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

NIA2_NGET0087

Project Registration

Project Title

UAV-based Remote Hyperspectral Imaging for Condition Assessment (URHICA)

Project Reference Number

NIA2_NGET0087

Project Licensee(s)

National Grid Electricity Transmission

Project Start

May 2025

Project Duration

1 year and 1 month

Nominated Project Contact(s)

Aisha Ali

Project Budget

£326,315.00

Summary

Electricity transmission asset monitoring is a time consuming and laborious task, which is often inconsistent and not quantitative or reliable. The URHICA project proposes the use a UAV-based hyperspectral imaging system for condition assessment of steel lattice towers. Both hardware and software solutions including machine learning will be employed to allow automated grading of rust with high accuracy and distinguishing rust types.

Preceding Projects

NIA2_NGET0009 - Visual Inspection and Condition Assessment Platform for OHL Steelwork (VICAP)

NIA2_NGET0048 - Visual Inspection and Condition Assessment Platform for OHL Steelwork 2 (VICAP 2)

NIA_NGET0215 - Automated assessment of steelwork condition using innovative imaging techniques

Third Party Collaborators

Nottingham Trent University

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

National Grid Electricity Transmission (NGET) owns 21,900 steel lattice towers that carry the 400kV and 275kV overhead transmission conductor wires for England and Wales. Structural steelwork condition deteriorates through corrosion, so periodic assessments are made to understand the health of the assets throughout the network. Following photographic capture by helicopters

and / or UAVs, approximately 200,000 images are viewed manually, and an assessment of any corrosion levels is made. The steel is assigned one of 6 grades in this visual assessment.

One of the issues with colour still images is the inconsistency in the colour and image detail owing to the changing daylight levels owing to the weather conditions (e.g. moving clouds). It is impossible to achieve high accuracy assessments if the only data available is within a still colour image. Electricity transmission asset monitoring remains a time-consuming and laborious task, often resulting in inconsistent, non-quantitative, and unreliable assessments. The existing NIA_NGET0009 & NIA2_NGET0048 (VICAP I & II) Innovation projects have allowed us to rollout a UAV-based system using a colour DSLR camera combined with AI for automatic corrosion mapping. We do see post-processing issues that can lead to errors due to varying landscape conditions such as autumn leaves because of the similarity in colour with rust. Additionally, steelwork deterioration through corrosion necessitates climbing inspections for grades 5 and 6, requiring significant manpower that may be drastically reduced with the use of more accurate and non-subjective data. We intend to build on our VICAP rollout by adding this technology and approach if it proves successful. We also had a previous NIA_NGET0215 innovation project that showed the potential of a ground based 10-band spectral imaging system, however it was too bulky to be used on an UAV, and therefore we are looking to improve this in this project.

Method(s)

Spectral imaging, which offers higher spectral resolution than traditional colour images, can differentiate between the spectral signatures of the surrounding landscape and those caused by rust. Additionally, spectral imaging has the potential to identify varying levels of rust severity by utilising detailed spectral features as indicators of rust type. This refinement will enhance the automated grading system that will be explored in this project. In previous VICAP projects, an AI model demonstrated the capability to detect corrosion and assess historical steelwork imagery to determine corrosion rates for towers across the network over the past decade.

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 our 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.

In line with the ENA's ENIP document, the risk rating is scored low risk.

Scope

URHICA will deliver a UAV-based hyperspectral imaging system for condition assessment of steel lattice towers. Both hardware and software solutions including machine learning will be employed to allow automated grading of rust with high accuracy and distinguishing rust types. The project deliver comprise of 6 milestones.

· Milestone 1: Completion of hardware and software adaption to UAV-based hyperspectral imaging system, UAV setup and testing on NTU campus (include test results on daylight variability correction).

· Milestone 2: Completion of field testing for UAV based hyperspectral/LIDAR solution.

· Milestone 3: Completion of initial (Machine learning) ML software development/adaptation for processing of hyperspectral imaging data with test results based on data collected on one steel lattice tower.

· Milestone 4: Completion of fieldwork for steel lattice scenario.

· Milestone 5: Completion of software for automated corrosion grading and steel lattice post processing for validation.

Milestone 6: NIA compliant completion final report along with training manual for the internal stakeholders and dissemination.

Objective(s)

The key objectives of URHICA project are:

- Demonstrate that the drone-based hyperspectral system provides accurate automated classification of rust grades, enhancing the quality and consistency of visual assessments.
- Reduce the time required for data capture and assessment of steelworks.
- Establish the solution's capability to differentiate between various types of corrosion.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

Enhancing the efficiency of operations and maintenance for assets positively impacts system availability. This project also offers cost benefits using machine learning and spectral imaging. With its higher spectral resolution, this technology can accurately differentiate between rust and the surrounding landscape, as well as identify varying levels of rust severity. Ultimately, vulnerable customers will benefit from improved system availability by reducing the risk of outages caused by asset conditions.

