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.

NIA Project Registration and PEA Document

Date of Submission

Aug 2025

Project Reference Number

NIA_SPEN_0118

Project Registration

Project Title

Enhancing Network Restoration Capability under 'New Normal' – Feasibility study

Project Reference Number

NIA_SPEN_0118

Project Licensee(s)

SP Energy Networks Transmission

Project Start

October 2025

Project Duration

1 year and 1 month

Nominated Project Contact(s)

James Yu

Project Budget

£250,000.00

Summary

This project aims to evaluate current and emerging technologies that enhance electricity system resilience, with a focus on minimising the likelihood and impact of system restoration events (Black Start scenarios). The goal is to support a safe, timely, and effective restoration process when required, in alignment with the new System Restoration Standards.

The energy industry requires clear, evidence-based guidance on the technologies, methodologies, and operational processes that can enable fast and secure system restoration under all conditions. This project will deliver that clarity by:

- Assessing the landscape of available and future restoration tools;
- Developing a Key Performance Indicator (KPI) matrix to evaluate and prioritise these tools;
- Providing actionable insights to inform a strategic roadmap for system restoration for the industry.

Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

Problem Being Solved

The UK energy sector is undergoing profound transformation. The shift in electricity generation mix, evolving consumption patterns, and changes in operational procedures have introduced significant engineering and regulatory challenges in restoring our supply. This country has been fortunate and had not system restoration events for decades- which would also means the conventional methods and legacy approach could be improved. Recent incidents in Spain and then Czech Republic have highlighted vulnerabilities in grid stability, demonstrating the increased likelihood that secure events under standard Grid Codes/SQSS can no longer be taken for

granted. The overall readiness of the industry will benefit from this feasibility study.

The pace of technological development, ambitious political targets for decarbonisation, and the increasing frequency of extreme weather are creating complex, integrated impacts on energy supply standards and system resilience. These developments underscore the urgent need to reassess and adapt our regulatory and engineering frameworks to safeguard the electricity network. Naming a few:

Extreme Weather: the system restoration capability is based on the availability of energy, which needs to be stable, lasting and fast when required. The pace and scale of the extreme weather would easily invalid the restoration plan: such as prolonged and unprecedented drought (over 1-3 months), warm winter (means no wind, nor solar).

Generation Mix: the conventional thermal generation is capable of adjusting/controlling voltage and frequency 'instantaneously'. The availability and controllability from wind and solar make the restoration planning more uncertain. Energy storage has technical limitation to provide enduring support.

Demand Evolvements: the customer and major industrial users are adjusting to be flexible. Such flexibility can minimise the cost under normal operational condition; but can also present another layer of challenge in the event of system restoration.

Power Electronics, its control and its combination capacity with energy storage: GB power industry is pioneering the regulation on Grid-Forming. Their role in the system restoration is yet to be confirmed and verified.

Method(s)

This low TRL and feasibility study is to conduct a comprehensive evaluation about the current and emerging challenges to electricity system resilience, with a focus on the implications of new regulatory standards—particularly the Electricity System Restoration Standard (ESRS). The study aims to identify gaps, assess risks, understand the cross-sector dependencies and propose actionable recommendations to enhance system restoration capabilities.

Scope

Risk assessment, taken into account the current engineering, control and regulatory landscape; industry trend on engineering code and regulation on Black-start;

- An assessment of recent grid disturbances and their root causes; to validate the work under Scope 1 and potential mitigations
- Ø Review of the technology advancements, such as power electronics+ energy storage (corresponding to the risks identified); their control algorithm, reactions to grid events with simulation if necessary
- This forward-looking evaluation of emerging technologies, their TRL and their impact on grid stability should provide certainty and credibility with a clear timescale in the UK
- An evaluation of the whole energy system and its readiness to support network resilience and restoration

The project will work closely with key stakeholders such as NESO and research community.

