

NIA Project Registration and PEA Document

Date of Submission

Oct 2023

Project Reference Number

NIA2_NGESO004

Project Registration

Project Title

Trial on Implementation of Wide Area Monitoring and Control System (WAMCS)

Project Reference Number

NIA2_NGESO004

Project Licensee(s)

National Energy System Operator

Project Start

September 2023

Project Duration

1 year and 0 months

Nominated Project Contact(s)

Jay Ramachandran & Tim Pinto

Project Budget

£800,000.00

Summary

This project will explore the use of the Phasor Measurement Unit (PMU) based Wide Area Monitoring and Control System (WAMCS) on the GB electricity network. This system has been recognised as a tool to facilitate system operation in low inertia scenarios with high penetration of renewables. The project will explore how to fit the hardware of the WAMCS into the ESO's Electricity National Control Centre (ENCC) and define the communication requirements for the links built between the WAMCS and the Transmission Owners' PMU/commercial participants. A prototype of the WAMCS will be established and trialled in different scenarios to demonstrate the performance of the WAMCS during various system events. Moreover, this project will specify the communication latencies via different operational stages within the WAMCS.

Nominated Contact Email Address(es)

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Problem Being Solved

The penetration of renewable generation, primarily converter-based wind and solar, in the electricity network is forecast to increase substantially and replace the traditional synchronous generation. These converter-based renewables will not provide system inertia like synchronous generators; the system will become weaker and more vulnerable to the risk of instability and system collapse in the occurrence of faults or events. This would need to slow down/constrain the penetration of renewables. The PMU-based WAMCS has been recognised as a solution to maintain system operation with high penetration of renewables. The WAMCS could be used for different applications, including network islanding management, oscillation damping, power flow control, dynamic voltage control, and

frequency control. All these applications will help facilitate stable system operation in a low inertia scenario and accommodate more renewables.

WAMCS is being explored by industry and academia worldwide. To date, the majority of work has focused on algorithm development, assuming there is effective communication/execution hardware for the WAMCS, with minimal work on the implementation of the MCS communication/execution hardware.

As the system operator in GB, the ESO would be the primary user of the WAMCS. It is unclear how the hardware of the WAMCS could be fitted into the ENCC, how to feed the PMU measurement data from Transmission Owners (TO) to the MCS in ENCC, and how the MCS could communicate with the service providers.

Communication latency is critical to the performance of WAMCS as it affects how quickly the control action can be initiated. Long communication latency could cause a delayed control response, making the WAMCS response ineffective or even inversely disturbing the system. Currently, the communication latency using either the existing communication infrastructure or the new communication facility in the GB system is unknown.

Method(s)

This project will undertake the following steps to achieve its targets:

WP1 – Design

Gather all required inputs from partners, finalise the design of the demonstration and initiate any access approvals (e.g. background check for GE personnel to access ESO IT environments) or additional procurement required.

Key Outputs

- Statement of Work
- Documented access requirements for GE and identification of how ESO can provide this access and/or plan for implementing project remotely with local ESO support
- All hardware available or under order
- Training delivered

WP2 – Monitoring and Control System (MCS) Development

This work package captures the work required to extend the MCS resources developed under the [Enhanced Frequency Control Capability \(EFCC\)](#) project to meet the needs of EFC and prove successful development. This covers new PhC functionality, modifications to the EFCC logic to enable the demonstration and dedicated tooling to enable the demonstration.

Key Outputs

- PhC version that allows connection to the NG ESO IPsec tunnel from a remote site

WP2.2 - Enhanced Frequency Control Logic Development

The logic developed for EFCC must be modified in a number of ways to enable the EFC demonstration. Furthermore, entirely new logic is required for the Local Device (a new addition to the EFC MCS that was not required within EFCC) and to deliver the manual Central Supervisor required for the coordination demonstration

WP2.3 – MCS Trial Run

This work package consists of the preparation, execution, and review of a trial run of the EFC MCS. This trial run will take place entirely within the GE offices and network.

WP2.4 – Asynchronous Latency Monitoring

This work package will develop a solution for monitoring the latency of the IPsec tunnel between the LC and the LD which is used to exchange IEC104 messages. The latency monitoring solution applied elsewhere is not appropriate for this asynchronous communication.

