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

Dec 2022

Project Reference Number

NIA_SHET_0039

Project Registration

Project Title

OHL Foundation Uplift

Project Reference Number

NIA_SHET_0039

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

December 2022

Project Duration

2 years and 6 months

Nominated Project Contact(s)

Brant Wilson – Innovation Portfolio Manager

Project Budget

£584,307.00

Summary

This project will produce learning on improved designs for OHL tower foundations, including a better understanding of the optimal edge profile/roughness, and how this can reduce the materials/space required. It will also provide an understanding of any associated cost
savings and benefits. Preliminary work estimates that the cost savings generated by the more efficient design, per tower with pad and column foundations, could be between 5 – 10%. Average Transmission circuits have hundreds of towers which means that the average
saving per new circuit could be in excess of £1million.

Nominated Contact Email Address(es)

transmissioninnovation@sse.com

Problem Being Solved

When designing OHL tower foundations, most Transmission Operators specify the adoption of the ‘frustum method’ via the National Grid
standard TS 3.4.15 and Energy Network Association standard ENA TS 43-125. The frustrum method specified has not substantially changed
since the 1920’s and has been demonstrated, by initial work undertaken by the University of Dundee, to be, when appropriately factored,
generally over conservative and potentially underestimating foundation uplift capacity by up to 25% in some cases.
Furthermore, the adoption of the pad and column style foundation (circa 1990’s onwards) dramatically increased the size and concrete volume of foundations in return for a simpler construction. By incorporating a thick straight sided concrete pad, the depth of soil mobilised
was reduced by up to 20%, further reducing the effectiveness of the design.

Method(s)

This project will continue previous investigations by the University of Dundee into current methods used to calculate the uplift capacity of overhead line (OHL) tower foundations. The aim is to determine if there are more optimal design methods which could increase the uplift capacity of new foundations. This would allow the foundation size to be decreased which would also reduce the cost. This project will finalise the design methods and carry out appropriate lab testing. Further large-scale testing of the new design methodology will be undertaken by University of Bristol to validate project findings.

Scope

The research undertaken and proposed is under the broad heading of improvements to design and construction practice with regards to new and existing OLE foundations. Broadly the proposed new scope of works will cover:
• Development of initial investigations into improved design methodologies in clay and fine-grained soils.
• Expanded physical model testing to develop greater confidence in model and partial factors to be used with the new Giampa (2019) based foundation design approach.
• Further investigation of potential improvements to new foundation geometry to maximise uplift capacity whilst reducing material use and CO2 input.
• Further investigation of the potential to use solutions such as geogrids and ground improvement to increase the capacity of existing foundations.

The aspects highlighted above have already undergone at least preliminary investigation through numerical modelling and where beneficial effects have been noted these require further limited numerical investigation and validation of findings through scaled physical model testing to develop full design approaches and appropriate safety or partial/model factors for implementation.

Objective(s)

The objectives of the project are as follows –
• Development of improved design methodologies in clays.
• Expanded physical model testing to develop greater confidence in model and partial factors to be used with the new Giampa (2019) based foundation design approach in granular soils.
• Investigation of potential improvements to new foundation geometry to maximise uplift capacity whilst reducing material use and CO2 input.
• Investigation of the potential to use solutions such as geogrids and ground improvement to increase the capacity of existing foundations.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An assessment of distributional impacts (technical, financial and wellbeing related) for this project has been carried out using a bespoke assessment tool, which assesses the project as having a positive, negative or neutral effect on consumers in vulnerable situations. To help inform the assessment, this tool considers the categories of consumers identified in the Priority Services Register.

This project has been assessed as having a neutral impact, meaning that it does not have any effect on customers in vulnerable situations. This is because it is a transmission project.

Success Criteria

The project will be deemed as successful if all items in the scope, objectives and learnings are achieved and this will contribute to advancing industry knowledge on foundation uplift.

Project Partners and External Funding

The project will be undertaken using NIA funding by Scottish Hydro Electric Transmission and National Grid, with research being delivered by University of Dundee and University of Bristol.

