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

Jul 2025

Project Reference Number

NIA2_NGESO051

Project Progress

Project Title

MinGFM

Project Reference Number

NIA2_NGESO051

Project Start Date

September 2023

Project Duration

2 years and 1 month

Nominated Project Contact(s)

Dechao Kong

Scope

To harness the substantial potential control capabilities of IBRs such as offshore wind farms and interconnectors, and to advance the emerging concept of GFM control for IBRs as a solution for declining inertia and fault level challenges, it is crucial to develop new mathematical models and tools. These tools will help to unlock the control potential of renewable energy sources without requiring additional investment in energy storage. Investigating data-driven smart controller design methods will enable the realisation of grid forming control capabilities. A techno-economic framework will be employed to devise optimised combinations of control strategies in various trial regional networks to ensure secure, cost-efficient, and coordinated system operation.

This project will yield the following benefits:

- By negating the need for additional energy storage investments particularly in offshore wind farms where space is limited, the constraints associated with these investments will be reduced.
- The implementation of MinGFM stability services, which will rely on software upgrades rather than additional hardware (energy storage) installations, can significantly reduce associated costs.
- Unlike standard GFM, which requires substantial investment in energy storage, MinGFM stability services are expected to become basic grid connection requirements for wind farms, thus greatly reducing the associated service costs.
- The outcomes will also help shape new ESO policies and strategies for creating a portfolio of stability control services utilising GFM, thereby supporting the industry in achieving net-zero targets.
- Increased competition in the offshore wind market through the facilitation of appropriate entry requirements will benefit both generators and consumers through reduced costs.
- Appropriately setting market entry requirements will help capture value for all participants in the value chain.
- The contribution to incentives will significantly accelerate the net-zero energy transition in the UK.

Objectives

- Investigating the stability service capability of wind farms employing MinGFM control through the sole upgrade of wind farm control systems (primarily software updates) without the need for additional energy storage investment.
- Defining the implementation of GFM control by unlocking the control capabilities of IBRs, allowing them to release certain amounts of stored energy within wind turbines through data-driven smart control strategies.
- Conducting economic comparisons between Grid Following Control (GFL), standard GFM (with energy storage), and MinGFM (without energy storage), subsequently proposing a roadmap for implementing MinGFM services under electricity market environments and recommending changes to the Grid Code

Success Criteria

1. The capability of minimised control of IBRs Type 4 Wind Turbine (WT with Full-scale Converter) Power System Management Group Type 4 Wind Turbines + High Voltage Direct Current can be fully assessed, and the economic values can be quantified.
2. Recommendations and a developed roadmap on the implementation of the MinGFM can be provided to show market development routes.

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

Project summary:
The UK Government has set ambitious targets of 50GW of offshore wind installed on the GB transmission system by 2030. Increasing these inverter-based resources provides new opportunities for stability services via grid forming control (GFM) of power electronic converters. The GFM control can help deal with issues synonymous with future electricity systems, such as low inertia and low fault levels. However, while using a GFM approach has benefits, significant energy storage investment is needed.
This project will investigate new methods and control strategies for when additional energy storage is not needed. This project will help develop an understanding of the potential for data-driven intelligent control of wind turbines while delivering a techno-economic comparison of various control strategies.
The project is being delivered in three work packages. At this stage of the project WP1 have been delivered. The scope of WP1 tasks are shown below:
WP1: Development of individual wind farm models using GFL, Standard GFM with Energy Storage and MinGFM (without ES), as well as system studies including stability and fault level assessment.
In WP1, a final report was delivered, including system studies in RSCAD showing MinGFM does have the capability to provide inertia support by extracting the kinetic energy of the WTG rotational mass. However, the inertia support is limited as there is no extra energy storage.

WP2: actions are expected from this work package:

Consider studying the performance of GFM STATCOM (or extend to any IBR based):
Study the performance of a GFM STATCOM (no internal & external storage, just the typical capacitor size). What compliance test can be passed and which can't.
Perform sensitivity analysis: keep increasing the storage size from 0.

1). At what level can a STATCOM pass all the compliance tests (considering if no minimum inertia requirement).

2). What should be the minimum requirements for the converter and storage

- MinGFM controlled VSC-HVDC connected offshore WF with compliance simulations
- Inertia support
- Phase jump
- FRT

Currently the WP2 draft report has been finished.

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

Because of the late appointment of the research fellow who is critically important for the research, the project has been extended for 6 months.

The due date for WP2 has been extended to 09th June 2025 and WP3 to 10th Sep 2025

Lessons Learnt for Future Projects

The critical people's availability for the project should be checked in advance to avoid any delay.

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

WP1 report covered the theoretical background of the MinGFM control technology and a literature review of different IBR based plants' control technologies. In addition, the feasibility of MinGFM control was demonstrated through a series of GFM compliance simulation tests. The comparison studies have been done considering SG, GFL and GFM with BESS as reference.

WP2 draft report has been finished. NESO proposed minor modifications. The final report should be finished in time.

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 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

The following Foreground IPR will be generated from the project:

- A RSCAD based MinGFM model and simulation. (The current model is in RSCAD, however, we have been requesting an extra PSCAD model.)
- An innovation report/paper regarding MinGFM control technology.