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# NIA Project Registration and PEA Document

## Date of Submission

Jul 2020

## Project Reference Number

NIA_NGSO0032

# Project Registration

## Project Title

Control REACT

## Project Reference Number

NIA_NGSO0032

## Project Licensee(s)

National Grid Electricity System Operator

## Project Start

July 2020

## Project Duration

1 year and 1 month

## Nominated Project Contact(s)

Jean Hamman

## Project Budget

£400,000.00

## Summary

The uncertainty that Control Room (CR) engineers must handle in their decision-making is growing rapidly due to increases in renewable and embedded generation. At the same time, the CR has seen a huge rise in the number of units involved in their balancing decisions (from 40 to over 1,000). It is inevitable then, that the costs of balancing the grid has also been rising and will continue to do so until an approach is adopted which allows CR engineers to effectively manage uncertainty. It is believed that if information about forecast uncertainty was presented in real-time to CR engineers, that this would provide opportunities for them to make more economic and secure balancing decisions.

## Nominated Contact Email Address(es)

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## Problem Being Solved

The uncertainty that Control Room (CR) engineers must handle in their decision-making is growing rapidly due to increases in renewable and embedded generation. At the same time, the CR has seen a huge rise in the number of units involved in their balancing decisions (from 40 to over 1,000). It is inevitable then, that the costs of balancing the grid has also been rising and will continue to do so until an approach is adopted which allows CR engineers to effectively manage uncertainty.

One source of uncertainty in CR decision-making is the limitations of the forecasts created by NGESO, including those for national demand, GSP demand, network constraints (group constraints), renewable generation, Physical Notifications (PNs), total generation and more. The cost impact of these forecast limitations and the magnitudes of the uncertainty for each type of forecast is not well understood.

At present when CR engineers are making balancing decisions, they are not automatically presented with information about forecast uncertainty, i.e. the range of possible forecast errors. This information can be obtained by manually extracting historic data and performing a comparison of forecast and actual observations post-event. This analysis is not easy to undertake being both cumbersome and time consuming. Therefore, in the vast majority of cases, forecast uncertainty is not explicitly considered in operational balancing decisions, or analysis of their cost-effectiveness after-the-fact. It is believed that if information about forecast uncertainty was presented in real-time to CR engineers, that this would provide opportunities for them to make more economic and secure balancing decisions.

## Method(s)

**Workstream 1 – REACT (led by Smith Institute)**
The first three work packages of Workstream 1 are structured around demonstration of increasing advanced versions of a Proof of Concept (PoC) for a prototype visualization tool called REACT (Real-time Error and Cost Tracking).

The concept under investigation is that binary SORT files can be processed to present useful and visually appealing forecast error and cost information for CR engineers. This concept will be proven in a Python implementation of REACT and delivered alongside plans for its future integration into the Control Room's Business Network.

For each of work packages 1-3 the deliverables will include:

- An agreed cost model for forecast errors.
- Agreed visualizations to be included in the REACT PoC.
- Demonstration of the REACT PoC.
- Report summarizing learning and insights gained in work package.

There is an option dependent on innovation funding in RIIO2 to proceed with Work Package 4 in April 2021, it will focus on support to NGESO's implementation of the REACT PoC as a tool in the Control Room.

**Workstream 2 – Probabilistic Forecasts (led by TNEI)**
Probabilistic forecasts are predictions that include uncertainty quantification; in contrast to more familiar "point" forecasts which provide a single-valued prediction with no indication of how probable errors of any size may be. Workstream 2 will explore how existing point forecasts can be extended to produce innovative probabilistic forecasts for demand and wind, and will demonstrate how these probabilistic forecasts could lead to more efficient decisions in the Control Room.

It consists of four work packages and the deliverables will include:

- Work Package 1 – Initiation: Project feasibility study including literature review.
- Work Package 2 - Demand: Scripts and models for producing probabilistic demand forecasts
- Work Package 3 - Generation: Scripts and models for producing probabilistic generation forecasts
- Work Package 4 – A report detailing the methods for producing these forecasts, evaluating them, and showing the benefits of using them in decision-making.

## Scope

**Workstream 1**
Error Identification and Quantification: The Control Room receives a number of data streams to inform the actions to balance the grid. Many of these data streams are forecasts. Identifying forecast errors and quantifying them, with a view to understanding their impact on the cost of balancing the grid is the main aim of this workstream. A selected number of forecast data sets will be analysed. For each category of forecast the errors will be considered (i.e. difference between forecast and actual) at time horizons of 8 and 4 hours ahead and 90, 60, 30 and 10 minutes ahead.

