

NIA Project Registration and PEA Document

Date of Submission

Nov 2023

Project Reference Number

NIA2_NGESO048

Project Registration

Project Title

GB Inertia Forecasting with Regional Extrapolation

Project Reference Number

NIA2_NGESO048

Project Licensee(s)

National Grid Electricity System Operator

Project Start

December 2023

Project Duration

0 years and 6 months

Nominated Project Contact(s)

Anna Blackwell (ESO)

Project Budget

£158,000.00

Summary

One of the primary inertia tools used by the ESO, forecasts inertia 24 hours ahead, but only for regions where Phasor Measurement Units (PMUs) enable inertia measurement. This project will investigate potential solutions for an inertia forecast model for England and Wales ahead of installations of PMUs in these regions, by using the inertia metering data from installed measurement units in Scotland to tune and verify models. These models built on Scottish PMU data would be fed with inertia predictor data (such as demand, synchronous and inverter-based generation levels) for the remaining regions of GB in order to provide inertia forecasts for the whole GB system.

Nominated Contact Email Address(es)

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Problem Being Solved

One of the primary inertia tools used by the ESO can forecast inertia 24 hours ahead of time, but only for the regions where Phasor Measurement Units (PMU) are installed. These PMUs enable real-time inertia measurements which are required to tune the current inertia forecasting algorithms. PMUs are currently only available in Scotland, resulting in a delay to the ability to improve inertia forecasting for the whole of GB. Currently the ESO makes control room decisions and defines frequency response holdings at a GB level (not regionally) based on an estimate of system inertia. The enhanced forecasting algorithm for GB would improve risk management of frequency response.

Method(s)

The existing inertia metering & forecast solution in question applies machine learning to build a forecast model for each inertia region that relates metered inertia (derived from real-time PMU data) to "inertia predictors" – variables such as regional demand, connected synchronous generator inertia, and levels of solar and wind generation. Such models can then be executed with forecasts of the same predictor values to generate a corresponding inertia forecast.

This project will explore the relationship between measured and forecast inertia in Scotland to investigate the possibility of applying this relationship to forecast the inertia for England and Wales. It will aim to use a machine learning model built solely from Scotland inertia metering data, to be fed with England & Wales and GB-wide predictor values to provide an inertia forecast for the whole of GB. In this way, inertia could be forecast for other network regions without the need for measured data from PMUs. Various approaches will be explored, for example the normalisation of inputs and outputs to the machine learning model to account for regional differences.

The project will be completed in a single work package and will utilise the following input data to explore potential solutions:

1. England and Wales predictors ideally for a period of 3-12 months, including rotating inertia, solar and wind generation, and demand
2. Validation events of known Megawatt Dispatch (MW) disconnections outside of England & Wales, either occurring in Scotland or on an external High Voltage Direct Current (HVDC) trip. Ideally these events should overlap with the predictor dataset in (1). The associated PMU frequency measurements from 45 minutes prior to, and 5 minutes after these events from across the GB grid will also be utilised so a GB Rate of Change of Frequency (RoCoF) value can be determined. Scotland-only PMU measurements will be suitable if it is not possible to get accurate information from other locations.
3. Estimates of GB inertia from the present GB-wide inertia estimation method (distinct from the PMU-based inertia metering & forecast solution), the 30-minute inertia estimate provided on the ESO data portal are expected to be sufficient for this.

Validation of the forecasts will be carried out by the ESO team against data from a number of methods and tools used within the ESO, looking at both continuous inertia calculations and trip events.

Deliverables include a report describing potential solutions explored and assessment of their suitability to achieve the project objective, followed by a workshop with the ESO to discuss findings within the report. If an identified method is demonstrated to give good results, the project will provide a proposal for implementing the chosen enhancement into the existing inertia forecasting solution.

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

TRL steps = 1 (2 TRL steps)

Cost = 1 (<£500k)

Suppliers = 1 (1 supplier)

Data assumptions = 2 (Assumptions known but will be defined within project)

Total = 5 (Low)

Scope

This project will focus on two potential solution areas:

1. Explore enhancements that can be applied outside the existing machine learning algorithms, including normalisation of data in and out of the machine learning model.
2. Evaluate alternative approaches and enhancements to the existing machine learning algorithm.

If these solutions are successful, the project will also consider an implementation plan for the chosen enhancements into operational inertia tools. Implementation of any recommendations to the existing solution will be made through a separate investment.

