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

Jul 2026

Project Reference Number

NIA3_NGET0002

Project Registration

Project Title

Twin Spacer Damper Installation and Removal Robots (TWIN-SPIDER)

Project Reference Number

NIA3_NGET0002

Project Licensee(s)

National Grid Electricity Transmission

Project Start

August 2026

Project Duration

1 year and 0 months

Nominated Project Contact(s)

Prem Ranjan, Box.NG.ETInnovation@nationalgrid.com

Project Budget

£280,000.00

Summary

The project specifically helps network operators gain confidence in to remove existing spacers and install type registered twin spacers on overhead lines. The robot will install the spacer at precise predetermined locations – ensuring spacers are installed at the correct locations at a precise 90º angle, improving the performance of the spacer dampers and reducing fatigue and wear on the conductor. FulcrumAir will develop specific robotic solutions to install and remove spacer dampers on new and existing OHTL assets. FulcrumAir have a global presence in this area, and already carry this work out in other countries and are willing to partner with National Grid to co-develop a tailored solution for the network within the UK.

Third Party Collaborators

FulcrumAir Ltd

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

Traditional installation and removal of twin spacer dampers on overhead lines (OHL) is labour-intensive, slow, and carries significant safety risks. Current methods rely on large field crews working at height using spacer carts, cranes, access platforms, and live-line techniques. These activities expose personnel to hazards including falls, electrical proximity risks, manual handling injuries, and challenging environmental conditions.

In addition, access constraints (terrain, weather, tower geometry) can significantly delay work, increasing outage durations and costs. As transmission networks expand to accommodate renewable generation and electrification, the volume of spacer installation and maintenance activity is expected to increase materially.

There is currently no widely adopted, standardised robotic solution in the UK for installing and removing twin spacer dampers on bundled conductors. This creates a gap between global best practice (where robotics is emerging) and UK network operations.

The project addresses:

High safety risk exposure to linesman
High operational cost and resource intensity
Limited productivity and scalability of manual installation methods
Need for reduced outage durations and improved asset availability
Lack of UK-specific robotic solutions adapted to National Grid standards

Method(s)

FulcrumAir will apply its globally proven robotic development capability for power line tools, adapted specifically for UK overhead transmission line (OHL) standards, to develop a tailored twin spacer damper installation and twin spacer removal system.

Key methodological elements include:

Leveraging Proven Global Robotic Platforms

FulcrumAir is a recognised global leader in aerial robotics for transmission line construction and maintenance, with prior successful deployments across multiple international networks. Existing platforms—already capable of installing spacers, accessing bundled conductors, and performing complex tasks—will form the foundation of this project.

This significantly reduces technical risk by:

Building on mature, field-tested robotic architectures
Utilising proven locomotion systems capable of traversing conductors
Leveraging existing control, stabilisation, and positioning technologies

UK-Specific Engineering Adaptation

The robotic system will be engineered to meet National Grid's specific requirements, including:

Already approved twin spacer damper geometries and installation tolerances. FulcrumAir will leverage existing relationships with key hardware manufacturers to ensure complete compliance with already approved hardware for National Grid
UK conductor bundle configurations
Electrical clearance and live-line working constraints
Compatibility with UK safety and operational standards

Advanced Control and Operation

Remote control and supervised autonomy will be implemented to ensure safe and efficient operation
Integration of sensing (vision systems, position feedback, force control) to enable precision alignment and installation
Operator interface designed for transmission network crews and contractors

Validation and Testing

Bench testing of mechanical and control systems in FulrcumAir's state of the art robotic development and engineering facility in Calgary, Canada
Simulated environment testing for repeatability and safety
Controlled field trials on de-energised and/or representative assets. FulcrumAir also has capability to perform energised Hi-Pot testing at its facility in Canada.
Progressive validation towards real-world deployment readiness

Safety Case Development

Development of a UK-compliant operational safety case
Hazard identification and mitigation strategies
Integration into National Grid working procedures and on-boarding with panel of contractors

Scope

The project scope covers the full adaptation and validation lifecycle required to introduce FulcrumAir's proven international capability into a UK-ready operational solution.