WP3 – MCS Deployment

This work package captures the effort required to deploy the MCS equipment at various sites and any supporting work required for the demonstration (e.g. data retrieval).

Key Outputs

- SPEN PMU data received as directly forwarded streams at NG ESO gateway PDC
- Review of relative latency of aggregate stream and direct forwards

WP3.2 – Deployment

This work package covers the installation of the MCS equipment within the ESO IT environments and basic testing to verify successful deployment.

WP3.3 – LD at ESO

A Local Device will be deployed at an ESO site (to provide a second LD site for the trial). GE will prepare a deployment guide that ESO or their approved 3rd party will apply

WP3.4 – Data Collection and Archiving

Demonstration that GE can access and retrieve all data that will be required.

WP3.5 – Data Collection and Archiving

Prove connection of LD to Data Centre endpoint

WP4 – Demonstration

This work package describes the effort required to perform the non-operational demonstration and certain preparation that is required outside of the other WPs.

Key Outputs

- All input and configuration files required for demonstration
- Reconfiguration procedures

WP4.2 – Execution

The demonstration execution will entail sampling latency of the data streams on a regular basis, and execution of the coordination tests.

WP4.3 – Decommissioning

After completion of the demonstration the MCS must be decommissioned and demonstration data archived for future use where appropriate.

WP5 – Reporting and Knowledge Share

After completion of the demonstration the key outcomes will be reported and a sanitised data set of relevant, available MCS data will be provided. Brief reports on the deployment and decommissioning will also be prepared to inform future MCS deployments and designs.

Data Quality

This project will collect the real time Phasor Measurement Unit (PMU) data, from eight different locations in the GB Transmission System, over a period of several months. These PMU data will be collected in synchronised manner, in line with PMU standards such as C37.118 and will be used to analyse the key parameters such as latency of PMU data from sending end to receiving end. The latency period will be determined over the period few months to flag any error in the PMU data.

To validate the Monitoring and Control System (MCS) developed in this project, frequency data also will be generated using PowerFactory tool. These data will be used to evaluate the function of MCS, to detect whether the system Rate of Change of Frequency (RoCoF) is exceeding the set value or not. The system frequency data, generated by PowerFactory tool, will be produced for different scenarios to validate the function of MCS.

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

TRL Steps = 2 (3 TRL steps)

Cost = 2 (£800k)

Suppliers = 1 (1 supplier)

Data Assumptions = 1

Total = 6 (Low)

Scope

This project will explore the implementation of the WAMCS communication/execution hardware by running a non-operational trial. A WAMCS prototype would be established on the GB electricity transmission network. It would be physically trialled by using the existing communication infrastructure. This non-operational demo trial will not instruct active power response so the trial would not affect the real-time system operation.

The WAMCS will be installed in the ENCC. Communication links will be established between the WAMCS and the PMUs/market participants so that the WAMCS can receive the PMU measurement data and send control instructions to the market participants. We will also develop the security and communication requirements for implementing the WAMCS in the GB system.

Communication latency is critical to the version of WAMCS as it affects how quickly the control action can be initiated. This project will measure the communication latencies at different stages in the WAMCS. This learning would be valuable to various WAMCS applications, such as network split prevention protection, oscillation control, etc. Moreover, the response of the WAMCS to different system events will be investigated.

This will be the first time such a WAMCS has been installed on the GB network, and the project will also provide valuable knowledge on how to fit the WAMCS in the CNI environment, which has yet to be explored previously. The project will consist of 5 main work packages:

- WP1 – Design
- WP2 – MCS Development
- WP3 – MCS Deployment
- WP4 - Demonstration
- WP5 – Reporting and Knowledge Sharing

Objective(s)

The objectives of the project are to:

- Establish the connectivity between the TOs' PMUs and the ESO PDCs to understand PMU accuracy and communications performance requirements for wide area monitoring and real time data acquisition.
- Install the WAMCS consisting of RA, CS and LC in the ENCC CNI environment and establish communication links to market participants via LD.
- To monitor the performance of the WAMCS system and understand solution latency on current infrastructure.
- To validate the response from WAMCS for different system events.
- To ascertain the technical aspects for potential response providers to connect to a wide area control system.
- Training for internal/external stakeholders.

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. The benefits to all consumers are detailed below.

