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

Apr 2025

Project Reference Number

NIA_SPEN_0111

Project Registration

Project Title

Vibration Monitoring of Wind Turbine Effects on OHL Conductors

Project Reference Number

NIA_SPEN_0111

Project Licensee(s)

SP Energy Networks Transmission

Project Start

October 2025

Project Duration

1 year and 7 months

Nominated Project Contact(s)

Simon Murray

Project Budget

£120,000.00

Summary

Undue conductor movement is a leading cause of mechanical failure in OHL fittings, conductors and spacers. By installing high-resolution sensors on two segments of a transmission line which passes close to a wind turbine site, this project will investigate the impact of wind turbine-induced vibrations on overhead line (OHL) conductors. One set of sensors will be placed on the segment near the wind turbines where faults have previously been recorded, and another set on a segment further away to serve as a baseline for comparison.

The data collected will help understand the correlation between wind turbine activity and conductor movements, helping to inform solutions that minimise faults and improve the reliability of the transmission network.

Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

Problem Being Solved

SP Transmission (SPT) have recorded an increasing number of faults due to conductor clashing in proximity to onshore wind turbines. There is limited research and knowledge regarding steps to monitor this phenomenon. In addition, existing Energy Networks Association (ENA) guidelines set out in the document, Engineering Recommendation L44 for separation between onshore wind turbines and overhead lines were established more than 10 years ago when onshore wind turbines were fewer in number and significantly smaller in size than they are today.

Underpinning the UK government's decarbonisation targets is the ambition to double onshore wind capacity by 2030. This is driving an upsurge in the volume and/or size of onshore wind turbines in the UK. New onshore wind farms are springing up and the existing ones are expanding and repowering. This has invariably led – and is projected to continue to lead – to a breach of the recommended

separation distance between wind farms and overhead transmission line (OHL) assets. The consequences are already being felt where this breach is significant. Development of solutions to manage these negative impacts is critical to support the needed onshore wind capacity growth the UK needs while ensuring that customers are protected from loss of supply quality, and the network assets protected from health degradation.

This project aims to conduct continuous live monitoring of conductor movement at a site within the SPEN networks where the prescribed separation between turbine and high-voltage OHL is suspected to have been encroached. Through analyses of the collected conductor vibration modes live data, this project will drive understanding of the impact on OHLs of downwind turbine wakes. To support the UK net zero goal of which onshore wind turbines are a centrepiece, this project will disseminate findings, GB-wide best practice, and appropriate mitigations with the wider networks industry.

Method(s)

This project sets out to investigate the impact of nearby wind turbines on overhead lines (OHL) through the deployment of high-resolution digital sensors which are motion- or time-triggered to record information on aeolian, sub-span, galloping and sway line activity. The technical approach adopted will be:

1. Deployment of vibration monitoring equipment on affected and control sections of OHL.
2. Continuous monitoring of all vibration mode activities over a period of around 12 months to capture all-year-round weather events.
3. Harvesting of meteorological data during live monitoring.
4. Analysis of line activity and meteorological data to identify correlation between conductor clashing events and proximity to wind turbine sites.
5. Development of mitigation strategies and dissemination of learnings with wider industry.

Scope

This project sets out to undertake a 12-month wind-induced conductor motion study on two existing OHL tower spans crossing through a wind farm. Monitoring systems are deployed to record four vibration modes. With two systems installed at a tower in a section where wind turbines are in proximity of the line, and two systems installed at a location with no wind turbines in proximity.

A total of two spans are instrumented on only one of the two double-circuits. The upper phase and middle phase of each span are equipped with sensors. Three sensor nodes are installed at the middle of the longest twin bundle sub-span of each of the two conductor phases.

The deployed sensors are powered from a built-in battery. The data gateway and weather stations on each span are powered by a combination of solar panel and battery system installed at the tower. Recordings are observed and processed at a remote dashboard terminal. A first report will be produced in PDF format within the first six weeks of installation. Following this, analyses will be conducted and reported on quarterly bases in the same format, with a final report published at the end of the 12 months of continuous monitoring.

Dissemination of project outcomes will advise on further works needed to address turbine wake led faults and outages and associated assets health condition issues. This will enable the connection of more wind turbines at the least possible detriment to the GB consumers, the network assets, and network personnel.

