to be developed to install and make use of the equipment.

Scale of Project

The team has developed a long-list of potential overhead line circuits, which will be reduced further before installation proceeds. The long-list represents circuits responsible for over 200 recloser operations in total in EPN in the last 12 months, and over 200 recloser operations in SPN in the last 12 months. As such, by selecting circuits from this long-list the project can run an effective trial which is likely to exercise the equipment. However, this scale of trial is required since individual circuits in some cases were responsible for only one or two recloser operations – as such, they are likely but not guaranteed to see a fault during the period of the trial.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The trial will be carried out in at least two different network areas in the EPN and SPN licence areas. The project will comprise approximately 30 feeders, depending on the specific number of LightHouse Power Sensors required per feeder.

Revenue Allowed for the RIIO Settlement

None.

Indicative Total NIA Project Expenditure

We expect to deliver the project within a project budget of £2,871k which will be recovered against our Network Innovation Allowance (NIA). Customer contribution will be £2,584k, which was previously indicated as the estimated budget.

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)

We carried out a study of our 11kV overhead networks in our EPN and SPN licence areas and their fault performance during the regulatory years 2011/12 through to 2014/15. For the purposes of the study we assumed that the system had been installed on feeders in EPN which had a poor fault history; had at least one spur which was not protected by an Automatic Sectionalising Link (ASL) and could impact the main line; and where the spur itself was frequently longer than 1km. We also assumed that the system had been installed on feeders in SPN which had a poor fault history; had at least one spur which was not protected by an ASL; or where the main line represented a long line >12km. We calculated that this would have achieved a saving of 0.71 CMLs in EPN and 0.64 CMLs in SPN. Savings in unplanned interruptions from detecting developing or incipient faults and rectifying these before they developed into permanent faults would be additional to this.

Please provide a calculation of the expected benefits the Solution

In the base case, we imagine that we continue to detect developing issues where possible by visual inspections, and to exhaustively search sections of line when a permanent fault occurs. As such, this represents no change and therefore no additional cost. The figures below represent the benefits at the scale of the trial being carried out within the Demonstration project, rather than the full-scale roll-out discussed in our answer to question 2b. It does not yet count any benefits from detecting developing or incipient faults and rectifying these before they developed into permanent faults.

Base Cost £0.00

Method cost £2,585k

Financial benefits 0.22 CMLs per annum
£167k per annum

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

We expect that other DNOs would apply this solution in a similar way, concentrating on long 11kV lines with multiple spurs which are not economic to protect with an ASL, or where spurs are protect but in themselves are very long.

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

In the study we carried out and referred to above, the costs amounted to £14m to equip around 500 feeders. This would be scaled by each DNO according to how many feeders they had which would meet similar criteria of being long feeders, or ones with unprotected

spurs, or which had a poor fault history. As an example, assuming Western Power Distribution had similar proportions of their total length of feeders which could benefit from the technology, a roll-out across their four licence areas would cost an estimated £35m.

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

We will report the performance of the system to other DNOs which will allow them to assess the potential impact against their network.

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

The project contributes to the following named themes in our Innovation Strategy:

- Understand the condition of our assets; and
- Managing asset risk and improving fault performance.

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.

We have reviewed a number of technologies including that being explored by Electricity North West (ENW) with Kelvatek under NIA project "Sentinel". Whilst the Tollgrade units share some similarities with the Sentinel units, we are specifically taking an approach of combining these advanced units with simpler Fault Passage Indicators and existing equipment, in order to create a hybrid solution.

We therefore believe that there is no unnecessary duplication.

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

The Aclara Power sensors have not been used in the UK previously. Aclara will develop distance to fault algorithm using the waveforms measured by the Power sensors.

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

We don't know whether the device will provide information necessary to identify fault locations or how information from other fault passage indications could be incorporated together.

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

Technical risk – integration with PowerOn may not work. Operational risk – unknown reliability to be installed on an overhead line.

This project has been approved by a senior member of staff

Yes