Cost Modelling: The costs associated with forecasting errors will initially be modelled using simple linear relationships agreed with the NGESO Subject Matter Experts (SMEs) for use in the development of the first basic PoC. In later versions of the PoC, more sophisticated cost models will be developed. For example, to more accurately represent the fact that certain types of error lead to more costly interventions to reduce the risks to system stability. This could include consideration of the costs associated with unwinding balancing instructions and emergency power plant use.

Visualisations and User Interaction: The method of presenting information about forecast errors and their cost impacts to the CR is not yet agreed. Throughout the project, Proof of Concept visualisations will be developed by the Smith Institute and regularly demonstrated to the NGESO stakeholders and the other project partners to obtain feedback on its fitness for purpose and suggestions for improvement. The initial PoC will provide visualisation of forecast errors and estimated contributions to balancing costs. The extent to which the user can interact with the visualisations will also be explored and incorporated into the Proof of Concept developed and implemented in the final PoC version.

Proof of Concept Implementation: A Proof of Concept (PoC) for REACT will be implemented by the Smith Institute in the Python programming language in this workstream. The PoC will assume that the eventual deployable visualisations will sit in the CR's Business Network and that the required data will be streamed from the SORT and SPICE systems. We envisage using open source Python packages to develop the visualisations in the PoC.

Integration Planning: The PoC created in Work Package 3 is not intended for deployment directly into the CR.

Following the development of the PoC, a draft plan for the implementation and integration activities will be prepared.

**Work Stream 2**
Development of new and sophisticated forecasting models has delivered increased accuracy within NGESO. However, this has been

through the improvement of single value forecasts representing “what we expect will happen” and managing the system on that basis. Material additional value can be achieved by explicitly acknowledging the uncertainty within these forecasts, and making decisions that account for this uncertainty. In this workstream, the focus will be on developing probabilistic forecasts for demand and generation to demonstrate that this is possible, and to explore how these could be implemented in future and used within a more advanced decision support framework.

Initiation: This WP will review relevant literature, develop methodology further and assess implementation challenges, engaging with NGESO Subject Matter Experts (SMEs). This may include exploring aspects such as forecast lead-times, the possibility of using ensemble Numerical Weather Prediction, how to model generation without operational metering and the most appropriate approach to probabilistic forecast construction e.g. demand net of embedded generation, separate DG and VG and demand.

Demand: WP2 will explore algorithms for constructing probabilistic forecasts of demand, using historic data comprising of demand point forecasts, actual demands, weather forecasts and actual weather variable values. This will include formulating forecast models, and writing the code/scripts to produce and validate forecasts. Furthermore, it will be necessary to account for the spatial correlation between different locations if the use-case (decision-support) in question involves multiple locations, power transfers between locations, or aggregations of probabilistic forecasts.

Generation: In WP3, state-of-the-art methods for probabilistic wind and solar forecasting will be developed, building on work already done by University of Strathclyde. Methods for capturing the correlations between generation and net-demand will also be explored. This will be necessary for use-cases involving multiple forecasts, as in WP2.

Demonstration and path to deployment: The principle that using probabilistic forecasts can result in more efficient decisions will be demonstrated using real historical data and the cost modelling approach developed in workstream 1. This will support the development and scoping of an advanced decision-making framework for forecasting, which, if successful, will be explored further in follow-on work. Implementation challenges will be updated based on the outputs of WP 2 and 3 and strategies developed to address these.

## Objective(s)

**Objective 1**: provide insight into the cost impacts of the forecast errors. Allowing NGESO to prioritise schemes for improving forecasting accuracy and managing uncertainty in future, such as those which will be suggested as outputs from Workstream 2 of this project.
**Objective 2**: prototype enhancements to the current Control Room capability in managing uncertainty by developing visualisations of forecast errors and their associated cost impacts (REACT PoC).
**Objective 3**: show how existing point forecasts can be extended to produce probabilistic forecasts for demand and wind
**Objective 4**: demonstrate that using probabilistic forecasts can lead to more efficient decisions.