Included in Scope

Engineering design of robotic system adapted for twin spacer damper installation/removal
Development of bespoke tooling and interfaces for UK hardware
Integration of robotic platform, tooling, and control systems
Testing and validation (laboratory and field-based)
Development of operational procedures and training requirements
Safety case and compliance assessment aligned with UK standards

Demonstration Activities

Deployment on representative National Grid overhead line sections
Evaluation of installation speed, precision, and reliability
Assessment under realistic environmental and operational conditions

Deliverables:

- Finalize agreement and appoint Steering Committee
- Information Gathering - robot specifications, capabilities/requirements, scope, spacer samples, etc.
- Design Prototype Dual Bundle Spacer Damper Installation Robot
- Design Prototype Dual Bundle Spacer Removal Robot
- Manufacture Prototypes (1 unit each)
- Testing Prototype/Design Iteration
- Manufacture Prototype Iteration (4 Units)
- Testing Prototype and pilot-scale deployment

Objective(s)

The primary objective of the project is to demonstrate that FulcrumAirs robotic technology already proven internationally can be effectively adapted and deployed within the UK transmission environment to safely and efficiently install and remove twin spacer dampers.

Technical Objectives

Develop a robotic system capable of securely installing and removing twin spacer dampers on UK OHTL conductors
Achieve precise positioning and installation within required tolerances
Demonstrate robustness across typical and varied environmental conditions (wind, rain, conductor movement, access constraints)

Operational Objectives

Reduce installation time compared to traditional manual methods
Minimise or eliminate the need for personnel working at height
Demonstrate repeatable and scalable operational workflows

Safety Objectives

Significantly reduce exposure to high-risk activities
Validate safe operation within UK regulatory and operational frameworks
Establish procedures for integration into live-line or adjacent working practices

Strategic Objectives

Provide National Grid with a deployable pathway toward robotic OHTL construction and maintenance
Establish a foundation for broader adoption of robotics across transmission assets
Position the UK network at the forefront of global best practice

Learning Objectives

Identify engineering adaptations required for UK deployment
Quantify performance improvements vs traditional methods
Develop case for wider rollout and investment

Consumer Vulnerability Impact Assessment

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

Success Criteria

· Design presented to NGET with updated design document and formal acceptance/feedback integrated as the robot design/manufacturing progress.

· Prototype robot deployed to transmission route and tested — pilot test report showing metrics meet agreed thresholds (or remediation plan), deployment checklist and stakeholder signoff.

Project Partners and External Funding

The project will be delivered in partnership with FulcrumAir, who will act as the primary industry supplier and provide the required technical expertise in spacer removal-installation robots. FulcrumAir will lead the research, development, and deployment validation activities throughout the project lifecycle and finally on a OHL route of NGET. The project is funded through NIA and does not rely on any external funding sources or third-party financial contributions.

Potential for New Learning

· Enables network operators to replace existing spacers with type-registered twin spacers with greater confidence.

· Robot installs spacers at precise, pre-determined locations.

· Robot ensures spacers are fitted at an exact 90° orientation.

· Correct 90° orientation improves spacer-damper performance.

· Improved damper performance reduces conductor fatigue and wear.

Scale of Project

This technology reduces the exposure of working at height for the line workers and removes the requirement for line workers to work from spacer trolleys during spacering activities on twinconductor bundles. After the project, a technology and process rollout across all OHLs is expected. The project focuses on dead OHLs but there is a potential to introduce this technology to work on live conductors.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

Laboratory based studies and manufacturing will be carried out at the innovation provider's facilities at FulcrumAir in Clagary, Canada. The trial and design approval will be carried out at a transmission OHL route of NGET in UK.

Revenue Allowed for the RIIO Settlement

Not Applicable

Indicative Total NIA Project Expenditure

£252,000

Project Eligibility Assessment Part 1

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

The project specifically helps network operators gain confidence in to remove existing spacers and install type registered twin spacers on overhead lines. The robot will install the spacer at precise predetermined locations – ensuring spacers are installed at the correct locations at a precise 90º angle, improving the performance of the spacer dampers and reducing fatigue and wear on the conductor. Extended asset life and reduced wear can decrease maintenance frequency and unplanned interventions, improving network reliability. Improved reliability and fewer outages support greater integration of variable low**l**carbon generation by reducing barriers to connection and operation. Automated, repeatable installation processes help reduce operational risk and cost per installation, making large**l**scale deployment of network resilience measures more economically viable.

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

The TWIN-SPIDER project represents an important technical foundation that enables broader system changes with cascading benefits for all electricity consumers, including those in vulnerable situations.

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

n/a

Please provide a calculation and/or description of the expected benefits of the solution

Based on assumption Robotic TRL and implementation in Q4 FY 2027 the potential NPV in T3 of ~£18k saving for every 3 span section completed or ~£278 per spacer using the spacer removal and installation robots.

