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

Sep 2022

Project Reference Number

NIA2_NGESO019

Project Registration

Project Title

Peak Demand Forecasting

Project Reference Number

NIA2_NGESO019

Project Licensee(s)

National Energy System Operator

Project Start

August 2022

Project Duration

0 years and 6 months

Nominated Project Contact(s)

Robbie Mulvany (NGESO)

Project Budget

£250,000.00

Summary

Peak demand is subject to a range of uncertainties, such as population growth, calendar effects, changing technology, economic conditions, prevailing weather conditions (and their timing), as well as the general randomness inherent in individual usage. To improve peak forecasting, the relationship between peak demand and its driving factors must be understood across the short, medium, and long-term ranges (5yr, 10yr, 30yr).

The project will study the latest advancements in peak demand forecasting, both in GB and select regions globally, comparing against National Grid ESOS's (NGESO) current methodology. The second phase will focus on quantitatively assessing the drivers of peak electricity demand.

Third Party Collaborators

Aurora Energy Research

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

Peak demand forecasting is subject to a range of uncertainties, such as population growth, calendar effects, changing technology, economic conditions, prevailing weather conditions (and their timing), as well as the general randomness inherent in individual usage.

There is a strong need for National Grid Electricity System Operator (NGESO) to have a robust annual peak forecasting methodology underpinned by a holistic understanding of the dynamics of peak demand components, including capacity auction targets. This project aims to improve the understanding of peak demand and its driving factors across the short, medium and long-term ranges (5yr, 10yr, 30yr) as the primary step in improving peak forecasting methods.

Method(s)

Working with Aurora Energy, the proposed approach is as follows:

- Work package 1: Literature review of approaches to demand forecasting, focusing on peak demand periods.
- Work package 2: Analysis of historical data on peak demand patterns and correlation to efficiencies, economic activity, weather events and uptake of new technologies.

The approach to each of these work packages is described in more detail below.

Work package 1: Literature review of approaches to demand forecasting, focusing on peak demand periods

In the first stage of the project, a literature review will be carried out, studying current methodologies that are being used to develop electricity demand forecasts, both in GB and in select regions globally. This will include an assessment of the current methodology used by NGESO to forecast demand and peak demand. This phase will commence by collating material from a range of academic and industry sources, as well as data from NGESO, reviewing:

1. Main drivers of changes to historical electricity demand,
2. Methodologies that have been developed for forecasting future electricity demand.

Considering GB and other comparable markets, the project will first examine how changes in population growth, economic activity, weather events, improvements to energy efficiencies, and technological developments have impacted historical electricity demand. This research will also highlight any other key drivers identified. In particular, the project will focus on how average cold spell (ACS) periods have impacted historical demand patterns.

Following this, the project will review current methodologies that are being used to forecast future electricity demand in GB and comparable markets, also focusing on average cold spell (ACS) periods. This review will highlight how:

1. Continuing energy efficiency improvements are expected to push down demand,
2. Increasing electrification of heating and transport will increase demand,
3. Time-shifting of demand could change the relationship between average and peak demand.

This research will also highlight key uncertainties in forecasting methodologies, challenge areas where they feel there is a risk to assumptions being made and suggest areas which should be studied in more depth.

The deliverables for this work package will be a written report.

Work package 2: Analysis of historical data on peak demand patterns and correlation to efficiencies, economic activity, weather events and uptake of new technologies

In work package 2, we will quantitatively assess the drivers of peak electricity demand. The analysis will test three hypothesis NGESO has laid out:

1. Core contributing factors that make up an annual peak demand are:

- underlying consumer behaviour & behaviour synchronisation,
- seasonal factors (weather),
- economic & socio-economic factors,
- incentives & restrictions.

2. Driving factors of change in short[s], medium[m], and long-term[l] range are:

- underlying behavioural change [s/m/l],
- technological advancement & uptake rates [m/l],
- fuel switching for certain type of use [m/l],
- incentives & restrictions [s/m/l],
- embedded generation contribution [s/m/l].

3. The relationship between annual and peak demand can be described as follows:

- peak demand is the amalgamation of available consumption components that align with the predominant synchronous factors,
- peak demand can be accurately forecast using summation/amalgamation of consumption elements (heat, appliances etc).

