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

Sep 2017

Project Reference Number

NIA_NGET0215

Project Registration

Project Title

Automated assessment of steelwork condition using innovative imaging techniques

Project Reference Number

NIA_NGET0215

Project Licensee(s)

National Grid Electricity Transmission

Project Start

September 2017

Project Duration

3 years and 11 months

Nominated Project Contact(s)

Jonathan Hennah

Project Budget

£300,000.00

Summary

The overall aim of this project is to reduce the amount of time taken to analyse images of tower steelwork, improve the quality of the assessment and avoid overly conservative interpretations using an automated process of steelwork imaging analysis.

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. Steelwork condition deteriorates through corrosion, so periodic assessments are made to understand the health of the network. National Grid targets the inspection of 3,650 steel lattice towers each year, capturing high definition still colour images of steelwork from a helicopter. These images are then processed manually by a pool of four inspectors. Each tower is separated into zones and each is classified by the worst grade present in each zone. One inspector can assess the condition of the steel on approximately 8 towers in an hour. This uses approximately 11 person weeks a year.

The steel is assigned one of 6 grades in this visual assessment. Grade 3 is the optimum point at which to re-paint a tower, Grade 4 requires enhanced preparation of the surface before re-painting, and Grade 5 is a trigger for replacement of the steel because of material loss.

Calibration of the colour still images to account for changing light conditions is not possible and reduces the accuracy of inspection. Whilst the exercise is carried out by a limited number of experienced inspectors, where classifications are marginal there is a risk of inconsistent subjectivity. The highest risk area of ‘marginal’ assessments is between Grades 4 and 5.

Where assets are affected by the worst Grades – ‘5’ and ‘6’, a climbing inspection is initiated where thickness measurements of the individual bars are made. Typically 2% of towers receive these condition classifications. This climbing inspection typically takes two

days for a full tower with a team of six inspectors. This equates to approximately 875 man days per year. Additionally, around 10% of the target of 3,650 cannot be inspected from a helicopter because of flight restrictions. Climbing inspection here equates to a further 4,380 man days per year.

The availability of an alternative technology - infra-red spectroscopy poses the following questions -

- Can we improve the quality and consistency of visual classifications?
- Can we reduce the amount of time spent on the data capture and assessment of steelwork?

The technology allows us to view the towers over a greater spectrum, allowing for changing light conditions. This in turn opens the possibility of automatic steelwork classification, from data captured by cameras that can be mounted on delivery vehicles smaller than helicopters – handheld devices and unmanned aerial systems (UAS). This project seeks to establish if the technology can offer improvements to the current steel inspection process.

Method(s)

Research

A portable remote spectral imaging system designed for imaging wall paintings at archaeological sites will be applied to the monitoring of electricity transmission assets. The system is capable of automatic capture of images at stand-off distances of tens of metres as well as automatic post-processing of the images datasets for material identification and revealing hidden features for large area imaging at high resolution.

The remote spectral imaging data could provide better spatial resolution than direct manual inspection and have the capabilities of distinguishing between types of corrosion and degree of corrosion. This distinction could significantly improves our understanding of deterioration, expected life, risks, and optimal repair and replacement time. The automated image/data processing methods developed for archaeology/conservation project can also be applied to corrosion detection and classification on electricity transmission assets.

The monitoring system developed will be trialled in selected sites with different environmental conditions (e.g. coastal and inland) to demonstrate the ability of the quantitative data obtained from spectral imaging at gauging environmental risk to electricity transmission assets.

Scope

A number of towers in different environmental conditions will be selected to trial this technique. Conventional high reslution visible light images will be taken and assessed in line with current practice. The same towers will also be imaged using infra-red spectroscopy and the images analysed using the automatic post-processing software developed by Nottingham Trent University. Samples of steel sections from the towers will be removed for detailed analysis of the degree of corrosion in the laboratory to assist with calibrating and testing the accuracy of the infra-red technique and enable a comparison with the accuracy of the current approach.

The project aims to:

1) trial of spectral imaging instruments and data analysis methods developed for science-based archaeology to the automatic detection of corrosion on electricity transmission assets

2) detemine a metric from the imaging data that correlates with the degree of corrosion defined by NG standards with the potential to become a new industry standard;

3) identify correlation between environmental factors and degree and type of corrosion;

4) verify of the translation of the technology to electricity transmission asset.

5) disseminate the method to the wider infrastructure management community through attending conferences, producing publications and organising workshops and networks;

6) trial a version of the spectral imaging system to be used on a drone or handheld as well as one to operate at distances of 10-15m from a helicopter; these instruments can also be used during the demo workshops for the wider asset management community

Objective(s)

The research objective is to compare quantrify the accruacy and time required between the current process using visible light images and manual assessment with the new method using infra-red spectroscopy and automated image processing.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be successful if we determine whether or not it is possible to analyse more data from transmission assets in a given time and the process developed proves to be accurate when verified against more intrusive asset condition data from laboratory tests on tower steelwork samples.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

Up to 10 National Grid substations/OHL towers in a range of environments (coastal, near power stations etc – different corrosion levels) and in different condition states (ranging from Grade 1 – Fully painted and galvanised to Grade 6 – perforated, significant pitting and loss of section = replacement

Technology Readiness at Start

TRL6 Large Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

England

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£300,000

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:

n/a

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)

If succesful this technique could result in savings of around £700,000 over 15 years or circa £65,000 a year for NGET alone.

Please provide a calculation of the expected benefits the Solution

NGET targets the inspection of around 3,650 steel lattice towers a year to assess the need for remedial work or steel replacement. The majority of these are currently assessed using HD visible light images taken from a helicopter, with a follow up climbing inspection for those assessed to be in need to significant remedial work (grade 5 or 6) to measure the degree of material loss through corrosion.

A climbing inspection currently costs on average a little over £4,000 per tower. Typically 2% of the towers (around 73) assessed by photography each year are assessed to be grade 5, so climbing inspections for those assessed to be grade 5 costs in the order of £290,000 a year.

If this technique is successful in reducing the number of towers that are assessed as being at grade 5 by reducing errors in assessment from variable light conditions and assessment subjectivity, towers that are marginally graded as grade 5 would not require climbing inspections. As many as 25% (around 18) of the towers assessed to be grade 5 are found to have been marignally graded as such.

Avoiding climbing inspections on 18 towers a year would save around £72,000 a year.

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

On the NGET 400 and 275 kV network in England and Wales alone there 21,900. The other TO's and DNO's also have significant numbers of steel towers on their networks.

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

For NGET, as we are already doing visible light surveys and have already invested in the helicopter capability, the roll out costs will be limited. One off costs will include the cost of appropriate infrared cameras and training of operatives which combined is likely to be in the order of thousands of pounds.

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 project seeks to provide an automated, faster, consistant and more accurate classification of steel conditions. The method developed and verified by this project could provide a proven technique for steelwork condition assessment of electricity transmission assets. This would be applicable to other TO's and DNO's with electricity assets and may also be of value to gas networks for in relation to above ground steel work.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

This project fits within the 'Managing Assets - Managing assets throughout their lifecycle' value area of the National Grid Electricity Innovation Strategy.

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

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.

n/a

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

n/a

Relevant Foreground IPR

n/a

Data Access Details

n/a

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

n/a

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

n/a

This project has been approved by a senior member of staff

☑ Yes