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 2022

Project Reference Number

NIA_UKPN0085

Project Registration

Project Title

Automated Tunnel and Shaft inspections

Project Reference Number

NIA_UKPN0085

Project Licensee(s)

UK Power Networks

Project Start

October 2022

Project Duration

1 year and 1 month

Nominated Project Contact(s)

innovation@ukpowernetworks.co.uk

Project Budget

£250,000.00

Summary

The Automated Tunnel and Shaft inspections project will develop a computer application that will compare images traditionally taken by specially trained tunnel entry authorised staff with images taken from remote surveys. These comparisons will generate automated reports allowing inspection and maintenance frequency periods to be optimised.

Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

Problem Being Solved

The current process of inspection requires many highly trained (both Health and Safety and Engineering) personnel to carry out tunnel and shaft inspections. Specific competencies and training are required for operatives to enter these very high risk confined space environments.

UK Power Networks currently spends in excess of £1m per annum inspecting and surveying tunnels and shafts.

The project will identify how automated techniques for capturing and processing inspection data can reduce the quantum of staff involved leading to subsequent cost savings and health and safety improvements including reducing the associated Health and Safety risks.

The comprehensive data capture and use of advanced analysis techniques such as machine learning to identify rate of change in condition of infrastructure and equipment in tunnels and shafts and will improve understanding of the deterioration and enable a more predictive, risk-based inspection and maintenance regime to be adopted. This in turn may offer maintenance cost reductions and better managed deterioration and monitoring.

Method(s)

A three phased approach is proposed:

• Desktop study to identify use cases; identify available technologies; and make recommendations to work with suppliers to support the research team carry out automated inspection demonstrator trials.

• Undertake trials. This may include use of lightweight automated vehicles with camera and sensor arrays, e.g. drones and tracked vehicles.

• Data analysis, interpretation of the data and peer review to confirm observations.

Arup have carried out similar innovative automated tunnel data capture projects, with UAV and ROV suppliers for other asset owners including HS1 and CERN in other sectors.

Scope

The scope of the project will involve:

• Desktop study of existing data and records;

• Formulate specification to undertake the trials;

• Formulate Method statements and risk assessments to support site trials in tunnels;

• Carry out data interpretation and analysis report;

• Use data insights to identify opportunities for risk-based intervals for inspection and maintenance;

• Produce web-based dashboard for visualisation;

• Closedown report to provide recommendations and insight into adapting proposed and existing tunnel assets to better facilitate autonomous methods; and

• Dissemination of the output and knowledge sharing to other stakeholders and DNOs.

Objective(s)

Objectives:

• To reduce the time and number of staff undertaking surveys in high risk environments;

• Undertake trials of remote survey techniques; and

• Enable condition degradation to be better understood and maintenance decisions made in a more targeted way.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

Not Applicable

Success Criteria

The project is able to demonstrate that data collected using remote surveys can be interpreted using automated processes to generate reports allowing asset managers to maintain the condition of cable tunnels.

The enhanced data allows asset managers to assess and investigate modifying existing Inspection and Maintenance frequencies for individual tunnels.

Confidence in the methods and technologies trialled to begin rollout of the enhanced processes across a wider range of tunnels as BAU.

Project Partners and External Funding

Ove Arup & Partners Limited (Arup). There is no external funding.

Potential for New Learning

The results of the project e.g. the dashboard or similar, will presented internally at civil engineering forum and team meetings.

The dashboard can be demonstrated to interested DNOs either via MS Teams or other physical events.

Scale of Project

The project will survey a high criticality cable tunnel in London. This tunnel has good historical electronic and paper-based condition records that will allow the computer application to compare images and data to automatically generate condition reports that are able to identify rate of change and interacting defects.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The project is limited to a cable tunnel in London (LPN).

Revenue Allowed for the RIIO Settlement

No revenue has been allowed for in the current RIIO settlement

Indicative Total NIA Project Expenditure

Expected total cost of project £250,000

Total Allowable NIA Expenditure £225,000

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)

The estimated savings are initially calculated to be £162k per year, and are forecast to rise to 324k per year in 2028 as utilisation of the expected benefits increase.

It is estimated that the Method may reduce the number of operatives required to carry out Inspection and maintenance costs by 50%.

Please provide a calculation of the expected benefits the Solution

Base Cost

The inspection of 162 tunnels per year including Contractor and Tunnel manager costs £632k

Method Cost

Annual running costs - Cloud, hosting and storage, Licensing of the Data collection and analysis system £100k

Benefits include:

Reduction in the number of operatives required to carry out the inspections £146k and automation of the inspection reports of £16k.

The benefits will reduce our inspection and maintenance costs.

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

Within UK Power Networks there are 47 DNO owned tunnels. This accounts for around a third of DNO owned tunnels in GB.

In addition to DNO owned cable tunnels, there are often third-party tunnels within urban centres, including tunnels owned by National Grid, local authorities and other utilities which are utilised by DNOs for power cables.

The autonomous drone and vehicle aspects are replicable within tunnels, basements, and other subterranean and confined environments.

The machine learning and asset dashboard aspects are replicable to most assets that exhibit external condition changes over time.

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

The cost of rolling out this Method would include: Cloud, hosting and storage, Licensing of the Data collection and analysis system per DNO group.

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

n/a

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

Current inspection and maintenance surveys requires specially trained tunnel entry authorised staff and additional safety teams on site ready to rescue. This Method will allow previous manually collected data to be compared with remote surveys allowing automated reports to be generated. Asset managers will be able to change fixed frequency inspection and maintenance periods.

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.

NIA_UKPN0015 Tunnel Data Capture Enhancement carried out in 2015 after the Kingsway tunnel fire trialled different types of data collection vehicles for the purpose of gaining access where otherwise not available. This project is agnostic to the method of data

capture (either aerial or ground) but focuses on the comparison of images and collation of sensor data to automate and advance the cable tunnel condition reports.

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

This project is very different in scope to the previous tunnel project as it focusses on the automated dashboard, improvements in data and machine learning - not the method of data capture.

Additional Governance And Document Upload

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

Currently tracking the condition of cable tunnels requires asset management staff to compare series of survey images before a condition report can be produced. The severity of a defect and remedial action required is largely dictated by a process of analysis of all historic data to identify the rate of change. The dashboard will compare survey images and generate automated condition reports using multiple surveys to track the rate of deterioration. An enhanced understanding of whether a tunnel is undergoing deterioration beyond what is expected will permit periods between inspections and maintenance to be varied according to risk.

Reducing (and eventually avoiding) putting people into high risk, confined tunnel environments is also an innovative way to reduce H&S risk.

Relevant Foreground IPR

The processing of data from the cameras and other sensors for this project will make use of background IP that Arup has developed from their previous projects in other sectors. The processed data will be presented in a web-based dashboard that will rely on Arup's background IPR to display enhanced data. This is commonly referred to as the 'Loupe 360 dashboard'. The demonstration of functionality such as the use of machine learning techniques will also rely on Arup's background IPR.

Data Access Details

To view UK Power Networks' Innovation Data Sharing Policy, please visit here.

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

TThis project involves the application of a technology that is not used in UK Power Networks as part of their business as usual activities. It involves research and trials and does not have certainty on its results.

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 NIA funding will enable UK Power Networks to undertake a project which has technical and operational risks associated with it, in terms of a lack of certainty on results. In addition, UK Power Networks is working with a small supplier, for which there is a degree of commercial risk should their operations be affected for economic reasons.

This project has been approved by a senior member of staff

☑ Yes