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

The project will be a success if the following can be achieved:

- Insight and learning gained through the analysis of forecast errors and cost modelling
- The concept that binary SORT files can be processed to present useful and visually appealing errors and forecast costs is proven.
- The PoC is demonstrated in a Python implementation of a prototype tool named REACT and delivered alongside plans for its future integration into the Control Room’s Business Network.
- Development of probabilistic forecasting models of demand and generation.
- Understanding of the additional benefits provided by these forecasts as compared to existing point forecasts.

Insights and learning on the potential value of probabilistic forecasting and decision-support, how these could be implemented in the Control Room, and a description of next steps to progress towards this

## Project Partners and External Funding

The work is to be undertaken by a consortium made up of Smith Institute and TNEI Services

External Funding – (nil)

## Potential for New Learning

This project has the potential to create learning about the extent of Control Room forecast uncertainty and their impact in terms of balancing costs. Furthermore, this project will also give insights into the potential to reduce balancing costs through explicitly modelling forecast uncertainty and decision making ability in the CR.

## Scale of Project

The project will include desk-based research, data analysis and programming lasting approximately 12months.

### Technology Readiness at Start

TRL3 Proof of Concept

### Technology Readiness at End

TRL6 Large Scale

### Geographical Area

The project will focus on the GB-ESO system.

### Revenue Allowed for the RIIO Settlement

None.

### Indicative Total NIA Project Expenditure

The total forecast NIA expenditure for this project is £400k

## 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)

**Consumer benefits:**
Large cost savings to consumers (likely of order £100 million each year). Consumer costs are impacted by:

- BSUOS: this project will enable NGESO to make better use of staff time/effort prioritisation (for example in CR); prioritising projects (BAU and innovation)
- TNUOS: the outcomes of this project will enable NGESO to run assets harder with better information; reduce costs associated with construction of new assets
- Wholesale: a long-term outcome will be better data to external parties, therefore more accurate tendering for NGESO requirements

Further Benefits include:
**Environment:**

- The outcomes of more efficient operation and project prioritisation will lead to the facilitation of more renewable generation and more services to the grid
- Another outcome is a likely reduction in the reserve requirement, these leads to less reliance on fossil fuel plants
- Reduced infrastructure build, resulting from more potentially more efficient use of current assets

**Security of Supply:**

- A greater degree of automated decision support will lead to less exposure to human error
- Much improved understanding of forecast uncertainty gives greater confidence that we have sufficient operating reserve for operational security, and at lower cost

**Stakeholders:**

- Increased competition in the market, since the risk of investment is decreased by confidence in data
- Better stakeholder knowledge of NGESO's need for balancing products

**Society as a whole:**

- Efficient use of NGESO budget and reduced total cost of energy supply
- Less pollution

- Increased market competition

## Please provide a calculation of the expected benefits the Solution

This benefit is made up of two parts:

- The direct benefit associated with understanding the extent of forecast errors and their impact in terms of balancing costs in the control room.
- The wider financial benefit associated with improving the accuracy of the forecasts, introducing greater decision support for managing uncertainty and improve the efficiency of the existing system balancing tools.

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

The probabilistic forecasting techniques explored in this project have wide applicability for both transmission and distribution networks across GB. In particular, forecasting is a key pillar of the DNO's transition to DSOs, and several DNOs have undertaken projects to consider how to approach this. To our knowledge, these projects have tended to work within the paradigm of point forecasting. Learning from this project will be valuable in advancing forecasting methods used in control rooms for NGESO and the DNOs, and could potentially be used in operational planning timescales, for example in supporting development of flexibility services at distribution level.

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

The project has identified a number of potential methodologies with different costs associated. The output of the project will be the most economic and efficient.

## 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

n/a

## 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 fits against the following strategic priority areas as identified by the ESO in its Innovation Strategy published March 2020:

- System Stability
- Forecasting of Supply and Demand

- Digital Transformation

☑ 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.

The activities in this project are unique and have not been trailed before.

### 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

This project is novel for the GB energy system but internationally (very few other TSOs are using probabilistic forecasts and significant specialisation is needed for the GB system).

### 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 scope of work in this innovation project involves research and development activities and the model and tools created will require validation before the outputs can be utilised to support system operations in the control room.

### 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

The project allows the collaboration of multiple project partners and the learnings from the project can be shared more widely to the Network Licensees which couldn’t be achieved if deemed as BAU activities.

### This project has been approved by a senior member of staff

☑ Yes