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NIA Project Registration and PEA Document

Date of Submission

May 2015

Project Reference Number

NIA_UKPN0006

Project Registration

Project Title

The Prediction of Weather-Related Faults

Project Reference Number

NIA_UKPN0006

Project Licensee(s)

UK Power Networks

Project Start

May 2015

Project Duration

1 year and 4 months

Nominated Project Contact(s)

Chino Atako

Project Budget

£128,310.00

Summary

The aim of this project is to develop a model to enable us to forecast the impact of different weather conditions on our assets. The scope of the project will include analyses of low voltage and high voltage (up to 11kV) underground cable and overhead line faults, in relation to weather conditions, in the three license areas (EPN, LPN and SPN).

The key weather data that will be analysed will include: (1) precipitation, (2) wind speed and direction, (3) lightning and (4) ice accretion.

Nominated Contact Email Address(es)

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Problem Being Solved

Key challenges faced by Distribution Network Operators (DNOs) include:

- Poor understanding of the impact of various combinations of weather conditions on specific asset types and their components
- Limited forecasting capability for faults
- Limited local resources during a significant weather event (in these instances fault volumes are usually significantly higher than normal so often require additional contractor resources)
- Increasing operational costs for dealing with weather-related faults

Within UK Power Networks, resource requirements for forecast weather conditions are determined based on engineering judgment and a subjective view of the impact of historical weather events. A detailed analysis of historical fault and weather data will provide a better understanding of the specific relationship between different combinations of weather conditions and overhead and underground assets. This will enable us to develop algorithms that would feed into a faults forecast model. A validated faults forecast model will improve the accuracy of fault forecasts and provide the enabler to improve deployment of resources, reduce, CMLs and operating costs. The faults forecast model will allow us to carry out localised impact assessments for weather conditions in different geographical

areas.

Method(s)

The prediction of weather-related faults is being carried out as a two-stage project:

- Phase 1 Proof of concept
- Phase 2 Prediction of weather-related faults

Phase 1 of the project was completed by the Met Office and funded by UK Power Networks. Analyses by the Met Office on LPN data showed that there was indeed some relationship between a combination of weather conditions (rainfall, dry spells, soil condition etc.) and faults. This proved that there was some benefit in carrying out a more detailed analysis to understand the relationship between faults and weather data.

In phase 2 the intention is to carry out a more detailed analysis using more granular weather data (hourly 2km data). This will focus on underground cable faults and overhead line faults in the three licence areas. The product that will be delivered by the project will be a faults forecast model and the outputs will be faults impact assessments that will accompany the daily/weekly weather forecasts that we receive from the Met Office.

In phase 2 the intention is to carry out a more detailed analysis using more granular weather data (hourly 2km data). This will concentrate on underground cable faults and overhead line faults in the three licence areas. The product that will be **delivered** by the project will be a faults forecast model and the outputs will be faults impact assessments that will accompany the daily weather reports that we receive from the Met Office. The data will provide daily (and potentially sub daily) fault forecasts up to five days ahead for the three UK Power Networks licence areas and be delivered daily or sub-daily.

The project will be broken down into five key work packages; data restoration, precipitation,) wind speed and direction, lightning and (ice accretion. This will allow each element of the work to progress independently so that forecast services for the various aspects can be implemented as soon as that particular work package is completed.

Data restoration

The work outlined in the different work packages requires historical gridded weather information (hourly 2km data covering the UK). This information is held on off-line storage media, by the Met office, and takes some time to restore. This would be the first task to be undertaken and would take three months to complete including quality assurance and validation of the data.

Historical data analyses

Analyses of historical fault data to identify trends in relation to precipitation, wind speed and direction, lightning and ice accretion will be carried out. The results of these analyses will be used to develop algorithms which will help implement the fault forecast models.

Annual Verification

Annual verification of the forecast models will be carried out using updated UK Power Networks faults data to ensure that the models remain fit for purpose. Changes may need to be made to reflect the changing resilience of the distribution network due to investment and ageing. Model improvements may also be necessary to capture important influences not yet incorporated in to the models. An annual report on performance would highlight how well the models are performing and make recommendations for future improvements. The Met Office will retain all of the forecasts that it has issued and analyse how well each performed at varying forecast lead times. UK Power Networks could use this information to determine how far in advance decisions should be made relating to the forecast services.

