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

Jun 2018

Project Reference Number

NIA_NGSO0015

Project Registration

Project Title

Optimisation of weather data to improve energy forecasting

Project Reference Number

NIA_NGSO0015

Project Licensee(s)

National Energy System Operator

Project Start

May 2018

Project Duration

1 year and 7 months

Nominated Project Contact(s)

Sumit Gumber

Project Budget

£124,000.00

Summary

This innovation project involves analysis of vast sets of historical weather data to investigate the effects of increasing the frequency of delivery of weather forecasts, the spatial resolution of weather forecasts and assess which weather variables National Grid should use to optimally estimate demand, wind and PV generation.

Third Party Collaborators

The Smith Institute

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

Our analysis shows that around 50% of the electricity demand forecast error is influenced by the weather data used.

The weather data used to generate the energy demand forecast is based on data from a number of geographically dispersed weather stations and is received every six hours. This is then used by the GB System Operator's Energy Forecasting team to generate energy demand forecasts for the electricity control room, energy trading and commercial operations team as well as communicating this to the wider energy market.

With increasing generation output from renewables (i.e. PV and Wind) on the GB electricity system, and unforeseen weather events being experienced more frequently, the size of the errors in the SO demand, PV and wind generation forecasts are increasing.

Method(s)

This research project seeks to understand the extent to which increasing the frequency and spatial resolution of forecasts in the weather data used can improve the accuracy of demand, PV and wind generation forecasts.

The proposed work and methodology will also aim to make recommendations on the weather variables which should be used in PV, wind and demand forecasting models to deliver an optimum result.

This will be achieved through analysing historical weather data as part of the project and answering the following research questions:

1. What is the optimal frequency and resolution for the GB System Operator to receive weather forecasts?
2. What is the optimal number and locations of weather stations?
3. Which weather variables (e.g. temperature, wind speed) are best to use for energy forecasting?
4. What are the impacts of weather forecast error on the forecast accuracy of PV generation, wind generation and national demand?

To answer 1) above, the project will use the data from the historical weather forecasts created four times a day and compare them against the actual values to understand the relationship between lead-in time and errors in weather forecasts. Through this approach, it is expected that a functional relationship can be created to determine the weather forecast sensitivity to lead-in time, and thus answer questions such as “what is the expected weather forecast error if the lead-in time is 1 hour?”. In answering this question, the impact of weather data on energy demand forecasting can be better understood,

The analysis and methodology for answering question 2) above will be based on data from weather stations where both forecast data and actual observed data are available. The output of this analysis will be graphs displaying how errors in weather forecasts (i.e. temperature, wind speed and radiation) depend on the number of weather stations and the average distance to the nearest neighbouring weather station. These investigations will help understanding how spatial representation of weather data impacts solar PV, wind and overall energy demand forecasting.

To answer question 3, a thorough review will be conducted to determine the state of the art of wind, PV and demand forecasts models and what weather variables they incorporate. These activities will inform the future energy forecasting strategy.

Investigations for answering question 4) will specifically consider how errors in weather forecasts and the associated data (from the learnings and analysis carried out in answering questions 1, 2 and 3) propagate through the forecasting models and give rise to errors in MW outturn in the overall energy demand forecast.

Scope

This innovation project involves analysis of vast sets of historical weather data to investigate the effects of increasing the frequency of delivery of weather forecasts, the spatial resolution of weather forecasts and assess which weather variables National Grid should use to optimally estimate demand, wind and PV generation.

Objective(s)

The objective of this project is to identify the properties of weather data which will optimise generation and energy demand forecast accuracy in the most cost-effective way.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be successful if the System Operator is able to:

1. Better understand and get insights into the specific components of the weather data-related error which accounts for approximately 50% of the overall energy demand forecast error.
2. Understand the impact that more granular weather data and its timeliness can have towards improving the national energy demand forecast.
3. Use the outcomes from the project to inform the future energy forecasting strategy as well as the design and architecture of the

future energy forecasting system and processes - in particular the type of weather data and associated components/interfaces which will be required as the energy landscape continues to change.

Project Partners and External Funding

The project will involve collaboration between National Grid's Energy Forecasting team and the Smith Institute. There is no external funding involved in this project.

Potential for New Learning

This innovation project is expected to deliver new learning by:

1. Providing a framework to identify the optimum properties of weather data for energy forecasting.
2. Guiding future energy forecasting strategy for the GB System Operator, as well as informing the wider industry on how to improve their energy forecasts.
3. Informing the approach for enhancing Grid Supply Point (GSP) level demand forecasts in future projects.

Scale of Project

The project will predominantly involve desk-based research and data analysis activities at National Grid and the Smith Institute for Industrial Mathematics and System Engineering.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

This work will take place on a national scale and will benefit the accuracy of GB demand, wind and solar PV generation forecasts.