Planned twin spacer replacement for T3 = 755km or ~ 2200 spans or ~39,600 spacers to be replaced.

Potential savings of ~£10m during T3 period if the spacer removal/installation robots were implemented as BAU by AO OHL by Q4 2027. It can greatly reduce the risks associated with working at height and from overhead line trolleys – musculoskeletal, manual handling injuries. Productivity, labour efficiency, cost savings, and installation quality are significantly improved through robotic technology. Reduced outage timescales as spacers can be replaced during insulator replacement works. Improved NARMS delivery is possible using the spacer removal/installation using the technology under live working conditions (if developed).

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

Implementation of the technology can be rolled out and benefitted by all the UK utility industry (electricity transmission and distribution) and EPC partners.

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

Deployment strategy - primarily the robot technology will be used on NARMS capital investment schemes.

Deployment budget requirements – costs of deployment will be covered by the NARMS capital investment schemes for NGET. For other networks and EPC partners in GB, the results will be shared through the steering committee to enable the roll-out.

Requirement 3 / 1

Involve Research, Development or Demonstration

Projects 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

Involve Research, Development or Demonstration - Please select all that apply

☑ 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

NGET will be using the robot technology on NARMS capital investment schemes with budget from these schemes. It is expected that - this to be both a technology and process rollout across all OHLs. Reducing risk to ALARP is a mandatory requirement under the Working at Height Regulations. This technology reduces the exposure of working at height for the line workers and removes the requirement for line workers to work from spacer trolleys during spacering activities on twin conductor bundles.

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. Networks must explicitly mention similar projects that they have considered and how these differ.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

There are no other projects in development looking at spacering that can help with removal and installation of spacers. The risk of duplication will be addressed through dissemination of progress with other licensees and being open to co-operate with licensees working in this space.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

Not applicable

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

The project is innovative because no existing robotic solution is available to remove or install type‑registered twin spacers on overhead lines, so it replaces a wholly manual process: spacer replacement is currently done by skilled personnel on overhead‑line trollies, a method that is labour‑intensive and time‑consuming. The current practice has recognised quality‑assurance gaps (human error and no recorded installation data) and exposes many people to working‑at‑height risks, manual‑handling and musculoskeletal injuries. Automating spacer removal and installation therefore addresses an unmet technical need—creating a capability that does not yet exist—while reducing reliance on highly skilled staff to perform a routine, repetitive task and enabling objective installation records for QA.

Relevant Foreground IPR

Relevant foreground IPR expected from the project may include documented methodology, solution design outputs, pilot learning, user guidance, implementation lessons and final project reports.

The main foreground learning to be shared through NIA dissemination will focus on the method, findings, governance considerations, value evidence and lessons learned, rather than security-sensitive implementation detail or restricted internal information.

Any foreground IPR and related learning will be managed in line with the applicable NIA framework and project contractual arrangements, with appropriate protection for personal, commercial, security-related and operationally sensitive information.

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:

· 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 a part of it's business and usual activities

Network Licensees are unlikely to fund this as business‑as‑usual because the robot solution is an innovation and requires non‑routine R&D, testing and specification changes before it can be adopted across the network. Key reasons are:

· It is a development/demonstration activity rather than routine maintenance: BAU budgets typically cover established, repeatable workstreams; this project needs trials and proof of performance.

· There is insufficient evidence and QA data today: the robot’s claimed benefits (speed, precision, digital records, reduced exposure) need controlled validation and recorded results before BAU funding is appropriate.

· Implementation and safety risk: introducing robotic removal/installation requires additional safety case development and approvals that sit outside routine activity.

· Unquantified commercial and performance risk: without trial data the return on investment, reliability and whole‑life benefits remain unproven, so BAU funds (which are prioritised for established deliverables) are not the right source.

· Potential operational impacts: trials may require different working arrangements or outages and therefore need dedicated project funding and oversight rather than being absorbed into normal maintenance schedules.

Because of these factors, the appropriate route is targeted innovation funding to deliver the testing, validation and specification updates needed before the solution can be funded and deployed as 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 project requires NIA support because it is a non‑routine innovation with material technical, operational, commercial and regulatory

risks that cannot be absorbed within businessIasIusual budgets or delivery processes. NIA funding enables the controlled testing, deIrisking and specification work needed before the solution can be approved, procured and rolled out at scale. Therefore, considering the risks associated with the success of the project, NGET believes NIA funding is the best route for the project.

This project has been approved by a senior member of staff

☑ Yes