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

Oct 2015

Project Reference Number

NIA_NPG_007

Project Registration

Project Title

FORESIGHT – LV pre-fault recognition and management

Project Reference Number

NIA_NPG_007

Project Licensee(s)

Northern Powergrid

Project Start

October 2015

Project Duration

5 years and 3 months

Nominated Project Contact(s)

Rebecca Kelly

Project Budget

£3,999,000.00

Summary

This project is to improve our understanding of indicative pre-fault behaviour and the development of management options for LV cable networks.

NPg has a population of such networks based on Consac and Aluminium waveform cables. These are more prone to some particular fault types than other cables. This project will utilize these networks as the chance of seeing real, active pre-fault behaviour is likely to be higher than for some other cable types. This reduces the level of technology deployment required to capture faults and contributes to keeping project costs down.

We have concluded, through an analysis of the expected failure types, that the learning developed is relevant to all types of LV cable networks and their management.

Nominated Contact Email Address(es)

yourpowergrid@northernpowergrid.com

Problem Being Solved

As a result of mature cable designs installed over the last 50 years, LV faults managament in both Northern Powergrid licence areas is becoming increasingly difficult. Restoration times can be lengthy, as the majority of the LV network is not monitored or controlled automatically. One of the key challenges is the current inability to assess the condition of LV cable systems and to predict the timing and location of faults.

For LV networks, identification of a cost effective means to predict timing and location of faults in the underground LV cable asset, which in turn would lead to a better performance in restoration or the avoidance of a faulted cable situation in the first place is the ultimate objective. Traditionally LV cable replacement has been driven by the reliability history of cable sections and this project offers us the opportunity to radically change that strategy to incorporate condition based information to guide replacement decisions.

Method(s)

This is a programme of work that will develop and test a low cost sensing system which will enable DNOs to monitor LV networks, identify developing LV faults, then to locate the position of defects which will develop into LV faults before supply interruptions occur. The programme of work includes a trial with the aim of verifying the efficacy of the system, identifying any practical “Business as Usual” issues associated with wide-spread deployment of the system and to identify associated costs.

we will:

- Deploy Alvin Reclosers and link box switches to monitor and control selected LV feeders
- Identify and categorise pre-fault signature waveforms for LV cables
- Deploy prototype low cost sensor devices which incorporate pre-fault recognition algorithms based on the pre-fault signatures which are identified in this project. (These sensors will be developed by EA Technology in parallel to this project)
- Develop and perfect pre-fault location devices and techniques. These will be a development based on existing LV TDR equipment and techniques which are used to locate LV cable faults.
- Install low cost sensor devices in LV substations, deploy LV pre-fault location equipment to fault teams and trial the management of LV cable faults by intervening before supplies are interrupted by faults.
- Produce draft equipment specifications and network operating procedure documents to enable transfer into business as usual the management of LV cable faults by intervening before supplies are interrupted by faults.
- Draw conclusions for LV fault and pre fault management approaches that are applicable to all LV networks

This approach offers the prospect of avoiding a large proportion of unplanned interruptions to customer supplies.

Scope

This project is to improve our understanding of indicative pre-fault behaviour and the development of management options for LV cable networks.

NPg has a population of such networks based on Consac and Aluminium waveform cables. These are more prone to some particular fault types than other cables. This project will utilize these networks as the chance of seeing real, active pre-fault behaviour is likely to be higher than for some other cable types. This reduces the level of technology deployment required to capture faults and contributes to keeping project costs down.

We have concluded, through an analysis of the expected failure types, that the learning developed is relevant to all types of LV cable networks and their management.

Objective(s)

Primary project objectives of the project include:

* Detection and location of developing faults, enabling remedial works to be carried out as part of a planned programme of work before faults develop into loss of supply events.

* Demonstration of the use of a network of low cost sensing devices and associated communications.

* Development of a strategy and protocol for detection and location of incipient faults on the LV cable network.

* Generation of knowledge relating to the evolution of LV cable defects into supply interrupting faults using a method which minimises the impact on customers.

* Development and testing of novel techniques with the potential to deliver a significant decrease in DNO CMLs and CIs originating from LV cable faults.

* Demonstration that low cost sensing devices combined with LV Reclosing devices deliver significant performance improvements.

