NIA Project Annual Progress Report Document

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.

Date of Submission

Jul 2023

Project Reference Number

NIA2_NGESO025

Project Progress

Project Title

3MD (Market Monitoring Model Development)

Project Reference Number

NIA2_NGESO025

Project Start Date

November 2022

Project Duration

1 year and 0 months

Nominated Project Contact(s)

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Scope

Whilst ML and hidden variable models are used across multiple innovation projects for different purposes and also in other industries and organisations outside of the ESO, they have not been applied in a utility for a similar purpose.

Learnings will be shared within the ESO where applicable, however this will be a non-default innovation project and, as such, detailed findings and models will not be shared externally.

Ultimately, knowledge of enhanced monitoring capabilities being used, may encourage market participants to better consider REMIT and Grid Code requirements as they develop new trading strategies and support the market monitoring team in working with trading parties to reduce instances of potential breaches. This may reduce costs to consumers through a reduction in incidents of prices that do not directly result from normal market supply and demand interactions. It will also enable detection of changes in pricing or positioning in response to the management of system conditions, reducing the risk for exploitation of dominant market positions where they arise because of geographic or technological monopolies.

Objectives

1. Develop methods for out-of-characteristic market prices, physical positions in response to system operability issues such as constraints by applying statistical techniques to identify potential market abuse.
2. Develop methods for detecting and characterising anomalies.
3. Enhance current manual investigative techniques by using multiple new data sources to generate alerts. This will enable detection of cross market events and ensure alerts better consider market externalities, reducing false positives compared with current monitoring systems.
4. Enable models of pricing and positioning to be developed that are individual to Balancing Mechanism Units (BMUs) which each have different economic drivers and therefore will behave differently given the same set of system and external conditions.

Success Criteria

The project will be successful if it improves potential REMIT breach detection and provides contextual information regarding pricing and positioning this will be tested through:

1. 90%+ effectiveness at detecting known anomalies within historic datasets
2. An input/output method that enables live system data to be assessed in this way
3. A low level on the number of false positive investigations to review

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

National Grid Electricity System Operator ("NGESO") has endeavoured to prepare the published report ("Report") in respect of 3MD (Market Monitoring Model Development), NIA2_NGESO025 ("Project") in a manner which is, as far as possible, objective, using information collected and compiled by NG 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 NG and the Project partners).

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The aim of the project is to develop sophisticated statistical analysis-based tools with machine-learning based solutions to increase the efficiency of the market monitoring team's activities and scope of automated alerts received which are scalable to new balancing services and increasing market participant numbers.

The project is exploring methods to identify types of possible market manipulation in the balancing mechanism. It seeks to apply core principles set out in the REMIT legislation and review balancing mechanism pricing, physical positioning, and any systematic patterns with network constraints. These were split out into different work packages and ordered such that each one builds on the previous work package. Each of these packages will develop methods for detecting and characterising anomalies with datasets from ESO internal databases and external data sources, create ways of displaying the resulting information for the market monitoring team and produce a report and proof-of-concept code for finding the anomalies and displaying visualisations.

WP1 – Exploratory data analysis and error removal (07/02/2023 – 21/03/2023)

Due to the complexity and number of datasets provided as part of this project, the exploratory analysis will naturally be a part of each work package where analysis is conducted with the different datasets to improve understanding of the data. As part of WP1, a data workshop was hosted with project partner Hartree to support and walkthrough relevant datasets and reaffirm the direction and outcomes the team would like to see. In addition, a data dictionary was produced by the market monitoring team detailing what every dataset was showing with a description for each column of data. Three commented Jupyter Notebook reports were produced covering analysis of the datasets and the different filtering and error checking that was worked through together. This resulted in the market monitoring team streamlining what datasets to utilise for development future project requirements.

WP2 – Price based anomaly detection (22/03/2023 – 16/06/2023)

Currently the team is part way through WP2 following a successful exploratory analysis undertaken with ongoing weekly meetings with analysis and feedback shared. Training of a machine learning model has been undertaken with the datasets provided which will be developed over the course of the remainder of the work package with worked examples being shared to the market monitoring team to investigate and feedback .

WP3 – Position based anomaly detection (19/06/2023 – 08/09/2023)
WP4 – Constraint based anomaly detection (11/09/2023 – 01/12/2023)
WP5 – Prototype integration and implementation (04/12/2023 – 02/02/2024) OPTIONAL

At the end of each work package if the data does not allow for detection of anomalous characteristics with the required confidence, then there will be a decision to assess whether to continue with the next stage of the project.

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

The biggest material change to the project against the original plan was the delay of the commencement of the projects with the original start date being 01/11/22 in comparison to the revised start date of 07/02/23. This was the result of ensuring all security

requirements were met and agreed on both sides by the ESO and Hartree given the scale of data intended to be shared and the confidentiality. The revised and updated timescales of the project can be found in the section above.

The only change to the planned approach was the addition of further online datasets to the exploratory data analysis stage within WP1 which originally had been solely from internal databases. This included a range of sources from public platforms and datasets. These were included as not only did some datasets provide valuable information which would not have been covered by internal datasets alone, but it was valuable to determine whether public datasets would be sufficient to reduce the reliance on integration to secure internal databases.

There have been no changes to the cost of the project with the delays in starting the project nor the small change to the project scope.

Lessons Learnt for Future Projects

The conclusion to WP1 determined that some internal datasets would enhance the capability of the tools for monitoring the types of manipulation and there were fundamental differences in naming conventions between the ESO and public datasets selected. It was considered not beneficial to continue conducting analysis on all these datasets given the volume of data provided in WP1 and especially where the data provides a similar level of information. Therefore, it was concluded to focus on a subset of data from the ESO database with some public datasets for the development of the models in the future work packages.

WP2 will set the standard of how the tools will be created and integrated into ESO's systems and market monitoring processes for the future work packs and thus the outcome will be critical in setting the direction of the solutions for the rest of the project.

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 successful outcome of the project will be a new suite of tools which allow for anomalies to be identified and investigated by the market monitoring team against the different REMIT principles. The tools are integrated into market monitoring processes and are understood and utilised within the team. At the end of WP2-WP4, a report describing the methods for finding and characterising anomalies for the type of manipulation alongside a proof-of-concept code for extracting the anomalies with visualisations will be produced. In the instance where the behaviour can't be detected with the required confidence, the difficulties and the possible routes to improve the data will be identified.

Following the completion of the exploratory analysis for WP1, three written Jupyter notebooks were produced covering initial statistical analysis on the datasets with visualisations, initial pricing analysis in preparation for the commencement of WP2 and a comparison of the datasets between the National Economic Database and public datasets. These datasets include outturn prices across BMUs as well as forward price submissions which are confidential to the ESO, bid offer acceptances with the price and volume instructed, all dynamic data units submit, the de-rated margin and loss of load probability, intraday and day ahead market prices, temperature data and gas prices.

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

We are planning to share the following project results for 3MD (via a Completion Report on the Smarter Networks Portal):

1. Learnings from the statistical/machine learning techniques can be disseminated to other network licensees.
2. Outcomes of the project including a general discussion of functionality and detection capability can be shared alongside lessons learned from the process

3. Discussion of applications for these techniques in other business areas (if identified through the workpacks) can also be shared

However, due to the obligations of REMIT as a PPAT (Persons Professionally Arranging Transactions), we will not be able to share any specific identified cases with anyone except OFGEM. We would also not be able to publish the full code or full data models developed due to ability to infer thresholds for detection or methods of avoiding detection