Revenue Allowed for the RIIO Settlement

None.

Indicative Total NIA Project Expenditure

The total indicative NIA expenditure for this project is £124,000.

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)

Through understanding the weather data used for energy demand forecasting and the properties of weather-related errors, it is expected that the results of this project will bring about significant MW reduction in forecasting errors for demand, wind and PV generation.

Achieving this will lower the electricity control room balancing actions and enable wider market participants to also forecast better. The potential savings which can be achieved in terms of MW reduction in error versus balancing costs will be evaluated and quantified as part of the implementation of this innovation project.

Please provide a calculation of the expected benefits the Solution

Not applicable as this is a research project.

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

The project will benefit all GB network licensees and the outcomes of the project will be made available such that licensees and other industry users can access the learnings from the project to better understand the impact of more granular weather data to improve energy demand forecasting.

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

The project's results will inform the design requirements and architecture of the future energy forecasting capability and processes for the GB System Operator.

It is expected that the methodologies used during the project to investigate weather data properties for energy forecasting and learnings can be shared with other network licensees and the energy industry to enable novel approaches in understanding their implications in operating the GB electricity network and future changes to it.

the costs to implement the learnings from this project into National Grid SO's BAU systems and activities has already been budgeted for.

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 outcomes and learnings from this innovation project will be disseminated through the National Grid SO Innovation website, the ENA website, the annual Low Carbon Network Innovation conference.

It is expected that the outcomes from the analysis carried out in this innovation project will give GB network licensees new insights in understanding weather data and its influence on the forecast accuracy and energy demand forecasting.

The benefits achieved from the project learnings will be shared with the industry in the form of improved energy demand forecasts via National Grid's Operational Data Explorer website (https://www.nationalgrid.com/uk/electricity/market-operations-and-data/data-explorer).

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

This project will directly address the strategic innovation area "Improving short-term forecasting of generation/supply and demand" in the National Grid System Operator Innovation Strategy document published in Feb 2018.

It will also have indirect benefits in the following other strategic areas – Optimising constraint management, Managing volatility in a low-inertia system, Enabling more non-synchronous connections and Unlocking flexibility.

☑ 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.

No unnecessary duplication will occur as a result of this project. There are no other known innovation projects investigating weather data and how it can be optimized for energy demand forecasting and supporting real-time operational decision making.

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

Weather forecast data is a critical input to National Grid System Operator (SO) renewable generation forecasts, as well as to our demand forecasts (an estimated 50% of the energy demand forecast error now attributed to the weather data used). Renewable generation capacity is growing at historically high rates on the GB electricity system. Weather is becoming increasingly unpredictable. These two trends are compounding to make SO's job of forecasting exponentially more difficult. The timing is now critical that we look to optimize the weather forecast data that we use in our forecasts. This project is the first of its kind. So far, weather forecast data used to inform energy forecasting has been based on a specific frequency of receiving and processing the forecast, on data from a certain number of weather stations of specific types and on using specific weather variables. This project seeks to investigate and analyse, through innovative methodologies and applying mathematical techniques, the extent to which increasing the frequency and spatial resolution of forecasts in weather data can improve the accuracy of demand, PV and wind generation forecasts. It will also assess the optimum weather variables to use in PV, wind and demand forecasting models. This project will therefore enable the delivery of a novel framework to identify the optimum frequency and spatial distribution of weather data and associated variables, to inform future energy forecasting system design and forecasting methodologies, not just for the SO but for the wider industry.

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

The applied research activities and methodologies proposed in this project have not been carried out before and cannot be carried out directly on the operational systems at National Grid. The project results will need to be tested and validated in a simulated environment before they can be used in the SO's operational systems as part of business as usual activities, and disseminated for use by the wider energy market. The activities involved in this project are dependent on the specialist skills and knowledge of the chosen innovation partner, the Smith Institute.

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

NIA funding is the chosen funding route for this innovation project for the following reasons: 1. It will facilitate collaboration with the chosen innovation partner to access their specialist skills and expertise in a cost-effective and timely manner, given the key operational challenges which this project is aiming to address. 2. It will allow the SO to easily disseminate the key learnings from the project to the energy sector and GB network licensees. The insights from this project are expected to benefit the SO and the energy sector in better understanding the characteristics and impact of more granular weather data in enhancing renewable generation and demand forecasting. This will benefit the distribution network operators (DNOs), renewable generators, traders, suppliers, etc. 3. This project will test a number of approaches and methodologies that could not be applied to the SO's operational systems as they are too risky. They must be tested in an agile way offline, before the most effective approach is validated, before implementing as BAU. The SO Innovation approach, complemented by the NIA funding framework, is the most cost-effective way to do this.

This project has been approved by a senior member of staff

☑ Yes