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

Jan 2019

Project Reference Number

NIA_WPD_038

Project Registration

Project Title

OHL (Overhead Line) Power Pointer

Project Reference Number

NIA_WPD_038

Project Licensee(s)

National Grid Electricity Distribution

Project Start

December 2018

Project Duration

3 years and 6 months

Nominated Project Contact(s)

Steve Pinkerton-Clark

Project Budget

£1,302,413.00

Summary

As the utilisation and requirements of the distribution network increase so too does the need for localised network monitoring. The overhead network has historically been difficult to capture data, due to the construction of the system and the availability of equipment throughout the network to gather data.

This project will trial a device that is capable of self-powering operation to provide real-time voltage, current and power flow information. This information will be used to more accurately assess network operation, such as hidden generation output and directional fault detection to more quickly identify the location of faults.

Third Party Collaborators

Nortech

Problem Being Solved

Historically, it has been difficult to capture data in overhead networks, due to the construction of the system and the availability of equipment throughout the network to gather data. As Western Power Distribution (WPD) transitions from a DNO to a DSO, there is an increasing requirement for localised network monitoring to enable and enhance system operation functions. Moreover, improved monitoring could unlock latent capacity, hence leading to more efficient and economical utilisation of the assets.

The connection of Distributed Generation (DG), across all Distribution voltage levels has the potential to back-feed into faults. Currently in multi-branched radial or closed-ring networks it is very difficult to pinpoint the specific location of faults, while OHL fault locations tend to be currently identified via manual visual inspections.

Auto-recloser operations are also recorded manually via visual inspections. This is time-intensive for field staff that could be better deployed on other tasks. Moreover, due to operating temperature uncertainties and limited visibility, the control room currently only makes limited use of probabilistic post-fault OHL ratings, thus potentially underutilising the available circuits.

Method(s)

As the utilisation and requirements of the distribution network increase so too does the need for localised network monitoring. Historically, it has been difficult to capture data for the overhead network due to the construction of the system and the availability of equipment throughout the network to gather data.

This project will trial a device that is capable of self-powering operation to provide real-time voltage, current and power flow information. This information will be used to more accurately assess network operation, such as latent generation output and directional fault detection to more quickly identify the location of faults.

Five business needs have been identified, all referenced within WPD's Distribution System Operability Framework, which will be addressed by the following trials:

1. Method 1: Directional Power Flow Monitoring;

2. Method 2: Directional Power Flow State Estimation (using directional monitors to infer power flow direction through non-directional sensors);

3. Method 3: Detection of Auto-Recloser Operations (to assist with maintenance efficiency and short interruption quantification);

4. Method 4: Directional fault detection (especially in 33kV networks with high levels of DG); and

5. Method 5: Conductor Temperature Monitoring (feeding into the post-fault rating of overhead lines).

Scope

The project will be delivered in over the course of three years, in three phases, as summarised below.

Phase 1: Design and Build (December 2018 – March 2020)
In this phase, the functionality of the OHL Power Pointer solution will be defined for each of the five Methods (directional power flow monitoring, directional power flow estimation, auto-recloser operation detection, directional fault passage indication (FPI) and post-fault rating of overhead lines). The software will be designed and implemented. Network locations will be identified and equipment installation locations selected. In addition, the trials of the various methods will be designed.

Phase 2: Install and Trial (August 2019 – February 2021)
In this phase, the Smart Navigator 2.0 equipment (for directional power flow monitoring, auto-recloser detection, directional fault passage indication and post-fault rating determination) will be installed and trialled. Initially, 50 sets of devices will be installed to cover the trials of the various Methods. These devices will communicate to Nortech's iHost system for rapid prototyping of the software and support with the solution design. As part of the main trials, an additional 50 sets of devices will be installed, communicating to WPD's iHost system and the 50 sets installed as part of the initial trials will be transitioned across to WPD's iHost system.

Phase 3: Analysis and Reporting (December 2018 – November 2021)
In this phase, the results from the trials will be analysed and a report on the learning resulting from each of the Methods will be produced. Results and key learning outputs will be disseminated and policies will be written to facilitate the wider adoption of the OHL Power Pointer solution WPD's business should WPD proceed with Business as Usual (BaU) roll-out.

