

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

Feb 2019

### Project Reference Number

NIA\_UKPN0046

## Project Registration

### Project Title

Underground fault predictive model and earthing assessments

### Project Reference Number

NIA\_UKPN0046

### Project Licensee(s)

UK Power Networks

### Project Start

February 2019

### Project Duration

2 years and 7 months

### Nominated Project Contact(s)

Chino Atako

### Project Budget

£692,887.00

## Summary

UK Power Networks experiences faults on Low Voltage (LV) and High Voltage (HV; Note 6.6 or 11kV) underground cables each year, with over 80% of these faults attributed to “age and wear” or “unknown” causes. A previous study on an NIA project, “Prediction of weather-related faults”, showed that there was a measurable relationship between the amount of rainfall and the number of LV and HV faults. However, the previous study also showed that further work was required to develop an operational faults forecast model for LV and HV underground cables. A review of soil characteristics in combination with rainfall is likely to provide additional detail to be able to develop an operational faults forecast model. The data on soil characteristics can also be used to develop a soil resistivity assessment tool, for secondary substation earthing studies.

### Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

## Problem Being Solved

UK Power Networks experiences faults on Low Voltage (LV) and High Voltage (HV; Note 6.6 or 11kV) underground cables each year, with over 80% of these faults attributed to “age and wear” or “unknown” causes. A previous study on an NIA project, “Prediction of weather-related faults”, showed that there was a measurable relationship between the amount of rainfall and the number of LV and HV faults. However, the previous study also showed that further work was required to develop an operational faults forecast model for LV and HV underground cables. A review of soil characteristics in combination with rainfall is likely to provide additional detail to be able to develop an operational faults forecast model. The data on soil characteristics can also be used to develop a soil resistivity assessment tool, for secondary substation earthing studies.

## Method(s)

This project will involve a study of the effect of soil characteristics in combination with rainfall, on a number of LV and HV underground cable faults. The learning from this study will be used to develop an operational faults forecast model for LV and HV underground cables if a well-defined relationship is observed. The project will also involve the development of a soil resistivity assessment tool, for secondary substation earthing studies, using information on soil characteristics.

Update, January 2021:

The soil resistivity assessment tool was completed as planned in the first half of the project and has been implemented in UK Power Networks' Geospatial Analytics tool (GSA).

The fault prediction model based on geology in combination with weather, was not implemented because analyses completed by British Geological Surveys (BGS) did not identify a strong enough correlation between geology, rainfall and underground cable faults. As a substitute we plan to implement a statistical fault forecast model, based on weather alone.

A time extension to the project is being made, for six months, up till August 2021. The time extension will enable the Met Office to complete essential analyses to tweak a statistical faults forecast model based on weather alone, which will include underground cable fault predictions. The time extension will also enable us to implement the statistical fault forecast model in GSA. Overall this will allow the project to offer valuable conclusions and a functional faults forecast model at the end of the trial.

## Scope

The operational fault forecast model and the soil resistivity assessment tool would both be embedded in UK Power Networks' GIS tool, the Geospatial Analytics Web Application (GSA). The soil resistivity assessment tool, in GSA, will replace an unsupported out-of-date web version currently hosted by British Geological Surveys.

The project will be delivered as two use cases:

Use case 1 – Impact of geology on cable faults:

- Analyse soil data sets, historical rainfall and faults to determine correlations and to build a faults forecast algorithm
- Integrate static and dynamic data sources in the GSA tool including:
  - o Static data sources: soil type, soil moisture, compound topographic index, and other major key components related to faults identified in the project. These will be supplied as either ESRI .shp or MapInfo .TAB, although other formats may be available on request.
  - o Dynamic data sources: daily and future weather forecasts. These will be provided via a web map service.
- Apply a faults forecast algorithm to the GSA tool, to display a heat map for faults forecasts, based on a combination of weather, soil type, soil conditions and geographic location.

Use case 2 – Data visualisation of engineering assessment results for substations:

- Integrate static data sources in the GSA tool including:
  - Soil type, soil moisture, compound topographic index, and other major key components related to faults identified in the project. These will be supplied as either ESRI .shp or MapInfo .TAB, although other formats may be available on request.
- Earthing data
- Fault level data
- Protection settings data

This project will involve working with two project partners:

- British Geological Surveys – To provide soil data and analyses;
- Met Office – To provide rainfall data (from their Met Office Global and Regional Ensemble Prediction System - MOGREPS) during the project.

And one supplier:

- Tata Consultancy Services – To provide design, testing, development and deployment activities to implement a fault prediction model and soil resistivity assessment tool, for secondary substation earthing studies, in GSA.