Potential for New Learning

This project will produce learning on improved designs for OHL tower foundations, including a better understanding of the optimal edge profile/roughness, and how this can reduce the materials/space required. It will also provide an understanding of any associated cost
savings and benefits.
Learnings from the project will be disseminated via internal and external stakeholder event which will be conducted during the project. The learnings will also be shared within the annual project report and at relevant dissemination events such as the Energy Networks Innovation Summit.

Scale of Project

This project is designed to get maximum learning for minimal cost. Preliminary work estimates that the cost savings generated by the more efficient design, per tower with pad and column foundations, could be between 5 – 10%. Average Transmission circuits have hundreds of towers which means that the average saving per new circuit could be in excess of £1million. A smaller scale project would not allow the learning outcomes to be achieved

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The project will be undertaken in the Scottish Hydro Electric Transmission licence area in Scotland. This research project is performed in collaboration with University of Dundee where the work will be undertaken.

Revenue Allowed for the RIIO Settlement

No allowance has been made for this type of development within the RIIO-T2 settlement. No savings are expected during project implementation; future savings may be possible depending on the outcomes of the project and future adoption of the learnings.

Indicative Total NIA Project Expenditure

The total expenditure expected from the project is £584,307 split 50/50 between the licensees. 90% of which £525,876 is allowable NIA expenditure.

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 learning can facilitate energy system transition by –
• Reduction in embedded C02 and C02 expended in construction due to smaller foundation size and less concrete used.
• Reduced disruption to land as a small area is excavated.
• The potential to deliver required reinforcements at lower cost to customers.

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 analysis will endeavour to cover most aspects of the SSEN Transmission geographical area in Scotland and will assess overhead line projects due for design and construction in. Any reduction in design capability (removal of overdesign) could therefore result in significant cost saving for customers.

SSEN Transmission have 1529 OHL towers currently contracted at a pre or early design stage. OHL design is a complex process with widely varying inputs. Construction costs vary by project however indicative costs are £2.346m per km of overline line. Benefits will therefore vary by project, so assumptions have been used for the purposes of this CBA as follows;
For steel OHL, the benefits of can be realised from a reduction of foundational costs across suitable towers. The benefits below have been estimated using High, Medium and Low adoption of a reduced foundation cost applied to 50% of the towers built.

Scenario Application Benefit
High 1529 Towers @ 50% application = £10,091,250
Medium 913 Towers @ 50% application = £6,025,750
Low 273 Towers @ 50% application = £1,801,750
Subject to these assumptions, a reduction in foundation costs could result in benefits ranging from £1.3m up to £8.4m if applied to the currently contracted pre-design OHL projects in the SSEN Transmission area. Further benefits would then be realised by future projects

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

The learnings are of interest is not limited to Scottish Hydro Electric Transmission and National Grid, all transmission and distribution network operators across GB could benefit from this research work.

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

This research project is at low TRL level, consequently the costs for rolling out the method across GB network will be established as the project progresses.

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 project will publish a draft journal publication of the results from the tests, this journal will be open to review from industry experts and will inform relevant Network licensees of the results of the testing. This could lead to amendments of the current foundation standards and allow benefit realisation.

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.

To date, no other projects have been undertaken to conduct centrifuge testing and validation of new foundation design. Other GB TOs have been involved in developing the scope of work and problem statement, so it is unlikely to lead to duplication of any other 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

The project is innovative as centrifuge model testing of the new and existing foundation styles in clay has not been undertaken previously.

The testing will validate assumptions that have been made regarding foundation design. Preparation and model testing in clay soils is far more challenging than working with sands and takes significantly longer periods of time.

Relevant Foreground IPR

Any new intellectual property which are completed as part of the NIA project will be made available to other relevant networks licensees. No background IPR is required.

Data Access Details

See Strategic Innovation Fund (SIF) and Network Innovation Allowance (NIA) Data Sharing Procedure at *Innovation - SSEN Transmission (ssen-transmission.co.uk)*

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

NIA has been deemed the best method of supporting the delivery of this project. Development projects funded by NIA give suitable financial support to investigate areas for potential development that could not be funded by BAU as no allowance was made in the RIIOT2 settlement.

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

This project can only be undertaken with the support of NIA due to the overall costs and timescales required. There is significant research work that will be undertaken which has inherent risk involved with it.

This project has been approved by a senior member of staff

☑ Yes