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 2014

Project Reference Number

NIA_NGET0028

Project Registration

Project Title

Impact of extreme events on power production at the scale of a single wind-farm

Project Reference Number

NIA_NGET0028

Project Licensee(s)

National Energy System Operator

Project Start

January 2013

Project Duration

1 year and 7 months

Nominated Project Contact(s)

David Lenaghan

Project Budget

£150,000.00

Summary

The post doctoral research assistant will be encouraged to examine innovative ways to process the data provided to minimise forecast error. Suggested techniques include calculating rate of change and integrals of parameters in addition to using the explanatory variables directly. It is expected that this work will both improve the accuracy of the wind power predictions as well as improve the expression of the range and degree of uncertainty in forecast values.

The effect of wind shear across a wind farm is of particular interest. The particular behaviour of individual turbines as well as the aggregated power output of the wind farm in relation to small scale and rapidly changing wind phenomena is currently not well understood.

Third Party Collaborators

University of Reading

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

The generation mix in the UK is changing. Controllable large thermal generation units located relatively close to centres of electricity demand are being closed down. Dispersed intermittent, predominantly wind generation located towards the periphery of the network

are being developed. This is radically changing the nature of system management and increasing the complexity of the problem. Knowledge about generation patterns and network flows are essential to the appropriate placement of network outages as well as balancing the cost and risks of procuring necessary energy reserves.

Wind power forecasts have become essential to the safe and economic operation of the GB transmission system. As experience has been gained in the process of generating forecasts and improving their accuracy it has become apparent that there is a need to better understand extreme meteorological events.

The current models used by National Grid are based upon mean wind speed at the average hub height of the wind farm. It is known that this approximation leads to varying degrees of forecast error. It is anticipated that incorporating more detail about the true nature of wind flow will improve this significantly. Specifically information describing different forms of turbulence caused by convection or wake from terrain and neighbouring wind farms is believed to be very significant.

Method(s)

Research

The method that has been proposed for this project includes;

· Report on relevant literature and comparison of academic and industry approaches (small scale wind activities

- Conference-style paper summarising literary research

· Report on proposed model design including inputs and outputs.

· Results from initial model scoping work.

· Deliver Model Code

- Report on activities, findings and progress

· Integrate wind-field model with turbine characteristics to give power output (follow methodology of D.Drew; use a range of different turbine models)

· Updated Model Code

- Report on activities, findings and progress

· Undertake simulations for a range of atmospheric conditions leading to extreme gust conditions;

- Provide presentation of code results
- Full project report delivered describing method, approach, findings and areas of interest for future research

Scope

The post doctoral research assistant will be encouraged to examine innovative ways to process the data provided to minimise forecast error. Suggested techniques include calculating rate of change and integrals of parameters in addition to using the explanatory variables directly. It is expected that this work will both improve the accuracy of the wind power predictions as well as improve the expression of the range and degree of uncertainty in forecast values.

The effect of wind shear across a wind farm is of particular interest. The particular behaviour of individual turbines as well as the aggregated power output of the wind farm in relation to small scale and rapidly changing wind phenomena is currently not well understood.

Objective(s)

The objective of this project is to develop advanced models that have the capability of forecasting wind power output more accurately.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

- Conference-style paper summarising literary research
- Deliver Model Code
- Provide presentation of code results
- Full project report delivered describing method, approach, findings and areas of interest for future research

Project Partners and External Funding

University of Reading

No external funding

Potential for New Learning

There is significant potential for new learning as this project will develop a greater understanding of the interaction between these extreme small-scale phenomena and the architecture of wind farms which will allows improved turbine designs and geographical layout to provide more consistent services and greater reliability to the grid.

Scale of Project

The project will be concentrated on a university study which will be utilizing Computational Fluid Dynamics.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

This project will deliver tools and techniques for use on the whole of the UK Transmission Network (national).

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£150,000.

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)

Improved forecast accuracy – A 1% error in the forecast power output of the 5000MW installed wind capacity is 50MW. To ensure balance between generation and demand in real-time, this requires energy reserves to be purchased at System Buy Price or System Sell Price. Avoidance of 50MW of error this would give a cost saving of approximately £1500 per hour. This project is one of several that National Grid is conducting to understand better factors which affect renewable generation and to improve forecasting techniques. Whilst specific savings may or may not be specifically attributable to this work in the future, it is clear that all effort which improves wind-power forecast accuracy will be beneficial.

Improved understanding of situations where the model does not perform well is useful as an input into response and reserve setting procedures. This will allow greater amount of reserve to be held during periods of lower confidence in the model output. This will also allow a lesser amount of reserve to be held when there is higher confidence in the model output.

A greater understanding of the interaction between these extreme small-scale phenomena and the architecture of wind farms will be valuable to the industry which could lead to improved turbine designs and geographical layout to provide more consistent services and greater reliability to the grid. Findings and subsequent design changes and industry code changes which reduce the tendency of farms to cut-out under gusty conditions reduce the need for balancing reserves. As a consequence one can anticipate not only an economic saving but also a reduction in GB carbon emissions, since this reserve is currently provided by thermal generation.

Please provide a calculation of the expected benefits the Solution

Research Project - Not Required

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

This can be applied to every location where wind farms are installed, but also will impact the balancing operations for the whole of the GB Transmission system.

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

The primary objective of the project is to develop improved forecasting of wind farm output. In order to integrate this into the routine operations of the GB System Operator, an interface between the succesfully developed wind forecasting model and the existing forecasting models used by National Grid will be needed. This kind of roll out would could cost in the order of £200,000-£400,000,

with the costs maily attributed to ensuring the continued security of critical control systems.

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 that will be generated could be used by relevant Network Licenses as they will be able to use advanced models that have the capability of forecasting wind power output more accurately.

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.

Given a review of all companies IFI report, the project engineer confirms that no duplication of innovation work.

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