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# NIA Project Registration and PEA Document

### Date of Submission

Dec 2024

### Project Reference Number

NIA2_NGET0056

## Project Registration

### Project Title

BRIDGES - Building a Resilient and Intelligent Dynamic Grid Enhancement System

### Project Reference Number

NIA2_NGET0056

### Project Licensee(s)

National Grid Electricity Transmission

### Project Start

March 2025

### Project Duration

1 year and 7 months

### Nominated Project Contact(s)

Xiaolin Ding

### Project Budget

£1,392,000.00

### Summary

This project aims to develop an advanced Dynamic System Rating (DSR) solution that maximises the use of the existing transmission network, allowing circuits to operate closer to their true capacity without compromising system stability. The proposed DSR solution integrates with regional autonomous control to alleviate network congestion and enhance power transfer capability. Once validated in a laboratory environment, the system will be prepared for hardware deployment. This technology will reduce the need for extensive network reinforcement, providing cost savings to consumers and facilitating the efficient integration of renewables. Ultimately, it will enhance grid controllability and flexibility, supporting the transition to a Net Zero-carbon energy system.

### Third Party Collaborators

GE Vernova

### Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

### Problem Being Solved

The UK's rapid transition to net zero is placing considerable strain on the existing transmission network. To meet future energy demands and achieve net zero targets, significant upgrades and reinforcements on the network are necessary. However, it is also essential to enhance the network's intelligence and controllability to maximise the utilisation of the existing infrastructure. Technologies like Dynamic Line Rating (DLR) can improve the efficiency of the current transmission system by allowing circuits to operate at higher ratings when environmental conditions are favourable. But DLR focuses primarily on thermal ratings, which can inadvertently push the system beyond steady state stability limits or introduce voltage issues if they cannot be coordinated. Furthermore, the lack of autonomous, coordinated control across regions limits the optimization of power flows, hindering the full utilization of the network's capacity.

## Method(s)

The proposed project aims to investigate the feasibility of integrating multiple Grid Enhancing Technologies (GETs) such as DLR and optimal power flow control into a new system architecture centred around the GridNode controller to provide Dynamic System Rating (DSR) solution that enhances the utilisation of existing capacity and improves network control capability.

The system will gather real-time thermal ratings from DLR systems, as well as current and voltage measurements from Phasor Measurement Units (PMUs) or other suitable devices. This data will be sent to the GridNode controller. The controller will then assess the steady-state angular and voltage stability in real-time and provide a dynamic system rating (DSR) based on simultaneous monitoring of thermal and stability constraints. Using this information, the system will calculate control commands to enable fast-acting zonal autonomous control. It will adjust the operation of tap changers for super grid transformers, reactive power compensation devices, and/or FACTs devices to optimize power flow. The goal is to alleviate congestion and maximise the capacity for active power flow transfer within the grid zone.

This project will primarily focus on developing the scientific model of the DSR software functions, serving as a proof of concept for the proposed solution. Once the concept is validated, the algorithms will be prepared for hardware implementation. They can then be directly converted to code and implemented into the Zonal control devices.

If feasible, the developed system will be tested using real-world data from 5-7 substations, preferably those connected to circuits with DLR enabled.

Data Quality Statement (DQS):

The project will be delivered under the NIA framework in line with OFGEM, ENA and NGGT / NGET internal policy. Data produced as part of this project will be subject to quality assurance to ensure that the information produced with each deliverable is accurate to the best of our knowledge and sources of information are appropriately documented. All deliverables and project outputs will be stored on our internal Sharepoint platform ensuring access control, backup and version management. Relevant project documentation and reports will also be made available on the ENA Smarter Networks Portal and dissemination material will be shared with the relevant stakeholders.

Measurement Quality Statement (MQS):

The methodology used in this project will be subject to the supplier's own quality assurance regime. Quality assurance processes and the source of data, measurement processes and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and economic assessments will also be clearly documented in the relevant deliverables and final project report and will be made available for review.

Risk Assessment:
TRL Change = 1
Cost = 2
Supplier = 1
Data = 2
Total risk score = 6 Low (L)

## Scope

The scope of this project is divided into four work packages, which encompass all the necessary tasks from network modelling to Hardware-in-Loop tests, culminating in a comprehensive project report with recommendations.

Work Package 1: Construction of a Network model

- Identify potential areas or zones in the network for future implementation, which can increase the capacity of the existing network and benefit consumers.
- Gather the required data, including network data, simulated software PMU data, and historical weather data, to develop the necessary network model for the selected network zone. This model should incorporate thermal response, angular and voltage stability responses, as well as relevant zonal control actions.

Deliverables:

- Development of a network model for the selected areas/zones, with accurate representation of thermal response, angular and voltage stability responses, and related zonal control actions. This model should incorporate simulated software PMU data and historical weather data inputs.

- Presentation slides detailing the development of the network model
- Cybersecurity Architectural Assessment for DSR.

