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.
Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

NIA Project Annual Progress Report Document

Date of Submission

Jun 2025

Project Reference Number

NIA2_NESO105

Project Progress

Project Title

Volta: Real Time Prediction

Project Reference Number

NIA2_NESO105

Funding Licensee(s)

NESO - National Energy System Operator

Project Start Date

January 2025

Project Duration

1 year and 1 month

Nominated Project Contact(s)

innovation@neso.energy

Scope

This project will explore the use of Machine Learning (ML) techniques to improve the minute-by-minute frequency-corrected electricity demand prediction. The project will be broadly broken down into three main deliverables:

- Model Development will follow an iterative and exploratory approach, which involves experimenting with a variety of model architectures to ultimately select the most effective solution for electricity demand prediction. This will include exploring the use of Time Series Models, Artificial Neural Networks (ANN), Kalman Filtering, Temporal Fusion Transformers (TFT), Times Net, and DeepAR.
- Model Testing and Validation against Evaluation Metrics will employ a time-based training-validation-test split methodology, cross-validation and sensitivity analysis.
- Reporting and Visualisation will be founded on the principles of User Centred Design to provide those using the Real-time Predictor with a best-in-class experience that supports their decision-making in an intuitive, transparent way.

Objectives

The Objectives of this project are to deliver the following

- Provide the NESO with 3 to 5 models capable of predicting frequency corrected electricity demand based on minute-by-minute observations of electricity demand and frequency,
- A clearly documented explanation of each of the different models and associated methodologies provided.
- Provide NESO with a clear assessment on the accuracy (in terms of a % improvement against the current model) and reliability (in terms of a reduction of number of times not providing a solution) of different machine learning techniques and methods.
- Provide NESO with a robust predicting solution (measured against the current approach) that aids in real-time decision-making in the control room, the solution should include level of uncertainty of the outcome (as a % or other agreed criteria once further learning is

developed) and will contribute to the overall stability and reliability of the power grid.

- Provide NESO with a proof-of-concept real-time predictions tool (available to the Control Room for SME assessment) that can then be implemented into ESO operational systems

Success Criteria

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

- The project delivers against objectives, timescales and budgets as defined in the proposal
- Development of models that will provide a solution for the real-time prediction of electricity demand
- Successful testing of models developed against a set of evaluation metrics

A new UI that enables users to interact with the prediction models in an intuitive and transparent way

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

National Energy System Operator ("NESO") has endeavoured to prepare the published report ("Report") in respect of Volta: Real Time Prediciton, NIA2_NESO105 ("Project") in a manner which is, as far as possible, objective, using information collected and compiled by NESO and its Project partners ("Publishers"). Any intellectual property rights developed in the course of the Project and used in the Report shall be owned by the Publishers (as agreed between NESO and the Project partners).

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Background information:
The Volta RTP (Real Time Predictor) project is part of the Volta program, which aims at delivering AI solutions for the NESO Control Room to enable the energy transition by optimizing the usage of the available generation (including renewables, batteries and small generators) in a secure and economic manner.
The current system used by the NESO Control Room to balance electricity in GB, known as BM, provides a Demand Predictor tool, which is meant to be replaced by the Real Time Predictor that will be delivered by the OBP program (Open Balancing Platform).

The outputs of the Volta RTP models are meant to meet specific accuracy thresholds that have been defined by the project team and, as a consequence, they are expected to decrease the manual interventions of the users. Moreover, they have to be robust enough to cater for unexpected losses of input data and they have to provide an explanation of the generated prediction, i.e. by defining the factors that contributed to the forecast figures in order to increase the situational awareness of the users.

Problem statement:
The current Demand Predictor tool in the BM system has shown overtime some problems to meet the expectations of the Control Room in terms of accuracy, robustness and explainability of the forecasts. Furthermore, it requires continuous manual entries from the users.

Progress against stated project plan:
The project is proceeding as planned without delays, the activities related to requirements gathering and data cleansing have been completed, the tickets with the requirements have been reviewed and signed off and the scripts for data cleansing have been delivered.

The model development is ongoing as expected. Now, the development is focusing on the models for single- point predictions, testing different datasets and assessing which types of models prove to be more accurate than others. At a later stage, the models for probabilistic predictions will also be developed.

WP1 – Documentation of Business Requirements, Data Collection and Pre-Processing
The business requirements have been gathered and documented. The datasets have been cleansed by IBM and the scripts have been handed over to the University of Oxford
The requirements have been organised in tickets divided into Epics, Features, User Stories and Development Tasks. The Epics are the following:

>Data processing
>Features extraction
>Evaluation metrics definition
>Model development
>System Architecture

The datasets that have been cleansed are the below, the start date is December 2021 and the end date December 2024:

>Metering data at national level
>Prices:
-BM prices
-Wholesale prices

>Weather Actual
>Inertia
>Demand flexibility services
>National Demand Forecast
>Frequency
>Historic events
>Non-BM generation – PV and Wind embedded generation

WP2 - Documentation of ML Model
WP3 - Assessment of different methods based on proposed evaluation metrics for ML and Deep Learning Model
WP4 - Assessment of different methods based on proposed evaluation metrics for all models

The WP2, WP3 and WP4 are proceeding in parallel. The documentation of the ML models will focus on the models that will prove to be more accurate during the ongoing testing with different datasets.

For single-point prediction models, the types of models below are being tested; the best performing ones will be further developed.

>Time-series based algorithms SARIMA
>Time-series based algorithms FFT
>Time-series based algorithms Kalman Filtering
>Time-series based algorithms TBATS
>Machine learning based algorithms Prophet
>Machine learning based algorithms Linear Regression
>Machine learning based algorithms XGBoost
>Machine learning based algorithms Random Forest
>Transformers based TFT

>Deep learning based RNN (LSTM)
>Deep learning based NBEATS
>Deep learning based DEEPAR
>Deep learning based TimesNet

For probabilistic prediction models, the development will focus on the following types:
>XGBoost
>NBEATS
>TFT

WP5 - POC Solution, Documentation & Training
This will be the final deliverable, the above milestones have to be completed first

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

No modification required

Lessons Learnt for Future Projects

During the initial implementation of the models for single-point predictions, the following points have been observed:

>The TFT model showed the most promising performance of initial implementation for both accuracy over the entire 24 hours window

and speed to train.
>The FFT model implementation does not have the ability to incorporate external datasets (past or future covariates).
>The Kalman Filtering model is fast to train, but its accuracy is poor close to prediction point.
>The Linear Regression model is quick to train on full dataset including covariates
>The XGBoost model is quick to train on full dataset including covariates
>The Random Forest model is quick to train on full dataset including covariates.
>The model Prophet has a fairly accurate generic shape, but its performance is poor for a particular example (prediction point midnight) within the first 4 hours of the horizon

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

Different single-point and probabilistic models are being tested, the overall outcome on the accuracy will be determined at a later stage of the model development

Data Access

Details on hownetwork 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 NESO can be found in our publicly available "Data sharing policy related to NIA projects (and formerly NIC)" and Innovation | National Energy System Operator.

National Energy System Operator already publishes much of the data arising from our NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Foreground IPR

Foreground IP will be delivered in the form of end of work package reports, model documentation and presentations for the following work packages (at the end of project):

WP1 – Documentation of Business Requirements, Data Collection and Pre-Processing
WP2 - Documentation of ML Model
WP3 - Assessment of different methods based on proposed evaluation metrics for ML and Deep Learning Model WP4 - Assessment of different methods based on proposed evaluation metrics for all models
WP5 - POC Solution, Documentation & Training