Success Criteria

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

- The WAMCS prototype is established, which receives PMU data from SPEN PDC to ESO PDC.
- The WAMCS logic correctly identifies the system event and sends a response instruction to the market participants.
- A project report is delivered on time, which details:
 - Architecture and design of the WAMCS, and communication requirements to obtain TO PMU data and send instructions to market participants.
 - The costs of implementing the WAMCS and the associated communication links.
 - The performance of the WAMCS, in terms of latency, correct coordination and discrimination with different level of PMU data quality and communication quality.

Project Partners and External Funding

GE Digital will be carrying out the work, no external funding required.

Potential for New Learning

The proposed project will be first of its kind to be investigated within GB electricity transmission system. Project outputs will:

- Provide knowledge of installing the WAMCS on the existing communications infrastructure, the impact in terms of latency and lost data and/or signals for speed of response and limitations.
- Provide the technical aspects of setting up communications links to resource providers and TO PMUs.
- Provide the communication latencies for different operational stages in the WAMCS.
- Validate the designed functions of the WAMCS in an operational environment and solve potential risks before entering the next steps of implementing the WAMCS in system operation.
- Feed the learnings into the PMU based WAMCS strategy work.

Scale of Project

The project spans 12 months with 1 project partner.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL6 Large Scale

Geographical Area

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

Revenue Allowed for the RII Settlement

None

Indicative Total NIA Project Expenditure

£800000

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:

The learnings from this project will help facilitate zero-carbon operations, allowing the system to accommodate more renewable generation and accelerating decarbonization. The amount of renewable generation, primarily converter-based wind and solar, is forecast to increase substantially and replace the traditional synchronous generation. These converter-based generations will not provide system inertia like synchronous generators; the system will become weaker and needs to slow down/constrain the penetration of renewables. The WAMCS in this project could be used for different applications, including network islanding management, oscillation damping, power flow control, dynamic voltage control, and frequency control. All these applications will help facilitate stable system operation in a low inertia scenario and accommodate more renewables.

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

The converter-based generation will not provide system inertia like synchronous generators; the system will become weaker and needs to slow down/constrain the penetration of renewables. To effectively manage the system, it could cost several hundred million pounds yearly in system operation. The WAMCS in this project could be used for various applications, including network islanding management, oscillation damping, power flow control, dynamic voltage control, and frequency control. All these applications will enable the system to accommodate more renewables, reducing system operation costs and consumers' electricity bills.

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

The ESO would be the primary user of the WAMCS due to its system operator role. In this project, only PMU measurement data from SPEN will be used since there is sufficient PMU coverage in the SPEN area. In future, all three TOs would be engaged, and the PMU data from all three could be used to enable a more comprehensive coverage of the GB system by the WAMCS. Please note that the SO-TO Code Procedure (STCP) obligates the TOs to install the PMUs at the GSPs by the end of the RIIO2 period.

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

As this is a research project the main objective is to give a cost estimate of implementing the WAMCS. With this final output, the cost of rolling out the WAMCS across GB can be estimated.

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 ESO would be the major user of the WAMCS due to its role as the system operator. The implementation of the WAMCS would require the TOs to build communication links to the ENCC to supply sufficient PMU data. This project will study the requirements for building the communication links from TO PMUs and market participants for high resolution data communication. These learnings will help TOs, DNOs, and market participants in the areas of business/network digitalisation.

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.

The proposed project will be first of its kind to be investigated within GB electricity transmission system. It will investigate the implementation of the MCS communication/execution hardware, and trial the MCS in an operational environment. While the other projects are focused on either the control algorithms or trialling hardware in laboratory.

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

- The proposed project will be first of its kind to be investigated on implementation of WAMCS within GB electricity transmission system.
- The most important innovation learning outcome is to evaluate how the WAMCS can be implemented using existing communication infrastructure and ascertain options for service providers to interface with the WAMCS.

Relevant Foreground IPR

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

- Report detailing key outcomes
- Sanitised data set of relevant, available MCS data
- Reports on the deployment and decommissioning to inform future MCS deployments and designs.

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 the communication options for the WAMCS and its performance in an operational environment, 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

The learnings from the project can be shared more widely to the Network Licensees which could not be achieved if deemed as BAU activities.

This project has been approved by a senior member of staff

Yes