NIA Project Annual Progress Report Document

Date of Submission

Jul 2023

Project Reference Number

NIA2_NGESO022

Project Progress

Project Title

BC Forecasting

Project Reference Number

NIA2_NGESO022

Project Start Date

November 2022

Project Duration

1 year and 6 months

Nominated Project Contact(s)

Daniel Drew

Scope

Four main work packages and one optional work package will form the basis for the project plan. These are as follows:

- **WP1** – Knowledge exchange and exploratory data analysis. Exploratory data analysis will be performed, looking at the current and proposed datasets in depth to determine what may be useful, and any limitations of the data, or additional processing needed. NGESO will explain the models they have developed and make them available to Hartree as code to ensure they can run these as a baseline for subsequent work

- **WP2** – Improve existing time series models. Ways of improving existing ARIMA models will be explored. The exact areas explored will depend to some extent on the findings of WP1, but it is likely to include; (1) Systematically exploring the choice of parameters trends and (2) the use of additional datasets as regressors. If successful the model can be run in parallel to the existing model, demonstrating the improved forecast.

- **WP3** – Improve temporal resolution of models. Adapt the models from WP2 to run at daily resolution, using similar approaches to WP2. Initially use the same models as in WP2, then adapt them for higher spatial and temporal resolution. This will likely entail a step up in computing power to allow the models to run in a reasonable time frame (although optimisation is included as a later work package). If successful the model can be run in parallel to the existing model, demonstrating the improved forecast.

- **WP4** – Exploration of alternative modelling approaches. This work package will focus on application of machine learning techniques such as Convolutional Neural Networks, Deep auto-encoders, and Recurrent Neural networks, to model and make predictions of balancing costs. Depending on the volume and type of data for each variable a suitable technique for each dataset will be selected for the modelling and prediction processes according to the literature. The performance of these models will be assessed and if they are not satisfactory alternative modelling techniques will be implemented to improve the results. If the model output is satisfactory techniques such as Monte Carlo sampling will be explored, to generate a probabilistic outcome for the trained models.

- **WP5** (Optional) – Code Optimisation. If runtime optimisation of the developed model is required, a code review and profiling pass will be carried out before preparing a detailed work plan.

Objectives

The objectives for the project are as follows:

- Develop a model to forecast balancing costs for 1-12 months ahead at a monthly resolution which uses more advanced statistical techniques than the current NGESO model and/or additional datasets.

- Produce a balancing cost forecast model with better temporal resolution (ideally daily) than current NGESO model.

Success Criteria

The project can be deemed successful if:

- The new balancing cost model delivers higher accuracy forecast in comparison to the existing NGESO model.
- The new balancing cost model provides higher granularity output (target is daily) than the existing NGESO model.
- The improved model is deployable in a way which meets NGESO's business needs (e.g. ease of use, run time, practicality, cost).

Performance Compared to the Original Project Aims, Objectives and Success Criteria

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Overview

The project is on track to produce improved forecasts of Balancing Costs incurred by National Grid ESO in operating the electricity system. Several techniques have been considered, which seem promising to produce a more accurate forecast and to provide predictions of daily balancing costs.

Work Package 1

Work Package 1 progressed in line with the project aims and objectives. The ESO model was successfully implemented in the Hartree Centre and a comprehensive exploratory data analysis was undertaken. A well-documented summary of the data analysis was completed, in line with the objectives.

Work Package 2

Work Package 2 is progressing well. Work is underway to improve the existing ESO time series model by:

1. Better capturing the relationship between the predictor variables of wholesale price and renewable proportion of demand with the target variable of balancing costs. Using the open-source forecasting package "Prophet", developed by Facebook, has shown good results. This has captured trends and seasonal effects in the relationships of the causal variables, and allows for change points, such as the increase in size and volatility of wholesale electricity prices since Autumn 2021.
2. Improved forecasting of explanatory variables, particularly the wholesale price. This accounts for a large component of forecast error, and several sensible steps are being taken to improve this part of the model.

Work Package 3

Work Package 3 has been combined with Work Package 2, to allow daily data to be used at an earlier stage in the project. This is a sensible approach, as improved models using only monthly data in WP2 may be outperformed by simple models which have increased time granularity from daily data. This part of the project is progressing well.

Work Package 4

Work Package 4 commenced in April 2023. There are plans to consider Long Short-Term Memory (LSTM) models, in line with the objective of exploring using state-of-the-art machine learning techniques to predict balancing costs.

Work Package 5

This optional work package has not commenced. A decision will be taken in summer 2023 as to whether to proceed based on progress in Work Package 4. The scope for Work Package 5 is to optimise the runtime of the model developed in Work Package 4.

Required Modifications to the Planned Approach During the Course of the Project

The planned approach had Work Packages 2 and 3 as distinct, by first improving on the ESO model with monthly input data, and then

extending this to consider daily input data. It was decided that combining these work packages would be beneficial, to allow for the more granular daily data to be used earlier in the project.

Lessons Learnt for Future Projects

In terms of how the work packages were planned, in retrospect the differences between Work Packages 2 and 4 were not as clearly defined as we first thought. Machine learning is a wide field and it made sense to apply these techniques within Work Package 2 alongside other approaches. Work Package 4 has therefore focused on neural networks as a sub-category of machine learning. We have been able to manage potential overlap through collaboration between the two teams working on these packages and ensuring there are enough people involved in both to spot any repeated work.

In terms of modelling approaches, the "Prophet" package explored in WP2 is something we could apply to other time series forecasting projects within the ESO.

Note: The following sections are only required for those projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

The outcomes of WP1 were that the ESO model was successfully implemented in the Hartree Centre and a comprehensive exploratory data analysis was undertaken. A well-documented summary of the data analysis was completed, in line with the objectives.

At this interim stage, no models have been completed and so performance improvement cannot yet be quantified.

Data Access

Details on how network or consumption data arising in the course of NIA funded projects can be requested by interested parties, and the terms on which such data will be made available by National Grid can be found in our publicly available "Data sharing policy related to NIC/NIA projects" and www.nationalgrideso.com/innovation.

National Grid Electricity System Operator already publishes much of the data arising from our NIC/NIA/SIF projects on the Smarter Networks Portal (www.smarternetworks.org) and National Grid ESO Data Portal (data.nationalgrideso.com). You may wish to check these websites before making an application under this policy, in case the data which you are seeking has already been published.

Foreground IPR

All relevant project reports and will be published on the Smarter Networks Portal when available.