Work Package 2: Conceptual development and validation of DSR solution (5 months)

- Describe the proposed Dynamic System Rating (DSR) methodology.
- Develop the integrated DSR solution with automatic zonal control, including:
- Fundamental algorithms to configure thermal limits, steady-state voltage limits, and angular stability limits, and determine the maximum power flow that circuits can handle without compromising system stability.
- Automatic zonal control algorithm to optimise power flow control by adjusting the operation of tap changers of super grid transformers, reactive power compensation devices, and/or FACTs devices.
- Validate the developed dynamic system rating approach and automatic zonal control algorithm against the network model through four major tests: DLR thermal limit, voltage stability limit, angular stability limit, and maximum dynamic power limit (DSR limit). This validation process, also known as software-in-loop tests, may involve modifying and fine-tuning the algorithms if necessary.

Deliverables:

- Presentation slides explaining the development and configuration of the DSR and automatic zonal control algorithms.
- Workshop to share key findings and validation results of the developed algorithms to key stakeholders, accompanied by presentation slides.
- Technical report detailing the development of the DSR and automatic zonal control algorithms, as well as their validation against the network model.

Work Package 3: Hardware Deployment and Hardware in Loop testing

- Convert the developed DSR with zonal control function into a scientific model and prepare for hardware implementation.
- Conduct Hardware-in-Loop tests using actual PMUs and Zonal Controllers. These real-time tests will verify the correct computation of DSRs, latency, and accurate decision-making for control actions. The tests will be conducted both with and without controllable assets to determine the impact of autonomous control on reducing network congestion.
- Assess cybersecurity risks and provide recommendations for final deployment architectures, including the implementation of security controls and the security review of data sets and sources to ensure that unauthorized access to data is prevented, and integrity of the data used.

Deliverables:

- A workshop to share the setup, key findings, and validation results of the Real-Time Digital Simulator (RTDS) testing of the developed algorithms.
- Technical report detailing the hardware deployment and Hardware-in-Loop testing.
- A collaborative workshop between NGET and GE Vernova to assess the cybersecurity architecture, identifying potential risks and recommending security reviews of data sets and sources, as well as security controls.
- An Architectural Assessment outlining future cybersecurity risks and recommendations, including the implementation of security controls and, if feasible, continuous security monitoring.

Work Package 4: Performance and Benefit Evaluation and Future Works

- Evaluate the performance of DSR in comparison with conventional static seasonal rating and DLR performance.
- Conduct a cost-benefit analysis based on the calculated increase in network capacity and reduction in curtailed renewable generated power.
- Identify future work required for implementation and propose implement plan.
- Provide user guidance and training on DSR with zonal autonomous control.
- Produce a final project report that covers the key work from all work packages, test results, performance evaluations, cost-benefit analysis, and recommendations for future implementation.

Deliverables:

- Final project report, user guidance, and training materials on DSR with zonal autonomous control.
- Organization of dissemination events to share the key outcomes and learnings from the project.

## Objective(s)

The key objectives of the project are as follow:

- Explore the feasibility of integrating multiple Grid Enhancing Technologies (GETs) such as DLR and optimal power flow control

within a novel system architecture centerd around the GridNode controller.

- Develop and validate a Dynamic System Rating (DSR) approach that enhances the utilization of existing capacity and improves network control capability.
- Evaluate the performance of DSR solution with ZAC and assess the cost-benefits of future application.
- Develop an in depth understanding of potential implementation of DSR with ZAC and further works required that lead to implementation.

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An assessment of distributional impacts (technical, financial and wellbeing related) for this project has been carried out using a bespoke assessment tool, which assesses the project as having a positive, negative or neutral effect on consumers in vulnerable situations. To help inform the assessment, this tool considers the categories of consumers identified in the Priority Services Register.

This project has been assessed as having an overall positive impact on consumers in vulnerable situations. The assessment has identified that this project will look to enhance the utilisation of the transmission network capacity which will reduce the costs for households including consumers in vulnerable situations.

## Success Criteria

The success criteria are listed below:

- Successful deployment of the proposed dynamic system rating solution in a lab environment
- Validation of Hardware-in-the-loop (HITL) of the proposed DSR solution with zonal automatic control system for a zone of the GB network
- Demonstration of cost benefit case for the proposed DSR zonal automatic control solution with detail CBA assessment
- Good quality of project final Report with recommendation of future work leading to implementation, and disseminate key project outcomes and learnings via workshops, and journal /& conference papers if possible.

## Project Partners and External Funding

Project partners: NESO.
No external funding support is required.

## Potential for New Learning

This innovation project aims to develop a Dynamic System Rating (DSR) solution with autonomous control functions that will optimise the operation of tap changers for super grid transformers, reactive power compensation devices, and FACTS devices to adjust the flow in the network to alleviate congestion. Once the DSR concept is validated, the DSR system will be prepared for hardware deployment and tested in a laboratory environment. This project will provide valuable insights into the feasibility, functionality and performance of the proposed DSR system, as well as the benefits it can offer. Additionally, the project will also outline the necessary steps that lead to future implementation.