Success Criteria

The project will be successful if it achieves the objectives set out in this document. In particular, the following outputs are expected:

- Hardware solution for daylight variability correction adapted to the drone (UAV) based hyperspectral system.
- Modified software solution for data calibration.
- Updated and adapted software solution for automated grading of corrosion using ML.
- Optimised data capture procedure
- Documentation of the optimised workflow
- Periodic reports including results of trials on site

Project Partners and External Funding

N/A

Potential for New Learning

·· The learning will be disseminated through the reporting via the ENA portal and dissemination events. Lessons learnt and output may be transferable to other TOs/DNOs with similar business-as-usual (BAU) environments.

Scale of Project

The total duration of the URHICA project is 12 months and will be an enabler for next stage if this stage is successful.

The scale of this project involves the following

· Data collection and processing.

· Modified software solution for data calibration.

· Testing of hardware and software using machine learning.

· Optimised data capture procedure.

· Documentation of the optimised workflow.

· Periodic reports including results of trials on site.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL6 Large Scale

Geographical Area

The project will be conducted at field tests, e.g. onsite and at a training centre.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£293,684

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 implementation of UAV-based hyperspectral imaging for monitoring electricity transmission assets plays a crucial role in facilitating the transition of the energy system towards greater efficiency and reliability. This advanced technology offers a more effective method for assessing the condition of steel lattice towers, which are vital components of the electricity transmission infrastructure.

- The system can identify different levels of rust severity, aiding in early corrosion detection.
- Accurate condition assessments enable better decision-making for maintenance and repairs.
- Utility companies can prioritise interventions based on rust severity, extending asset lifespan and reducing outage risks.

Overall, UAV-based hyperspectral imaging improves monitoring of electricity transmission assets, contributing to a more resilient energy system.

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 advancements improve the quality and consistency of visual classification, enabling better corrosion grading and reducing painting program costs through increased automation in image analysis. This enhances predictability of steelwork conditions and leads to cost savings by minimising inspections and related expenses.

It is estimated that approximately £2.5 million could be saved over a period of 10 years by implementing spectral imaging techniques in paint programming and inspection, resulting in a benefit-to-cost ratio of 2.99:1.

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

National Grid has about 22,000 towers and the method of assessment can be replicated across all the towers. The insights and lessons learned will be disseminated through reporting via the ENA portal and dissemination events. This will facilitate knowledge sharing within the industry, allowing other Transmission Operators (TOs) and Distribution Network Operators (DNOs) with similar business-as-usual (BAU) environments to benefit from the findings

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

Rollout costs are currently unknown.

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 learning generated from this project will be valuable for relevant Network Licensees in several ways. The updated and adapted software solution developed during the project can be further extended to create a more user-friendly hardware and software solution, making it accessible for broader applications.

The transferable nature of the outputs ensures that the advancements made in this project can enhance condition assessment practices across the network, ultimately improving operational efficiency and asset management for other organisations.

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.

There is no awareness of any similar projects that utilise UAV-based spectral imaging with machine learning for the condition assessment of steel towers. We have a strategy in place for this project to extend and build on previous work to date in the VICAP projects. Each of these projects are complimentary.

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 URHICHA project is innovative as it introduces a method for condition assessment using UAV based spectral imaging and machine learning, a technique not previously applied to steel lattice towers. While machine learning with spectral imaging has been utilised for wall paintings, its application in assessing steel lattice towers using UAV drone based represents a novel concept. UAV-based spectral imaging systems, which require lightweight payloads for extended flight times, have only recently become available. By adapting this technology for automated rust grading, the project enables the mapping of rust distribution and the identification of previously unrecognised rust types. Furthermore, as a result, this proposed innovation is both timely and aligned with current technological advancements.

Relevant Foreground IPR

It is likely the Foreground IPR will be in the form of copyright in the datasets and the implementations for the purposes of the project on NTU's Background IP. All Foreground IPR is governed by the "National Grid Standard RIIO-2 Contracting Position – JOINT IP OWNERSHIP" that sets out National Grid's standard approach to Network Innovation Allowance (NIA) funded projects under the RIIO-2 framework. The Foreground IPR shall be owned jointly between the Parties in equal shares.

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 apart of it's business and usual activities

The Network Licensee is not funding the project as part of its business-as-usual activities because it is classified as Research and Development project, currently at Technology Readiness Level (TRL) 4. This project focuses on developing a method for condition assessment using spectral imaging and machine learning. To ensure the output is applicable and fits within NGET's business framework, the project requires a subsequent stage that demonstrates the drone-based system's user-friendliness in both hardware and software. As such, it's a good fit as an innovation 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

The project involves considerable research and development and fits well as an innovation project.

This project has been approved by a senior member of staff

☑ Yes