* Investigate the effect of network reconfiguration options to optimise load and losses on the efficacy of the pre-fault detection method.

* Identifyand dissemminate conclusions that relate to the LV cable network management that are applicable to all GB LV networks.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

For this project to be considered a success, we intend to progress through the project objectives listed above and deliver each. We will consider progress, and the likelihood of success,at each project stage. Whilst completion of all objectives is the ultimate goal, success may also be achieved by halting the project at an intermediate milestone, if we believe the technology development is unlikely to deliver the anticipated benefits.

Dissemination of the all learning developed, regardless of the project endpoint, is a key element of success.

Project Partners and External Funding

N/A

Potential for New Learning

With project success DNOs will have a better method of determining and reacting to LV faults before they occur, in a totally new method of working to engage LV network restoration teams and information records with detailed pre fault location and proactive fault management.

Scale of Project

To understand pre-fault behaviour and intervention options it is necessary to instrument and monitor an area of network where a sufficient number of faults will occur during the duration of the trial. We have selected worst performing network construction types to improve the chances of observing an appropriate volume of faults. To ensure that we will experience a statistically valid number of faults over two-three years the following volumes of equipment have been specified:

Sensing

1100 low cost sensors across the identified circuits to collect pre fault signatures;

150 communication gateway modules across the network in combination;

600 reclosing LV circuit breakers (with integrated condition monitoring)

Intervention

100 pre fault and fault locating sensing devices;

50 link box switching devices.

Technology Readiness at Start

TRL6 Large Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

We anticipate installing and trialling the technology across the range of Northern Powergrid's LV networks covering both licence areas in the Yorkshire and North east.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£3,990,000

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)

Using the Base-Cost-Method Cost approach, and scaling up to the GB network as a whole, we estimate the potential saving as £96m.

Please provide a calculation of the expected benefits the Solution

Solution of this problem allows network operators to change strategy and tactics for tackling LV faults. Responding to pre-fault conditions could improve economic efficiency, hrough better and more timely potential fault location and operational response, whilst significantly reducing the inconvenience of supply interruptions and minutes lost to customers.

Financial benefits are calculated from the existing OPEX cost vs the anticipated OPEX cost of working with the new system:

Base cost (£7.585M)– Method cost (£7.212M)

= £373k (financial benefit to customer at project scale)

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

The method is widely applicable and has the potential to be rolled out across the entirety of the GB LV network.

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

Estimated from potential roll out of technology based on successful outputs with an average licence area having 8000 ground mounted substations and their being 14 GB licence areas.

Cost for the entire GB network is built up as follows:

Low cost sensor Cost (56000 units@ £100) = £5,600,000

Gateway Cost (7000 units@ £2100) = £14,700,000

LV Reclosing sensors (28000 units @ £2500) = £70,000,000

Phase identification sensors (1750 units @ £6500) = £11,375,000

Location identification sensors (1750 units @ £1000) = £1,750,000

Communication backhaul costs (119,000 units @ £50) = £5,950,000

TOTAL costs = £109,375,000

Total Cost for GB = Cost per DNO license * Number of DNO license areas = £16,425,000* 14 = **£229,950,000**

Based on the assumptions that:

* The expected cost for a device is as listed

* Communication backhaul over GSM / GPRS are £5 per device per month

* Capital expenditure only, Opex for equipment rotation and maintenance not included.

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

A successful project will develop an improved method of determining and reacting to LV faults before they occur alongside a totally new management approach to engaging and deploying LV network restoration teams. This will allow proactive LV fault management in manner applicable to all GB low voltage distribution networks..

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

An explicit requirement identified in our published innovation strategy is the improvement of network reliability and availability. Further, a specific commitment in our business plan is the improvement of intermittent fault performance, and a focus on the least reliable parts of our network. This project directly addressess both of these needs.

☑ 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.

Whilst LV monitoring in general is an increasingly mature approach to LV fault finding we can find no indication of this being used for fault anticipation and pre-emptive interventions with DNOs.

Searches of the internet reveal several academic assessments of the potential of such techniques but no indication that these have been applied in the real world.

UKPN have conducted some LV fault management work using some elements of similar equipment. Having consulted them we have identified no overlap between their project and the anticipatory learning to be developed in this 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 And Document Upload

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

n/a

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

n/a

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

n/a

This project has been approved by a senior member of staff

☑ Yes