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 2017

Project Reference Number

NIA_NGSO0001

Project Registration

Project Title

Optimisation of Energy Forecasting - analysis of datasets of metered embedded wind and PV generation

Project Reference Number

NIA_NGSO0001

Project Licensee(s)

National Energy System Operator

Project Start

June 2017

Project Duration

0 years and 9 months

Nominated Project Contact(s)

Jeremy Caplin (.box.SO.Innovation@nationalgrid.com)

Project Budget

£34,150.00

Summary

PV Generation

1. Analyse the data sets available in order to determine additional factors that can be included in PV power curves (temperature, wind speed, geographical location etc.), and derive optimal power curves for the conversion of weather forecasts into PV generation forecasts.

2. Investigate the need for seasonal power curves to take account of the difference in height of the sun, and its interaction with angle of inclination of the panels

3. Investigate the need for regional power curves to take account of the differences in sun angle, or local pollution issues or any other effects

4. Investigate the use satellite imagery of cloud cover to improve forecasting accuracy.

5. Determine how accurately national installed PV capacity be estimated from analysis of demand forecast error combined with the available PV data. (Information on PV installed capacity lags by many months).

6. Investigate the validity of our current methodology of extrapolating from around 80 weather forecasts for specific geographical locations to around 900,000 separate locations – effect of local variations in cloud etc, and suggest any ways of improving the methodology.

7. Investigate how much response should we carry on the power system to cope with short term fluctuations in total PV generation

8. Investigate how much reserve should be carried on the system to cope with potential sustained changes in total PV generation – in the form of a probability distribution for possible changes in total PV over say a 15 minute period.

Embedded Wind Power Generation

1. Investigate whether a system that automatically updates wind power curves for metered data (such as an ARIMA based model) give a better fit to the data

2. Investigate whether we can use anomaly detection on the time series components of the metered output to improve the power curves? (e.g. recognising a period where output is capped at say 50% of capacity as likely to be a partial outage on the wind farm and so adapting / ignoring this data in the derivation of the power curves – building on the work recognising unusual days from the recent ATI Study Group).

3. Seek ways of improving our representation of the effects of high wind speed shutdown. (The amount of data for this task is relatively limited, which makes it more challenging).

4. Investigate the possibility of developing better wind power curves for embedded wind generation modelled at Grid Supply Point level – is a single generic curve appropriate or can the data be classed into several types of wind farm with different curves?

5. Determine how accurately embedded PV capacity can be estimated from analysis of the demand forecast error combined with wind speed measurements – either nationally or regionally.

Third Party Collaborators

Alan Turing Institute

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

Forecasting renewable generation output is a key challenge for National Grid as GB System Operator; effective forecasting is vital to keeping the lights on and minimising the costs of operation that fall onto industry and consumers.

Two new datasets of embedded generation output have recently been acquired by National Grid:

- Several years of historic output from around 20,000 domestic PV installations, at 30 minute or better resolution. To go with this data, we have hourly weather forecasts and outturns for around 60 weather stations for the last 18 months, and 80 for the last 6 months.
- Embedded wind generation output by Grid Supply Point by half hour for the last 4 years. To go with this, we have wind speed forecasts and outturns for 80 – 100 weather station locations, and metered output from directly connected wind generators – both 10 second spot data and 30 minute integrated data.

We want to analyse this data to optimise the correlations used to convert forecast weather variables into power generation forecasts for both PV and embedded wind power generation.

Method(s)

The proposed work will be supported by three PhD research students from The Alan Turing Institute (ATI), under the supervision of academics from the universities of Oxford, Warwick, Edinburgh and Sussex to work on the identified datasets for three months this summer. The ATI, as a leading UK institute for data science, specialises in dealing with Big Data, such as the data sets now available to us at National Grid, and have the analytical tools, expertise and access to resources necessary to analyse this data.

The students will work with support from Senior Energy Forecasters from the Energy Forecasting Team at Electricity National Control Centre (ENCC) in order to analyse the large volume of data available and identify innovative ways of improving our demand forecasts.