To assess hypothesis one, the project will analyse historical data to assess the how the contributing factors listed above have impacted electricity demand and study their correlations to peak demand.

Using NGESO demand datasets, the correlation co-efficient between the listed contributing factors will be calculated, focusing on how changes in economic activity, weather and incentives/restrictions on electricity use have impacted demand patterns. This research will also analyse if and how the above factors have affected the ratio of peak demand to total demand with time, focusing on the impact on ACS periods on demand.

To assess the second hypothesis, how the listed factors would contribute to changing demand patterns will be considered. The statistical correlation between historical contributing factors will be used to consider how demand may change across the forecast horizon, assuming a continuation of the correlation. The project will then consider the impact of the additional factors laid out by NGESO and develop an estimate of the maximum and minimum change to demand and peak demand that might result from these factors, based on existing trends from these factors and potential uptake trajectories.

Combing these two factors, the projectwill assess whether NGESO's final hypothesis is reasonable and whether it provides an accurate basis for demand forecasting going forwards.

Finally, Aurora will comment qualitatively on the fourth hypotheses NGESO has laid out:

4. Future peak demand cannot be accurately forecast without consideration active reduction or time shift of demand such as: smart technologies introduction of reactive demand stratification, reactive or pre-emptive use of storage peak shifting.

Recommendations for further work that could be undertaken in this area will be highlighted.

The deliverables for this work package will comprise of a written report outlining the project and accompanying workbooks.

In line with the ENA's ENIP document, the risk rating is scored Low.

TRL Steps = 1 (2 TRL steps)

Cost = 1 (£250k)

Suppliers = 1 (1 supplier)

Data Assumptions = 2

Total = 5 (Low)

Scope

The analysis and knowledge generated in this project will provide:

- Improved understanding of peak demand forecasting in demand modelling.
- Enable improved accuracy and risk analysis of forecasted demand.
- Better capture of the forecasting uncertainty that feeds into the capacity markets, supporting BEIS' ambition to interpret forecasts based on appetite for risk.
- Recommendations of further steps for follow on work.

Objective(s)

This project will follow a staged approach, based on an initial exploration stage followed by a more in-depth analysis stage. This will provide the opportunity to identify data that could improve or validate assumptions derived in the preliminary stages of the analysis.

The objectives are as follows:

- Create a written report highlighting key uncertainties in forecasting methodologies and potential risk areas requiring further analysis.
- Carry out quantitative analysis of the listed contributing factors, focusing on how changes in economic activity, weather and incentives/restrictions on electricity use have impacted demand patterns to be presented in a written report and accompanying

workbook.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

The ESO does not have a direct connection to consumers, and therefore is unable to differentiate the impact on consumers and those in vulnerable situations.

This project has been assessed as having a neutral impact on customers in vulnerable situations because it is a transmission project.

Benefits to all consumers are detailed below.

Success Criteria

The following will be considered when assessing whether the project is successful:

- Findings from the project can be used to explain peak demand in its current state and the assumptions made from its future state to our stakeholders
- The project will improve understanding of uncertainty in NGESO forecasting methods and how to improve by targeting high return areas of improvement
- Evidence provided can support an industry discussion about risk appetite – e.g., how can stakeholders benefit from quantified uncertainty in future peak forecasts
- The project will help identify how societal behaviours that affect peak demand may change and under what conditions

Project Partners and External Funding

Aurora Energy Research will be carrying out the work, no external funding required.

Potential for New Learning

This project will help NGESO understand the answers to some fundamental questions:

- What is the underlying consumer behaviour & behaviour synchronisation that can be attributed to peak demand?
- What is the relationship between annual and peak demand?
- What factors will drive changes in demand?
- What effect does active reduction or time shift of demand have in peak demand?

Scale of Project

The project spans 2 months with 1 project partner. The project consists of desk-based research and workshops with the relevant teams across NGESO.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

We will be based upon the GB ESO area of operations.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£250,000

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:

NGESO 's remit is to provide a safe, reliable, affordable electricity supply. As a central player in the GB electricity system, it is NGESO's role to provide the leadership and guidance for the transition to Net Zero. We are seeking to facilitate a smooth transition through sharing insights and analysis to help industry stakeholders determine the direction of travel and make informed decisions.