The key findings from this project will be shared with other Transmission Owners and the System Operator through workshops, technical documentation, and publications. This dissemination of knowledge will contribute to a broader understanding of the DSR solution and its potential impact on the electricity transmission sector.

## Scale of Project

The objective of this project is to develop an advanced DSR solution that incorporates comprehensive monitoring information to compute the angular, voltage, and thermal constraints of the network. Based on this analysis, the system will take control actions to alleviate network congestion.

The project will involve the development and validation of the DSR solution within a network model. If successful, the DSR will be converted into a scientific model, prepared for hardware deployment, and tested in a laboratory environment. The performance of the developed DSR will be thoroughly assessed. Additionally, the project will evaluate the benefits of the DSR to gain a deeper understanding of the added value it provides compared to Dynamic Line Rating (DLR) technology. It will also identify further work required for the future implementation of this technology into the network.

All phases of the project are strategically linked and designed to achieve the defined objectives. Therefore, the scale of the project is intentionally set, as a smaller project would limit the potential for new learning and insights.

## Technology Readiness at Start

TRL3 Proof of Concept

## Technology Readiness at End

TRL5 Pilot Scale

## Geographical Area

The project will be a combination of computer-based studies and lab-testing. The project will be carried out at the innovation supplier's facilities.

## Revenue Allowed for the RIIO Settlement

N/A

## Indicative Total NIA Project Expenditure

£1,252,800

# 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 technology to be developed in this project will help maximise the use of the existing transmission network, allowing the circuits to operate closer to their true capacity without compromising system stability. This solution helps reduce the need for large network reinforcement, providing cost savings to consumers and a more efficient integration of renewables. The technology will also enhance the controllability and flexibility of the grid and enable future real-time autonomous control in a region, which will help to optimise the network operation and improve network resilience. All of this supports the energy system transition to the Net Zero-carbon energy system in future.

## 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 project aims to develop an integrated DSR system with zonal auto control function to optimise power flow in the grid and reduce the network congestions. If the project is successful and a follow up project will be expected to bring to the technology ready level to implementation. The benefits are calculated based on the reduced network congestion cost with assumption that the technology will be applied to the network by 2029/30. The estimated benefit in NPV value can reach around £76m if the technology is successful deployed for the duration of 15 year.

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

The proposed technology is of generic nature and would be applicable to all electricity network Licensees across GB.

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

If the project is successful, the next steps that will lead to future implementation will be identified and the estimated cost of rolling out will be reviewed at the completion of the project.

## 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 project will provide an in-depth understanding of the function, performance, and benefits of the advanced Dynamic System Rating (DSR) technology with zonal control for the Network Licensees. This knowledge will enable them to make informed decisions regarding the potential deployment of the technology to reduce network congestion to bring cost saving to consumers.

### 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.

No similar innovation projects have been found to develop an advanced and comprehensive grid enhancing technology that can provide dynamic system rating with consideration of both thermal and steady state stability limits, and integrated with autonomous regional control function to adjust the operation of tap changer, reactive compensation devices and/or FACTs to optimise power flow and reduce network congestion. No unnecessary duplication will arise as a result of this project.

### 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 innovation of this project lies in the integrated Dynamic System Rating (DSR) technology, which considers not only the thermal constraints of network circuits but also the voltage and angular steady-state stability constraints. Additionally, the DSR technology

incorporates regional or zonal control functions that optimize the power flow within the network, helping to reduce congestion and maximise the utilisation of network capacity. This technology is truly ground-breaking, as there are currently no similar commercial solutions available on the market.

## Relevant Foreground IPR

The Foreground Intellectual Property Rights (IPR) from this project include the development of an advanced and comprehensive architecture that integrates various Grid Enhancing Technologies (GETs), such as Dynamic Line Rating (DLR) and zonal automatic control. It also encompasses the scientific model prepared for hardware deployment, the scientific model of the DSR software functions, simulation results, hardware-in-loop testing results, cost-benefit assessments, project technical reports, and any associated publications. The findings will be documented in written technical reports, along with recommendations for further steps to incorporate this knowledge into Business as Usual activities.

The Background IPR that may be required to utilise the relevant Foreground IPR includes the algorithms related to the DSR and Zonal Automatic Control (ZAC) systems that GE has already developed.

## 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 several ways:

- 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 already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
- Via our Innovation website at https://www.nationalgrid.com/uk/electricity-transmission/innovation
- Via our managed mailbox box.NG.ETInnovation@nationalgrid.com

## Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

The project begins at a relatively low Technology Readiness Level (TRL), and the technology is not yet proven or commercially viable. This is not a business-as-usual activity, and there are significant risks associated with developing an innovative architecture and functionality. There is no guarantee that the overall development of the DSR system will be successful.

## 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 project contains high technical and commercial risk in developing an advanced DSR system that integrate multiple technology together to optimise power flow and maximise the utilisation of the network capacity. The developed DSR system need to be verified and the risk of failure can be high. Therefore, it can only be undertaken with the support of NIA.

## This project has been approved by a senior member of staff

☑ Yes