Objective(s)

1. Create policies for equipment installation and location;

2. Carry out assessments of the accuracy and consistency of determining power flow directions within WPD's distribution network;

3. Provide recommendations on the number and location of devices needed for full visibility of power flow direction;

4. Quantify the savings gained by using the Smart Navigator to detect and communicate auto-recloser operations (rather than using visual inspections of AR equipment);

5. Quantify the savings made to Customers Minutes Lost (CMLs) through the use of OHL directional FPIs;

6. Provide the control room with visibility of overhead line real-time post-fault ratings;

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

1. Power flow direction determined correctly at a minimum of 10 sites across 11kV and 33kV networks;

2. Power flow direction estimated correctly at a minimum of 10 sites across 11kV and 33kV networks;

3. Correct detection of a minimum of 5 auto-recloser operations during the project lifetime (recognising this is dependent on faults occurring);

4. Direction of passage of fault current determined at a minimum of 5 sites during the project lifetime (recognising this is dependent on faults occurring);

5. Post-fault ratings determined for at least one circuit at or above 33kV during the project lifetime

6. Completion of trials of the five different Methods, with a report on each Method detailing the learning and updated business case for wider business adoption; and

7. Development of policies to facilitate the wider business adoption of the technology at the end of the project should WPD decide for BaU adoption.

Project Partners and External Funding

Nortech Management Limited

Potential for New Learning

The knowledge gained through this project will relate to:

1. Creation of functional specifications to guarantee the suitability of the device for different applications and overhead line types;

2. Determination of a systematic methodology for identifying where enhanced network monitoring is required;

3. Identification of strategic installation locations for delivery of maximum operational benefit;

4. Evaluation of the performance and optimisation of the Directional Flow State Estimation method;

5. Quantification of the savings gained by using the Smart Navigator 2.0 to detect and communicate auto-recloser operations, rather than using visual inspections of AR equipment, and quantification of the savings made to CMLs through the directional fault detection method;

6. Assessment of the practicability of the real-time post-fault rating method, details of how the enhanced ratings could be used by WPD and other GB DNOs and identification of future enhancements.

Scale of Project

The project will run for three years with the live trials commencing in August 2019 and finishing in February 2021. The installations will cover the full range of HV levels (11kV, 33kV, 66kV, 132kV) in a way that they can provide the required network topologies for the trial of the different device functionalities.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

It is envisaged that the trials will take place in WPD’s West Midlands licence area as the network topology and configuration is such that it will provide diverse conditions for the different methods to be assessed. Other WPD licence area(s) could be considered for validation purposes if the sample from the West Midlands network is not sufficient.

Revenue Allowed for the RIIO Settlement

£0

Indicative Total NIA Project Expenditure

WPD contribution: £130,241
Funding from NIA: £1,172,172
Total Project Cost: £1,302,413

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)

Expected financial benefits occur through improvements in visibility and reliability of overhead line networks.

Directional power flow visibility will lead to improved accuracy and quicker turnaround times when providing connection offers. Network customers will benefit from the reduced network reinforcement capital cost due to deferral or even avoidance of network reinforcement arising from a better visibility of the network through the directional power flow (Methods 1 and 2). The OHL Power Pointer solution has the potential to enable savings of approximately £290k per 4km of overhead line that would otherwise need restringing. Method 3 reduces the time-intensive effort required by DNOs to visually inspect auto-reclosers to identify whether or short-term interruptions have occurred. Previous work by ENWL on unidirectional FPIs (relating to directional FPIs in Method 4) has shown that a reduction of up to 20 minutes can be achieved in the time spent to locate OHL faults. When coupled with Method 5, this could result in 33% CML reduction.

Please provide a calculation of the expected benefits the Solution

The financial benefit of the project is illustrated below for Methods 1 and 2:
i) There is a requirement to upgrade a 4km 11kV OHL due to overloading uncertainties from limited visibility;
ii) Cost of restringing is £75k per km*;
iii) BaU cost of OHL Power Pointer solution is £2k;
iv) Monitoring at 5 circuit locations is sufficient to improve network visibility and avoid reinforcement.