Key deliverables from the project would be new power correlations for wind and solar generation which could be implemented immediately into National Grid's forecasting process (after suitable testing to ensure that there is no risk to system security)

Scope

PV Generation

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4. Investigate the use satellite imagery of cloud cover to improve forecasting accuracy.
5. Determine how accurately national installed PV capacity be estimated from analysis of demand forecast error combined with the available PV data. (Information on PV installed capacity lags by many months).
6. Investigate the validity of our current methodology of extrapolating from around 80 weather forecasts for specific geographical locations to around 900,000 separate locations – effect of local variations in cloud etc, and suggest any ways of improving the methodology.
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3. Seek ways of improving our representation of the effects of high wind speed shutdown. (The amount of data for this task is relatively limited, which makes it more challenging).
4. Investigate the possibility of developing better wind power curves for embedded wind generation modelled at Grid Supply Point level – is a single generic curve appropriate or can the data be classed into several types of wind farm with different curves?
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Objective(s)

The project plans to deliver:

- Power curves for PV and embedded wind Generation, refined by location, season and/or any other factors found to be relevant.
- Methodologies for estimating installed capacity of PV and embedded wind generation, including review of the feasibility of using satellite imagery to identify solar panels
- Methodology for forecasting dispersed PV and embedded wind generation, including definition of appropriate levels of granularity for modelling, and making use of satellite imagery if this proves practicable.
- Analysis of generation volatility that can be used as an input to response and reserve holding policy.
- Anomaly detection to identify (for example) partial outages of wind farms in the dataset.
- Improved models for wind speed cutout.
- An analysis of the reduction in demand forecasting error that can be achieved by the implementation of the new models
- A plan for implementation of the new models, and a methodology for demonstrating the ongoing reduction in demand forecast error as a consequence of this project

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Delivery of objectives listed above, leading to a reduction in mean demand forecast error in the three months following completion of the project compared to the previous three months of at least 20 MW. The benchmarking analysis will be based on the 365 day average error. It is expected that a 20 MW step change would show as a 5 MW reduction after 3 months on a rolling 365 day average.

Project Partners and External Funding

The project partner is Alan Turing Institute. Through the Institute we will be working with academics from Oxford, Warwick, Edinburgh and Sussex universities.

Potential for New Learning

- Improved understanding of the behaviour of PV generation, and the factors affecting its performance
- Improved modelling of embedded wind generation.

Scale of Project

The project will involve National Grid's Energy Forecasting team in collaboration with PhD researcher interns from the Alan Turing

Institute and academic supervisors linked to the ATI.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

The research will be carried 50% at National Grid's Electricity National Control Centre and 50% at the Alan Turing Institute in London.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

NIA - £34,150

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)

This project will reduce the demand forecast error resulting from increases in embedded generation and legacy forecasting systems. Overall savings to consumers are expected from the reduction in system balance costs.

National Grid publishes demand forecasts on Balancing Mechanism reports. This information enables industry participants to reduce their imbalance costs by adjusting their generation profiles, thereby passing cost savings onto consumers.

Please provide a calculation of the expected benefits the Solution

Typically National Grid spend £200m per annum on holding an average of 1200MW of generation for margin and fast reserve purposes. It is anticipated that this project will deliver a 20MW reduction in this volume through improved forecasting techniques. This will result in a saving of £3m p.a. on balancing system costs.

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

The research outputs will be available at closure.

The research learning would be freely available specifically, not the input data per se as that is part of a commercial contract and not NIA funded.

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

All outcomes and lessons learnt will be disseminated via project reports on the National Grid Innovation Strategy and ENA websites.

Learning from this project will improve the PV, embedded wind and national demand forecast produced by National Grid and published daily.

The specific models and methodologies developed could be adopted by any Network Licensee in forecasting weather variable generation in their licence area.

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.

No unnecessary duplication will occur as a result of this project. This work relates to analysis of specific datasets only available in combination to National Grid.

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