Objective(s)

The primary objective of this project is to evaluate existing and emerging tools that can strengthen electricity system resilience by reducing the likelihood and impact of system restoration events. In the event of a partial or full system outage, the industry requires clear, practical guidance on the technologies, methodologies, and processes that enable a fast, safe, and effective restoration—fully aligned with the new System Restoration Standards. The project will also inform the development of an actionable roadmap to support strategic planning and investment in restoration capabilities.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

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

Success Criteria

The finding will be published, consulted with key stakeholders and their contribution will be included in the final publication.

Project Partners and External Funding

University of Cardiff, no external funding

Potential for New Learning

This research will inform the electricity system restoration and resilience strategy for the industry with evidence and analysis. This will serve as an independent testing and validation of the existing RIIO-2 and RIIO-3 strategies.

Scale of Project

UK wide feasibility study to look into the cause of the recent grid disturbances and evaluate the readiness of the GB network to support network resilience and restoration

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

Focused on SPEN's area, but also take into account the impact for the industry in general.

Revenue Allowed for the RIIO Settlement

0

Indicative Total NIA Project Expenditure

£250k

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:

This project directly supports the UK's energy transition by addressing the emerging challenges of a decentralised, inverter-based grid increasingly exposed to climate risks. As traditional restoration methods become less reliable, the project will investigate how to maintain system stability under new conditions. A key focus will be on ensuring that restoration strategies can prioritise critical infrastructure—such as hospitals, care homes, and essential services—and protect vulnerable consumers. By embedding equity into resilience planning, the project ensures that the benefits of a secure energy system are shared across all segments of society, especially those most at risk during outages.

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)

Not Applicable as it is RIIO-2 project

Please provide a calculation of the expected benefits the Solution

Not Applicable as it is a research project

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

The detailed benefit assessment can be developed as part of the project. The initial estimation is based on the risks that could be reduced if the industry can better prepare, and in the counter-factual scenario, utilising all new technologies available.

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

the learnings of the project will be available to GB network licencees

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

This research will inform the electricity system restoration and resilience strategy for the industry with evidence and analysis. This will serve as an independent testing and validation of the existing RIIO-2 and RIIO-3 strategies.

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.

A thorough review of the Network Innovation Allowance (NIA) and Network Innovation Competition (NIC) portfolios confirms that no existing project addresses system restoration from this holistic, low-TRL, discovery-led perspective. While there are initiatives focused on black start and DER integration, none combine engineering, regulatory, and cross-sector analysis under the ESRS framework. Coordination with NESO, Transmission Operators (TOs), and Distribution Network Operators (DNOs) will ensure alignment and complementarity, avoiding duplication and enhancing sector-wide value.

This proposal has also been circulated and tested at the Energy Innovation Managers forum at ENA.

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

Innovation is central to this project. It will:

- Apply dynamic simulation tools to model restoration in low-inertia systems.

- Explore whole-system interdependencies, including the interaction between power electronics, energy storage, and flexible demand.
- Integrate climate and cyber risk into resilience planning—an area not yet fully addressed in current standards.
- Use scenario-based foresight to stress-test existing restoration strategies and regulatory assumptions. This approach represents a significant departure from conventional restoration planning, offering a forward-looking, system-wide perspective.

Relevant Foreground IPR

N/A

Data Access Details

Access to this data must be requested by contacting innovation@spenergynetworks.com Please provide the following information in your request:

- Affiliation, position and contact details of requesting party
- Relevant project and type of data required
- Reasons for requesting this data and evidence that this data will be used in the interest of the UK network electricity customers
- How data will be shared internally and externally by the requesting party

Any data request deemed unsuitable for sharing will be highlighted to the appropriate requesting party. After receiving the request we will provide the estimated date for completing the data provision based on other requests and our team workload at that time. All requested data remains the property of SP Energy Networks.

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

The innovation funding is warranted based mainly on two reasons:

- The conventional and existing network resilience and restoration approach are still functioning. This research is in line with the strategic direction;
- The current developments and claims of new technologies are subjected to verification and are not ready as commercial solutions.

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 NIA funding presents as the best candidate for this research as it is an industry-led, industry-owned, but inclusive and transparent. This research will benefit from the research community contributions and their learnings to avoid duplications.

This project has been approved by a senior member of staff

☑ Yes