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 2016

Project Reference Number

NIA_NGET0177

Project Registration

Project Title

Solar PV Forecasting Phase 1

Project Reference Number

NIA_NGET0177

Project Licensee(s)

National Energy System Operator

Project Start

April 2016

Project Duration

2 years and 1 month

Nominated Project Contact(s)

David Lenaghan

Project Budget

£440,000.00

Summary

The scope of the project is to both support Numerical Weather Prediction (NWP) improvements and establish effective techniques to improve upon raw NWP output, both of which are areas the Met Office have scientific expertise in.

Preceding Projects

NIA_NGET0170 - PV Monitoring Phase 2

NIA_NGET0139 - PV Monitoring: Phase 1

Third Party Collaborators

Met office

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

There is approximately 8GW of solar photovoltaic generation in Great Britain as of November 2015, which consists of over 600,000 individual sites. The majority are 3.3kW domestic installations which sit on the distribution networks. National Grid has no direct

visibility of this generation as there is no obligation for National Grid to receive metering for such low level but numerous installations from the electricity distribution networks. The only visibility is in the indirect result of demand suppression seen in Grid Supply Point metering.

This increasing capacity of weather dependent generation has led to an increasing demand forecast error and a need for higher reserve levels as a result. Improving solar PV power forecasts is one way in which the forecast error can be reduced which in turn will reduce the need for higher levels of reserve and hence balancing costs.

The key weather variable that determines PV forecast model accuracy is irradiance. Sunshine is however subject to significant temporal and spatial variability, due to the complex and dynamic distribution of cloud. This makes it challenging to predict accurately. Innovations and further research in this area will help achieve improvements in the irradiance forecasts National Grid receives.

Method(s)

Cloud is the principal source of error in solar radiation forecasts. This is because interception by cloud introduces significant variability into the amount of radiation reaching the ground. In order to estimate surface solar radiation, Numerical Weather Prediction (NWP) models need to correctly establish several factors related to clouds, such as whether there is cloud at all, the proportion of sky coverage and the optical thickness of the cloud, as well as how these factors evolve over time. Much of this variability operates at scales at which NWP cannot wholly resolve. Whilst there is scope to target improvement in the NWP, there is also strong potential to develop post-processing techniques and statistical correction tools to better handle the uncertainties that remain in the Numerical Weather Prediction (NWP) leading to improvement in the end solar radiation forecast supplied to National Grid from the radiation forecast provider.

Scope

The scope of the project is to both support Numerical Weather Prediction (NWP) improvements and establish effective techniques to improve upon raw NWP output, both of which are areas the Met Office have scientific expertise in.

Objective(s)

The objectives of the project are to reduce demand forecast error attributable to embedded solar PV as a result of researching improvements in solar irradiance forecasting methods.

In order to achieve the objectives, the following work packages will be pursued and delivered:

Post Processing Work Packages:

WP 1 – Refinements to the existing solar radiation forecasting capability to best suit National Grid's requirements

Clear evidence shows the Met Office Global and Regional Ensemble Prediction System (MOGREPS) UK ensemble has a tendency to be too cloudy, which has a particularly strong negative impact upon solar radiation forecasts. For Day +1 forecasts, the Met Office will test replacing MOGREPS-UK with the global MOGREPS-G (Global) ensemble output which demonstrably performs well from Day +2 onwards. They will also test replacing the MOGREPS-UK ensemble mean with a blended forecast using multi-model solar radiation, including output from the Met Office's high resolution deterministic Numerical Weather Prediction (NWP). If testing demonstrates these changes are positive, the Met Office will implement these improvements by Summer 2016.

WP 2 – Investigation and development of statistical post-processing techniques

A number of techniques exist that can add value to raw forecasts through learning systematic error characteristics from making use of existing radiation observations. The Met Office currently deploy Kalman Filtering to temperature and wind speed. Application of a Kalman Filter; perhaps to normalised solar radiation, will be tested and assessed. The Met Office will also explore other techniques such as Model Output Statistics (MOS) and Neural Nets and potential combinations of techniques. Where these demonstrate added value, the aim will be to develop them into the Met Office operational environment by Summer 2017. A report of these methods will be published as part of the project deliverables.