The project's outcomes will be fed directly into the Future Energy Scenarios (FES), which outline various credible ways to decarbonise our energy system as we strive toward the 2050 target. The FES is a public document which plays a vital role in stimulating debate and helping to shape the energy system of the future.

To facilitate this, we would like to understand the driving factors behind peak demand to improve its forecasting and whether its current hypotheses on the underlying factors that make up peak demand are appropriate.

- The project will lead to improved assumptions underpinning peak demand modelling in NGESO.
- Improved understanding of peak demand forecasting in demand modelling.
- Improved accuracy and risk analysis of forecasted demand.
- Better capture of the forecasting uncertainty that feeds into the capacity markets supporting BEIS's ambition to interpret forecasts based on appetite for risk.
- Frees up resources to work on the Demand model
- Identify opportunities for follow on work.

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)

N/A

Please provide a calculation of the expected benefits the Solution

Not required as research project.

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

- The project will help shape our assumptions on peak demand forecasting in the FES which in turn will improve the modelling for the Network Options Assessment which is our recommendation for which reinforcement projects should receive investment during the coming year

- Upon completion of the project the reports will be shared with wider network licensees to gain feedback
- Based on the feedback and the outcomes of the reports we hope to then develop further projects to address potential next steps

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

The method will be run for GB and Western Europe.

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 project's outcomes will be fed directly into the FES, which outline various credible ways to decarbonise our energy system as we strive toward the 2050 target. The FES is a public document which is analysed by a range of other network licensees and plays a vital role in stimulating debate and helping to shape the energy system of the future. The project will help to improve the accuracy of the demand models and assumptions used in FES. As a result, networks will be better placed to prepare for and mitigate potential risks.

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

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.

We are not aware of any other projects in this space in the energy industry in the UK.

The proposed project will start with a literature review to understand the latest research and advancements in peak demand forecasting around the world. As mentioned previously peak demand forecasting is subject to a range of uncertainties, such as population growth, calendar effects, changing technology, economic conditions, prevailing weather conditions (and their timing), as well as the general randomness inherent in individual usage. Therefore, there is a need to constantly evaluate the models and assumptions used for peak demand forecasting.

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

- Uncertainty has previously only been qualitative analysis. We are now trying to quantify this using stochastic methods which have not been used before, because we have previously only used scenario-based methods, as per the license.
- We are now exploring the potential next phase of reviewing the forecasting data used within Network Planning.
- It will align how forecasting is done on the operational side – in line with work the Market Requirements Team are carrying out, it will look at demand forecasting up to 2050.
- This project will introduce new skills and techniques into demand forecasting.

Relevant Foreground IPR

The following Foreground IPR will be generated from the project:

- WP1 Report with key uncertainties in forecasting methodologies, challenge areas where there is a risk to assumptions being made and suggested areas to be studied in more depth.
- WP2 report outlining the project, assessment of hypothesis with recommendations for further work plus accompanying workbooks.

Data Access Details

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:

1. A request for information via the Smarter Networks Portal at https://smarter.energynetworks.org, to contact select a project and click ‘Contact Lead Network’. National Grid ESO already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
2. Via our Innovation website at https://www.nationalgrideso.com/future-energy/innovation
3. Via our managed mailbox innovation@nationalgrideso.com

Details on the terms on which such data will be made available by National Grid ESO can be found in our publicly available “Data sharing policy relating to NIC/NIA projects” at https://www.nationalgrideso.com/document/168191/download.

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

Due to the nature of the project and that it is researching potential future impacts to the grid based largely on assumptions, this does not fall into current BAU.

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

- There are increased risks associated with the availability of required data and a high level of assumptions, which makes this project better suited to NIA.
- The TRL of the overall framework is relatively low. Therefore, innovation funding is more suitable for exploring the project's potential and increasing the TRL before transferring into BAU activities.
- Conducting this project with NIA funding will ensure that the project findings can be shared more widely with other interested network licensees.

This project has been approved by a senior member of staff

☑ Yes