Base cost = 4km x £75k per km = £300k
Method Cost= 5 x £2k = £10k
Financial Benefits = £290k

* the cost for upgrading OHL is similar for 11kV and 33kV but there is more visibility at 33kV.

Since the Smart Navigator 2.0 devices are multi-functional, a number of financial benefits are unlocked simultaneously. Each function results in a net-positive financial benefit. When combined together across all five Methods, the overall financial benefit is further increased.

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

All DNOs have overhead line networks, of a similar construction to those found in WPD's networks. As such, the OHL Power Pointer solution is readily applicable to all UK DNO systems.

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

The BaU target price for the roll-out of the OHL Power Pointer solution across GB is £2000 per site (a set of three devices providing all five functions simultaneously) and £1000 per site (a single device used for auto-recloser operation detection and conductor temperature monitoring only) – these costs include the procurement and installation of Smart Navigator 2.0 technology.

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)

Based on the July 2018 Issue of WPD's Innovation Strategy: OHL Director: As the utilisation and requirements of the distribution network increase so too does the need for localised network monitoring. The overhead network has historically been difficult to capture data, due to the construction of the system and the availability of equipment throughout the network to gather data.

This project will trial a device that is capable of self-powering operation to provide real-time voltage, current and power flow information. This information will be used to more accurately assess network operation, such as hidden generation output and directional fault detection to more quickly identify the location of faults.

☑ 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 builds on the learning from the NIA project “NIA_ENWL007: Reliable, low-cost earth fault detection for radial OHL systems” in which a unidirectional fault passage indicator (the Smart Navigator 2.0) was developed and demonstrated by ENW. In OHL Power Pointer, the Smart Navigator 2.0 functionality will be enhanced to deliver real-time bidirectional power flow information for WPD’s business uses as outlined in the “Method” section of this NIA Project Registration Document.

UKPN’s NIA Project “NIA_UKPN0019: OHL Fault Location Concept and Directional Earth Fault Passage Indication” focuses on a fault location solution at 11kV. OHL Power Pointer will focus on directional fault passage indication at 33kV and directional power flow information across 33kV, 66kV and 132kV networks.

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 project will deliver a system, readily transferrable to other GB DNOs that allows directional power flows to be monitored, in a low-cost way, across wide areas of OHL networks. The software developed during the project will be made available to other DNOs without an additional licence fee; • The project is combining monitoring and modelling to deliver a lost-cost solution for real-time power flow direction visibility; • The solution allows AR operations to be detected and recorded, without the need for manual inspections. This feeds into, and informs, condition-based maintenance activities; • The project will demonstrate the first time use of a directional FPI on 33kV OHL networks to account for fault infeeds from distributed generation; • The project will demonstrate the use of real-time post-fault ratings for OHL networks. At present, pre-fault ratings are used for conventional network operation and, due to their conservative nature, could lead to unnecessary curtailment of distributed energy resources with flexible connections; • WPD will be the first GB DNO to use the Smart Navigator 2.0 for the aforementioned DSO applications.

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

• With the exception of the unidirectional FPI element, all other methods and interfaces are unproven and thus pose technical and operational risks and uncertainties; • The Network Licensee is exposed to the operational and financial impacts of a potential failure; • Trial project incurs high cost and long timescales that would be borne by Network Licensee

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

• Technically, the OHL Power Pointer solution consists of a first-of-a -kind device and the methods that WPD is interested in trialling are thus far unproven. The NIA offers a low-risk way of testing and validating the solution; • On a regulatory basis, any Smart Navigator 2.0 outputs would have no impact on operational performance; • Legally, the NIA represents a mechanism to make the knowledge and IPR generated by the project available to other GB DNOs to the benefit of all GB customers. Other mechanisms for funding this project could restrict access to the knowledge / IPR would not necessarily result in the same level of benefits for GB customers.

This project has been approved by a senior member of staff

☑ Yes