WP 3 – Development of a gridded solar radiation Nowcast

Accuracy in the 4-6 hour period is operationally significant for National Grid. The Met Office have an hourly updating Nowcast capability that combines observational data from both weather stations and satellite imagery with the latest high resolution NWP for a number of key parameters. This work package would extend that capability to solar radiation, for which both station and satellite measurements offer the clear potential for improving the fit to reality in the earliest hours of the forecast. The Met Office would also explore whether real-time available PV readings could be 'reverse-engineered' to give an additional observational source of solar

radiation, with good spatial coverage, that could be integrated into the Nowcast. The aim would be to operationalise by Summer 2017.

Core Science Work Package:

WP 4 – Focussed development of core NWP cloud/radiation schemes

This work package aims to:

- Perform research into model development that could lead to improvements in the forecasting of cloud and radiation at the surface.
- Deliver a report on research and development aimed at improving the representation of clouds, radiation and their interaction within the forecasting system.
- Provide a reference for future improvements in the MOGREPS forecasting system that would directly benefit the irradiance forecasts National Grid receive.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

This project's aim is to drive improvement in the key climatological variable that feeds National Grid's PV generation forecast model. These Improvements can be more accurately measured by comparing National Grid PV forecasts derived on project completion with the PV outturn data calculated using the method given by the NIA PV Monitoring Phase 2 project (NIA_NGET0170).

Post Processing Work Packages

- Immediate improvement in National Grid's operational PV power forecasts, including those published for industry visibility.
- Reduction of demand forecast error. This would lead to reduced balancing costs for managing the current level of solar PV on the system and reducing the costs to consumers of introducing further solar PV on the power system.

Core Science Work Package:

This work package would support and boost research and potential development in the fundamental cloud/radiation physics at the heart of our Numerical Weather Prediction (NWP) models. Where, as a result of this focus, the Met Office identify improvements, they will work to develop these into their operational capability as means to provide improved solar irradiance forecasting. However, the Met Office has to ensure that enhancements do not adversely affect other applications of NWP and for this reason cannot commit to specific timelines. A progress report will be provided in the research and development pertinent to solar radiation forecasting at appropriate intervals through the life of the project.

Project Partners and External Funding

The Met Office will perform the research and delivery under contract.

Potential for New Learning

The following improvements will drive accuracy in improvements in solar forecasting:

- Improved understanding of handling uncertainties in cloud.
- How to effectively apply statistical techniques to solar radiation, a parameter with a highly skewed distribution.
- How to effectively exploit observations that directly or indirectly permit actual solar irradiation to be estimated.
- Potential improvement in the representation of clouds, radiation and their interaction within the forecasting system.

Scale of Project

The statistical techniques assessed will be applied to all radiation forecast site data received by National Grid, and can be applied where appropriate to any further sites contracted for. The Core Science research package has the potential to improve the base numerical weather prediction models. Any improvement seen may feed through to data available via the freely accessible data published by the Met Office under their obligations as part of the Public Data Group.

Technology Readiness at Start

Technology Readiness at End

TRL3 Proof of Concept	TRL7 Inactive Commissioning

Geographical Area

GB

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£440,000

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)

In conjunction with the NIA project NIA_NGET0170 (Solar PV Monitoring Phase 2) and NIA_NGET0139 (Solar PV Monitoring Phase1). This project will reduce the demand forecast error that results from embedded solar generation. The subsequent reduction in system balances costs will lead to significant savings to the Industry, National Grid and the consumers.

National Grid publish GB PV forecasts which are publicly available from BM reports. This information will aid industry participants reduce their imbalance costs by adjusting their portfolio when applicable and pass these cost savings onto consumers.

Please provide a calculation of the expected benefits the Solution

On the basis that through this project we can deliver improvements in National Grid's solar PV forecast, we can expect a continued saving in reserve holding in excess of £1 million annually. In addition to this there are further savings through the balancing mechanism through the reduction of control room actions.

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

This project seeks to drive improvements in data freely available to Network Licensees.

The research learning would be freely available specifically, not the irradiance data per se as that is part of a commercial contract, However, the changes in this source data will improve the freely available PV power forecasts that National Grid provides publicly.

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

No additional costs.

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

Learning gained from the various work packages will be disseminated through papers and relevant documents published by the Met Office and disseminated through the National Grid Innovation Strategy website. The project team also intends to freely release the algorithm from Work Package 2.

Learning from this project could be used to further the understanding of solar irradiance, which is the key component of PV power forecasting for which Network Licensees may be interested in developing.

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.

NGET can confirm that no unnecessary duplication will occur as a result of 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

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