Objective(s)

- To establish if it is possible to use a model based on Scottish inertia metering data to forecast the inertia of England and Wales, and therefore the whole GB inertia.
- If successful, provide a proposal for implementing the enhancements into the relevant operational inertia tools.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

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

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.
- Improvements made to existing inertia forecasting algorithms are demonstrated.
- GB inertia forecast method(s) developed using normalised data from installed metering and validated against both relevant events across England and Wales and other available inertia tools.

Project Partners and External Funding

GE Digital (GE Vernova). No external funding.

Potential for New Learning

This project will build on existing algorithms within the inertia tools to improve machine learning techniques. The improved algorithms have the potential to improve the accuracy of the forecast model for all regions, as well as enabling England and Wales inertia forecasts ahead of the roll out of PMU installations.

Results could enable inertia forecasts to be created for smaller regions within GB to identify regional inertia values without the need for PMUs to be installed.

The approaches considered and findings gained through this project will be documented and disseminated via reports available on the Smarter Networks Portal at the end of the project.

Scale of Project

This is a 6-month, desktop-based project with one project partner. The main project output will be a report and workshop looking at potential solutions and their suitability.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

This project will be based upon the GB ESO area of operations.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£158,000

Project Eligibility Assessment Part 1

There are slightly differing requirements for RII0-1 and RII0-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RII0-2 / RII0-1).

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 RII0-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

The decarbonisation of the GB energy system is resulting in a decrease in inertia, and additional spend on managing RoCoF. The ability to forecast inertia more accurately for regions across the whole of GB will enable more informed operational decisions related to response and reserve holding, as well as Control Room decisions over plant holding for inertia management.

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 (RII0-1 projects only)

N/A

Please provide a calculation of the expected benefits the Solution

The inertia forecasting solution provides an improvement over the existing estimation method in use within the ESO, however this requires measurement data. This project will aim to develop a solution to remove dependency on PMU measurements and enable more accurate inertia forecasting for all GB. Having this enhanced full GB inertia forecast will improve operational processes regarding managing systems risks ensuring that response products such as Dynamic Containment are correctly purchased.

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

This project will use measured data from the Scottish electricity network and explore the possibility of using this to develop models for England & Wales in the absence of measured data.

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

The costs to roll out any successful solution will be developed as part of the implementation plan. Any improvements to the inertia forecasting algorithms developed will be implemented under BAU investment lines (IT investment 130, Emergent Technology & System Management).

Requirement 3 / 1

Involve Research, Development or Demonstration

A RII0-1 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

RIO-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

Results from this project could enable inertia forecasts to be created for smaller regions within GB to identify regional inertia values without the need for measurement devices (PMUs) to be installed, removing dependencies on TOs and enabling the Inertia Monitoring and Forecasting tool to be more flexible as the network changes.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIO-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.

This work compliments other ongoing activities across the ESO which consider inertia, including commercial products such as Dynamic Containment and stability pathfinders, as well as other innovation projects. [Short-term System Inertia Forecast \(NIA_NGSO0020\)](#) produced a more accurate inertia forecasting capability, however more accurate inertia monitoring data was required to complete further methodology analysis. This project to further develop GB inertia forecasting tools will build upon what was delivered in NIA_NGSO0020, considering how an accurate inertia forecast tool could work without the relevant metered inertia data from PMUs utilising developments in machine learning methodologies.

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 looking to investigate a new approach to forecasting inertia which has not yet been tried before. By applying new approaches and techniques to normalise data, the project will build upon existing algorithms to create inertia forecasts calculated using limited available PMU data and applying results across the whole GB electricity system.

Relevant Foreground IPR

The following foreground IPR is expected to be generated in the course of the project:

- Technical report describing potential solutions explored and assessment of their suitability to achieve the project objective.
- Proposal for developing and implementing the chosen enhancements in the existing inertia forecasting solution.

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

As this project is investigating potential new approaches to improve GB inertia forecasting by using machine learning techniques alongside available measurement data which is currently limited to the Scottish regions of the GB transmission network, this does not fall into current business as usual activities.

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 TRL is relatively low, therefore innovation funding is more suitable for exploring the potential solutions. This project is focused on improving the forecasting algorithms and enabling earlier adoption of improved techniques, which would not be feasible without the support of NIA due to the inherent risks around whether the planned project data is sufficient to deliver an accurate tool. A successful project will be also dependent on suitable normalisation of data from the Scottish measurements, and availability of largest loss event data to calibrate the normalised model. Due to significant network differences between Scotland, and England & Wales transmission networks, assumptions around demand and generation types may need careful consideration for this project to be successful.

This project has been approved by a senior member of staff

☒ Yes