Deliverables

The product that will be **delivered** by the project will be a faults forecast model and the outputs will be faults impact assessments that will accompany the daily weather reports that we receive from the Met Office. The data will provide daily (and potentially sub daily) fault forecasts up to five days ahead for the three UK Power Networks licence areas and be delivered daily or sub-daily.

The main benefits from the project include:

- Better understanding of the relationship between faults and weather including understanding of the relationship between ice accretion and faults on the network.
- Development of a faults forecast model which:

- Estimates the frequency of daily precipitation related faults on the low voltage network for each individual licence area.
 - Estimates the frequency of daily wind related faults on the high voltage network for each individual licence area.
 - Identifies areas which are more susceptible to lightning than others. This is dependent on the quality of historical lightning data. If a reasonable relationship can be found then a forecast model will be developed.
- Improved CML performance due to better utilisation of operational resources
 - Reduced operational costs by accurately predicting the number of resources required and reducing the number of non-utilized standby resources.

Scope

The aim of this project is to develop a model to enable us to forecast the impact of different weather conditions on our assets. The scope of the project will include analyses of low voltage and high voltage (up to 11kV) underground cable and overhead line faults, in relation to weather conditions, in the three license areas (EPN, LPN and SPN).

The key weather data that will be analysed will include: (1) precipitation, (2) wind speed and direction, (3) lightning and (4) ice accretion.

Objective(s)

The objectives of the project are to:

- Improve understanding of the relationship between weather and faults (including ice accretion and faults on the network.)
- Develop a forecast model which estimates the frequency of daily precipitation and wind-related faults on the distribution network (LV, HV) for each individual licence area.
- Identify areas which are more susceptible to lightning than others and develop a model if a reasonable relationship can be found.
- Reduce operational costs due to non-utilisation of standby staff
- Reduce Customer Minutes Lost

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Success criteria for the project are defined below:

- (1) Better correlation between observed number of faults and the forecast impact of weather condition on faults.
- (2) A reduction in non-utilisation of staff on standby

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project will cost £128,310 and will include five work packages: (1) data restoration, (2) precipitation, (3) wind speed and direction, (4) lightning and (5) ice accretion. These work packages will involve the analysis of historical weather data to determine the associated relationship to cable and overhead lines faults across our three license areas.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

London Power Networks (LPN)

South Eastern Power Networks (SPN)

Eastern Power Networks (EPN)

Revenue Allowed for the RIIO Settlement

No funds have been allowed for this piece of work in the RIIO-ED1 settlement.

Indicative Total NIA Project Expenditure

£128,310

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)

Network performance and financial – implementing a forecast model will allow us to more accurately utilise our resources during storms. This would result in a reduction in CMLs as well as a reduction in operational costs due to a reduction in non-utilised staff on standby:

- (1) CML – we estimate that we would achieve a CML benefit equivalent to **£126k** per year in UKPN (combined for the three DNOs), based on the saving of one-eighth of a CML in EPN and SPN respectively.
- (2) Operational cost savings for standby – we estimate that we would achieve saving equivalent to **£94k** per year in UKPN (combined for the three DNOs), based on a reduction in the number of non-utilized staff on standby.

Please provide a calculation of the expected benefits the Solution

Base Cost: £0

Based on the assumption that no fault forecast model is currently used.

Method Cost: £100,00

Based on the cost of rolling out the fault forecast model.

Benefits: £1,025,747 NPV of the CML benefits and operational cost savings over the RIIO ED1 period to 2022/23. The calculation takes into consideration an annual licence cost of £16,500 / license area

Financial Benefits: £925,748 Base cost – (Method cost – Benefits)

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

The end process will be applicable to all other network areas as other DNOs have the same operational issues.

DNOs will only need to have the fault-weather algorithms tailored to their network.

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

It is estimated that rolling out the methodology across GB will cost £100k per DNO. The assumption is that each DNO would need to have their fault data analysed to establish the fault-weather relationship in their respective network areas. The algorithm that will be determined for UK Power Networks may be different to those required for other DNOs as other DNOs use slightly different design standards for their distribution networks.

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

All DNOs have a similar infrastructure therefore the process and algorithms that will be developed could be applied to all networks. However it is important to note that the algorithms for the fault forecast models may need to be tweaked to cater for specific network design considerations in different DNOs.

The learning that will be gained can be used to improve network performance, safety, improve the environment and improve customer service.

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 challenge which has been identified is to accurately resource forecast the number of faults due to adverse weather conditions. This will ensure that deployment of resources is more efficient and will reduce operating costs.

- 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.

n/a

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