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

Oct 2023

Project Reference Number

NIA2_NGET0048

Project Registration

Project Title

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

Project Reference Number

NIA2_NGET0048

Project Licensee(s)

National Grid Electricity Transmission

Project Start

November 2023

Project Duration

1 year and 6 months

Nominated Project Contact(s)

Stephen Mbisike

Project Budget

£321,110.00

Summary

VICAP 2 builds on the success of VICAP. In VICAP, drones recorded success in automatically capturing asset condition for use in condition-based asset maintenance. In VICAP 2, a refined artificial intelligence (AI) model will be adopted to automatically process the asset data and grade the steelwork across the tower. As manual processing of the data will be removed from the system, there will be savings on time and cost. As a result, the AI will provide efficient, reliable and consistent output / recommendations. In addition, the AI model will predict future asset condition and make reports on recommendations for painting / replacement of steel work.

Preceding Projects

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

Third Party Collaborators

Keen AI

Nominated Contact Email Address(es)

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Problem Being Solved

National Grid Electricity Transmission (NGET) owns 21,900 steel lattice towers in England and Wales. Steelwork condition deteriorates through corrosion from exposure to chemicals that are present in the environment. Periodic assessments are made to understand the health of the network. NGET targets the inspection of 3,650 steel lattice towers each year, capturing high definition still colour images of steelwork from a helicopter / drone. These images are then processed manually by a pool of inspectors and are assigned 1 of 6 grades in this visual assessment. Whilst the exercise is carried out by a limited number of experienced inspectors, where classifications are marginal, there is a risk of inconsistent subjectivity in addition to substantial time and resource needs. Grade

5 and 6 steelworks also require climbing inspections if assessed incorrectly due to subjectivity in manual analysis.

The innovation project NIA_NGET0009 (VICAP) proved steel tower data can be captured with drones and that the data can be apportioned to their respective position on the tower. In this project, the artificial intelligence (AI) model will be extended to not only identify corrosion but also consistently grade data according to NGET standards. Furthermore, the AI will forecast how corrosion is likely to develop and operators could save millions by reducing the cost of assessment through a reduction in the number of data collection flights (drone or helicopter) undertaken and the need to climb towers.

Method(s)

n the previous innovation project (NIA_NGET0009), the ability of an AI model to detect corrosion and apportion the corrosion to their respective position on a tower was demonstrated. The AI models will be extended as part of this project to be able to not only identify corrosion but to grade it according to NGET standards. Historic steelwork imagery will be assessed to determine corrosion rates over the last decade for towers across the network. This will be combined with atmospheric and weather data to create a system which is able to forecast a tower's future state, presenting plans and scenarios for the network.

Scope

The first phase of the project will entail the collection of data comprising of images, historic atmospheric condition around steel works, manual assessment information of steel works and automated assessments by the AI. The combination of these will create an updated AI model and subsequently generate corrosion grading of the different parts of the steel tower using all the data sources highlighted.

In the second phase of the project, dynamic models of the future state of the steel tower will be created in the AI. The model will take as input the network constraints, cost and corrosion grading and with this, generate future scenario for levels of corrosion and spend.

The project will enable transmission operators to maintain the steelwork of towers to the same or better standard with reduced assessment costs and reduced number of surveys through more targeted surveys.

Key deliverables for the project are:

- Data Aggregation & Collection;
- Normalised manual assessments;
- Deep Steel Augmentation;
- Forecasting Model;
- Scenario Engine;
- Publication and Dissemination.

Objective(s)

The objectives of the project are:

- Reduce the cost, improve the assessment consistency and increase the speed of steel tower assessments using machine learning and AI;
- Combine the more consistent AI powered assessments with atmospheric / climate data to help develop a forecasting model for steel tower corrosion;
- Develop a painting strategy modelling algorithm that builds on the forecasting model to generate accurate future network condition scenarios (painting and replacement).

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An improvement in the efficiency of operations and maintenance of assets has a turnaround effect on system reliability. In this project, there is also a cost benefit in the form of automated artificial intelligence (AI) making the necessary recommendations. While the AI provides a cheaper and quicker alternative, it also provides consistency in its output data.

The project will have a positive impact as consumers will benefit from a more robust electricity system with additional reliability characteristics in its maintenance routine. The need for outages on the network will be minimized as the asset condition assessment procedure becomes automated and subsequently capable of forecasting future asset conditions.

VICAP 2 is a continuation of VCAP which had an overall aim of cutting emissions by replacing helicopters with drones. However, the success of VICAP 2 will improve the adoption of the VICAP, particularly as it saves time in image processing and in making consistent recommendations.

Success Criteria

The Project will be successful, if:

- The updated AI models are reliably able to detect and assess corrosion:
  - Corrosion extent
  - Corrosion key grades
  - Localisation to 2D schematic
- Future state forecasting models are reliably able to forecast the historic deterioration of a subset of test towers.
- Extract from the forecasting model can generate accurate future network condition scenarios (painting and replacement).