## Objective(s)

The objectives of this project include:

1. To determine the relationship between soil type, rainfall and underground cable faults
2. To build a faults forecast model for underground cables (if a meaningful relationship exists between soil type, rainfall and underground cable faults)
3. To build a soil resistivity assessment tool for desktop earthing assessments at substations

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

The following criteria will be used to determine whether the project has been successful:

- Should a relationship between soil data sets, historical rainfall and faults to determine be found, then the implementation of a reliable faults forecast model for underground cables in UK Power Networks' GSA
- Implementation of a soil resistivity assessment model in UK Power Networks' GSA

## Project Partners and External Funding

(1) British Geological Surveys – To provide soil data and analyses;  
(2) Met Office – To provide rainfall data (from their Met Office Global and Regional Ensemble Prediction System — MOGREPS) during the project.

### Potential for New Learning

The project will improve our understanding of the relationship between soil types, rainfall and underground cable faults.

### Scale of Project

The project will apply to underground cables in UK Power Networks' three network areas. This project scale has been determined to ensure that the solution (for fault prediction and soil resistivity assessment) being sought would be truly representative of different geographical areas. Limiting the scale to one network area will not provide us with enough information to determine whether the solution is applicable in different network areas which have different geo-related soil characteristics.

### Technology Readiness at Start

TRL3 Proof of Concept

### Technology Readiness at End

TRL8 Active Commissioning

### Geographical Area

The project will apply to underground cables in UK Power Networks' three network areas.

### Revenue Allowed for the RIIO Settlement

No revenue has been allowed for this project in the RIIO-ED1 settlement.

### Indicative Total NIA Project Expenditure

£692,887

## 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)

NPV (£k)

Base Cost: £2,944.32k  
Method cost: £1,617.39k  
Method Benefits: £1,674.24k  
Savings: Base Cost - Method Cost: £3,001.17k

The savings shown are from 2018/19 to 2030/31. It exclude the NIA project costs (development costs) but includes £188.83k of CML benefits and £214.75k of operational savings per year.

#### Please provide a calculation of the expected benefits the Solution

Total NPV (£k)  
Base Cost: £2,944.32k  
Method cost: £2,277.26k  
Method Benefits: £1,674.24k  
NPV: Base Cost - (Method Cost - Benefits): £2,341.30k

The savings shown are from 2018/19 to 2030/31. It includes the NIA project costs in 2018/19 to 2020/21 and subsequent rollout costs and benefits from 2021/22 to 2030/31.

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

All of the other five DNO Groups in GB have underground cables on their electricity distribution networks. Hence hence the method proposed in this project will also be applicable to them. Also, the method can applied to the five DNO Groups in GB, each at a similar cost to UK Power Networks, provided each DNO Group has an already existing software tool to implement the solutions (a fault predictive model and soil resistivity model). UK Power Networks is utilising its existing GSA tool to implement the solution.

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

Total Cost (£k): £ 4,157k  
Note this is not discounted

This cost is based on each of the 6 DNO Groups replicating this project (i.e. £692.9k x 6)

## 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

The learning aims to provide evidence of the impact of rainfall and soil types on underground cables faults. It also aims to prove whether it is possible to predict the number of weather-related underground cable faults based on rainfall and soil data. All GB DNO's have similar underground cable types, therefore learning from one DNO will be transferable to others. However DNOs will need a study of the soil types in their areas as this varies from one geographic area to the other.

Learning from the project will be disseminated via the project reports on the ENA Smarter Networks Portal. DNO will also be able to contact UK Power Networks directly to gain detailed insights into the work done on the project and the findings. We will aim to present the findings and any updates via our Better Networks events.

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

n/a

- 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.

In developing this project we have reviewed previous NIA and NIC projects, reviewed libraries of engineering projects and discussed the project scope with colleagues from the industry and have not come across any project that provides the outputs we aim to achieve from 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**

Traditionally, forecasts of underground cable faults are based on outputs from network monitoring devices and operational experience. However no standard approach exists to quantify the potential impact of rainfall and soil type on underground cables and faults. Similarly, earthing assessments at substations are typically done by taking soil resistivity measurements on site followed by desktop calculations. This project provides an innovative approach to fault prediction for underground cable faults by seeking to quantify the relationship between soil characteristics (in areas with underground cable) and the amount of rainfall. It also seeks to use the soil characteristics to build a soil resistivity model which would be used in an earthing assessment tool. We believe that this has not been tried before because the data on soil types has not always been available to the degree of accuracy that it is today.

**Relevant Foreground IPR**

n/a

**Data Access Details**

n/a

**Please identify why the Network Licensees will not fund the project as part of its business and usual activities**

The solutions being explored on the project are still at a low TRL level and there are a number of issues and risks to overcome before the solution can be deployed as part of business as usual activity.

**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**

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 solution requires a network test to prove its viability. The proposed approach to underground fault prediction also has an unproven business case. The viability of the approach using soil type and rainfall data 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 trailed in the project is not adopted at the end of the project. This could be due to the fact that the solution has not reach the level of maturity 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**

Yes