Objective(s)

This project will achieve the following objectives to:

- Leverage industry-leading collaboration to deploy cutting edge line vibration activity monitoring sensors on the GB transmission network.
- Continuously monitor and analyse aeolian, sub-span, galloping and sway line activities over 12 months.
- Understand the relationship between conductor clashing instances and the proximity of affected overhead line sections to wind turbine sites.
- Publish learnings and mitigation strategies for wider replication or adoption by other network licensees.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

This live trial is non-intrusive and has no electrical interface to the network. Hence, there is no significant potential for this project itself to impact vulnerable customers.

Success Criteria

The success of this project depends on the detection of enough conductor vibrations above baseline levels during the monitoring

period to drive investigation of the observed wake induced movements. The underlying success criteria includes the dissemination of learnings gained from the continuous monitoring and analysis exercise.

Project Partners and External Funding

Preformed Line Products (PLP-Great Britain) – Supplier of monitoring equipment, technical guidance on installation and O&M and analysis of recorded data.

Potential for New Learning

Preformed Line Products (PLP-Great Britain) – Supplier of monitoring equipment, technical guidance on installation and O&M and analysis of recorded data.

Scale of Project

The trial undertaken in this project is localised to two spans of SPEN-owned XJ overhead line transmission route. Each span represents the wake affected and unaffected sections of OHL. The set up on the unaffected tower span improves the reliability of the findings by giving baseline vibration and conductor motion levels. XJ route is a 400kV OHL which forms part of the Wishaw to Smeaton 400kV circuit. The section of interest is located near Shotts, in the vicinity of Blacklaw Windfarm Extension.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

South of Scotland.

Revenue Allowed for the RIIO Settlement

None.

Indicative Total NIA Project Expenditure

The total expenditure expected from this project is £120,000.

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:

Unrelenting pace of onshore wind developments have been witnessed by various parts of the UK over the past few years. The de facto ban on new onshore windfarms in England was lifted in July 2024. These developments are pursuant to the UK government's net zero commitment to double onshore wind capacity by 2030.

To move this low carbon electricity from where it is produced to the GB consumer homes and businesses, commensurate developments have followed in the transmission network.

As is inevitable with this pace of ongoing works, there have been cases of breach of the recommended separation between onshore wind turbines and OHL. This project is a first step towards facilitating the UK onshore wind targets by ensuring transmission assets in windfarm zones continue to operate safely.

How the Project has potential to benefit consumer in vulnerable situations:

Wind induced vibrations lead to early conductor assets ageing from mechanical stress and fault outages due to conductor clashing. As a first step towards uncovering the solution to this challenge, this project:

1. Ensures uninterrupted supply of clean electricity to those who need it the most.
2. Offers financial benefits to the transmission owners (TO) which gets passed down to customers in the form of reduced bills.

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

If successful, solutions learned through this field trial project will bring about savings through minimising incidents of turbine wake-induced fault outages and conductor movements. It will also inform solutions to improve asset lifespan of OHL conductors and fittings. Indicative preliminary estimate puts the benefit at a monetary value of £450k per wake induced permanent outage on the OHL. The savings accrued to TOs is passed down to the GB customers and network users in the form of reduced bills.

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

All network licensees are affected by the challenges this project seeks to address. Project learnings will be of value to all GB TOs. This project may be replicated on spans of any double-circuit OHL in proximity to onshore wind farm. With modification in sensor arrangements, the project would also benefit single circuit OHL sites.

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

It is not anticipated that the Method would be rolled out GB-wide however the learnings from this project will be relevant to the entire GB

transmission system and will help to influence policy around siting of wind turbines and OHL infrastructure in close proximity and may inform future projects that seek to develop mitigations for any impacts of such proximity.

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

Generated learnings will drive the development of mitigation strategies by network licensees to reduce conductor clashing occurrences and related concerns on supply safety, reliability, and resilience for OHL closer to onshore wind turbines than the existing separation guideline.

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.

Although the phenomenon addressed by this project has been discussed in academic research studies and simulated by other network licensee on a computer aided design tool, there are no records of any network trials on the ENA Smarter Networks Portal. More, internet queries reveal the problem has not previously been addressed elsewhere using the solution methods prescribed in 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

Public domain queries and industry consultations have revealed that no project with the same scope and focus as this has been previously undertaken. In this manner, this project is innovative.

Relevant Foreground IPR

N/A

Data Access Details

Access to this data must be requested by contacting SPInnovation@spenergynetworks.co.uk. 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

Due to its novelty and associated risks, this project may not be funded through business-as-usual activities. NIA funding is necessary to cover possible risk aspects of this project.

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

Never previously tried in the UK, NIA funding provides the right platform to manage this project’s associated commercial and technical risks and raise the TRL.

This project has been approved by a senior member of staff

☑ Yes