Project Partners and External Funding

N/A

Potential for New Learning

During the previous innovation project (VICAP_NIA_NGET0009), novel and state of the art deep learning architectures were developed to build a model that was reliably able to detect corrosion on a steel tower. The project structure was split into a set of distinct models to segment steel, identify corrosion and map to the 2D schematic completed by an assessor.
In this project, we hope to learn whether:

- the pipeline can be extended to determine corrosion grades i.e., whether the current state in deep learning can not only detect corrosion but grade it.
- rather than models arranged in series, a robust single model can take a set of survey images for a tower and complete a 2D schematic from it.
- the extent of the correlation between a tower location's environmental hostility (using recognised models for taking into atmospheric constituents e.g., chlorides, time of wetness, sulphur etc) and the degradation in steelwork experienced by the tower.
- this correlation can be used as part of a reliable predictive model enabling NGET to make better asset management decisions and for targeting condition monitoring spending better.

Scale of Project

The scale of this project involves the following:

Data collection and processing;
Presentation and documentation;
Development of the model to include forecasting;
Testing and optimisation of the AI platform.

The project scope and actions can be classed as a desktop exercise.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The project will be carried out on computers and software (desktop exercise).

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£288,999

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:

he aim of the project is to improve the efficiency of operations and maintenance of assets by providing automated asset condition assessment and making consistent recommendation for future works.

This VICAP 2 project further supports one of the original aims of the first VICAP project which is to cut emissions by reducing and/or removing the need for helicopters therefore supporting the energy system transition. The success of VICAP 2 will improve the adoption of this technology and approach, particularly as it saves time in image processing and in making consistent recommendations. VICAP 2 aims to allow for forecasting of asset condition which could reduce the need for condition monitoring and flights (drone / helicopters) moving forward.

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

While the project does not clearly target vulnerable customers, customers will benefit from the turnaround effect in system reliability. The project will provide a more robust electricity system with additional reliability characteristics in its maintenance routine. The need for outages on the network will be minimized as the asset condition assessment procedure becomes automated and subsequently capable of forecasting future asset conditions.

The AI provides a cheaper and quicker alternative to asset condition assessment, and it also provides consistency in its output data.

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 benefit will be achieved through a reduction in the number of towers assessed and the frequency of assessment carried out. With improvement in the data collection and processing, the need for assessment becomes more predictable which is guided by more accurate data.

It has been estimated that within a period of 7 years, about £1.3 m could be saved from data collection and data analysis cost.

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.

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

The costs of deploying the new methods should be relatively inexpensive as it would require an update on the AI algorithm in the software. The actual cost will be known as the project develops and more learning is captured on the true capability of the AI model.

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

During the previous innovation project (VICAP), we developed novel and state of the art deep learning architectures to develop a model that was reliably able to detect corrosion on the asset. We had to split the problem into a set of distinct models to segment steel, identify corrosion and map to the 2D schematic completed by an assessor. As part of this project, we hope to learn whether:

- the pipeline can be extended to determine corrosion grades i.e. whether the current state in deep learning can not only detect corrosion but grade it.
- Rather than series of models arranged in series whether a robust single model can take a set of survey images for a tower and complete a 2D schematic from it.
- the extent of the correlation between a tower location's environmental hostility (using recognised models for taking into atmospheric constituents e.g. chlorides, time of wetness, sulphur etc) and the degradation in steelwork experienced by a tower.
- whether this correlation can be used as part of a reliable predictive model enabling NGET to make better asset management decisions and for targeting condition monitoring spending better."

Fundamentally the introduction of AI is a huge opportunity for Network Operators to run networks at a lower cost to the consumer. This project will demonstrate to other Licenses how this can be done in a transformational way.

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 project that uses AI to assess the condition of steel towers and future predictions that covers the scope of 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

Until the completion of VICAP, it wasn't possible for AI to reliably detect and localise corrosion on towers despite many historic projects attempting to do so. With the use of deep learning architecture, we demonstrated it was possible. Now we intend to stretch the state-of-the-art technology further to see if it is possible not only to detect corrosion but to grade it and predict how it will evolve over time.

Relevant Foreground IPR

The following Foreground IPR will be generated by this project:

- A subset of historic steelwork survey imagery assessed and graded by AI algorithms;
- A localised map of environment hostility to steel towers;
- A report of on the rate of deterioration by tower and grade;
- A set of labelled steelwork images by grade;
- A forecast of predicted future state for the subset of towers graded by AI.

Keen AI's corrosion assessment deep learning algorithms are relevant Background IPR.

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 project has some risk associated with the development of the AI model. An enormous amount of data is required to train the AI model and validate its operation as fit for purpose. A significant hurdle will be the forecasting capability of the algorithm which would require weather data and a lot of resourcing. 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