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

Aug 2022

Project Reference Number

NIA_SHET_0038

Project Registration

Project Title

Ice Mapping

Project Reference Number

NIA_SHET_0038

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

August 2022

Project Duration

1 year and 7 months

Nominated Project Contact(s)

Tim Sammon – NIA Programme Delivery Manager

Project Budget

£359,080.00

Summary

The current values of radial ice accretion defined in BS EN 50341-2-9:2017 are regarded as conservative with little basis in modern Meteorological science, especially as applied in the North of Scotland. Application of these values may lead to overdesign of overhead lines being designed and constructed to enable the energy system transition.

This project will develop a new ice accretion model and integrate it with existing global Numerical Weather Prediction (NWP) models with high granularity topological and orographical parameters. It will thereafter use this composite model with extreme value analysis techniques to derive new values for radial ice accretion, which reflect modern meteorological practice.

The new values will be compared with BS EN 50341-2-9:2017 to assess the potential benefits of adopting a new design practice.

Nominated Contact Email Address(es)

transmissioninnovation@sse.com

Problem Being Solved

Ice Accretion has the potential to damage infrastructure and impair the performance of exposed equipment, and as a result is the subject of British and European engineering and construction standards.

All new overhead lines are designed subject to environmental loadings derived from the ice map of Figure NA.2 of BS EN 50341-2-9:2017 The map is recognised as being potentially flawed due to the:

- poor quality of the meteorological data;
- the lack of verifiable ice accretion models;
- the arbitrary categorisation of the landmass; and
- the lack of observational validation.

These deficiencies may have led to the development of radial ice values which are inaccurate and anecdotally recognised by both design and operational staff as potentially overestimated, particularly in coastal, lowland, or island environments. It is understood that this may lead to the overdesign of Transmission Overhead Lines in the North of Scotland, where many new overhead lines are required to enable the energy system transition.

Method(s)

SSEN Transmission will partner with the Met Office in this project. The Met Office will make use of the latest meteorological data sets and science to generate a high-resolution climatology of the relevant meteorological drivers for ice accretion covering the British Isles at multiple heights. Local effects of orography will also be considered to further optimise the Numerical Weather Prediction (NWP)parameters. By combining the latest state-of-the-art NWP parameters and types of mechanisms leading to ice accretion, a new ice accretion model will be developed for several overhead lines and compared to current engineering standards and practices. Potential costs and benefits of using the new design will be reported.

Scope

The development of an ice load map will be undertaken in two phases split into distinct work packages for each Phase. This approach is to enable the assessment of interim results to either prove or disprove the merits of further development of the model in finer detail. The Phases and Work Packages are as follows:

Phase 1

• Work Package 1) Discovery Phase
o Requirement's workshop
o Literature review
o Expert advice from Supplier scientists
o Technical report and Presentation
• Work Package 2) Data Retrieval
o Extract data meteorological data
o Extract engineering and observation data
o Extract case study observation data (Iceland, Deadwater Fell, Norway)
• Work Package 3) Data Processing
o Assess use of Improver wind downscaling module
o Code Review and QA
o Sense check/verification of correct grid point wind speeds
o Verification analysis
o Height and roughness corrected 4km grid point wind speed climatology capability
• Work Package 4) Ice Accretion Modelling and Validation
o Code development for wet snow, in-cloud-rime and freezing fog rime (same as in-cloud model for Phase 1
o Inspect output and determine independent icing events from time series of ice accretion model output, including occurrence of different icing events occurring at same time (take max ice load).
o Code review and QA
o Verification analysis (met input verification, case study, sense checks
o Verification Report
o 4km resolution ice accretion modelling capability. Deliverable: Report
• Work Package 5) Extreme Value Modelling
o Select events for EVA (e.g. by peak-over-though or annual max)
o Compute EVA of 1-in-50 year return ice loads
o Sensitivity analysis (on e.g. ice groupings, altitude, conductor)
o Code review and quality assurance
o Sensitivity analysis report (case study)
o 4km resolution extreme value ice loading capability. Deliverable: Report.
• Work Package 6) Mapping and Data Delivery
o Mapping of ice load results over SSEN Transmission network area
o Present results
o 50-year return ice load data packaging/delivery

Phase 2

Following a successful outcome from Phase 1 proving the validity for further developing the model, the Work Packages for Phase 2 will broadly include:

• Discovery phase
• Additional 1 in x year events
• Grid map analysis
• Additional height and asset size modelling
• Final mapping and data outputs

Objective(s)

The main objective of the project is to assess whether replacement of Figure NA.2 of BS EN 50341-2-9 with new ice design values derived from the application of state-of-the-art NWP values and revised Ice Accretion model would benefit customers.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

The primary impact of this project on consumers in vulnerable situations is its potential to reduce the cost of electricity transmission in the North of Scotland.

Success Criteria

The project will be deemed successful if the numerical outputs and new learning provide a new cost-effective and reliable alternative to current overhead line design process

Project Partners and External Funding

SSEN Transmission will partner with the Met Office to deliver Ice Mapping.
There is no external funding.

Potential for New Learning

The development of the new ice map will inherently develop new learning. Principally, this will be in the areas of ice accretion modelling, and specifically around:
• increasing the granularity of the ice map by the inclusion of topography and orography using machine learning techniques,
• critical evaluation of the current methodology for ice load calculation in BS EN 50341-2-9:2017.

The new learning will form part of the final report, which will be shared with all relevant parties and will also be presented in post-project dissemination sessions.

Scale of Project

The analysis will endeavour to cover most aspects of the SSEN Transmission geographical area in Scotland.

SSEN Transmission have 54.5km of wood pole OHL, and 27km of steel OHL currently contracted at a pre or early design stage and reducing ice accretion loading on these could result in significant cost saving for customers, as detailed in section 3.2.2.

Ice accretion loadings using the current British and European design standards are highest in the North of Scotland, where SSEN Transmissions network is located. A smaller project would not enable a consistent design approach in SSEN Transmission, and a larger project – for example, mapping the whole GB network – would risk diminishing returns. The potential for extending the new ice map will be assessed as part of the project's final report.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL6 Large Scale

Geographical Area

The project will take place in SSEN Transmission's license area in Scotland.

Revenue Allowed for the RIIO Settlement

No revenue has been allowed for this project in the RIIO-T2 settlement.

Indicative Total NIA Project Expenditure

The Total NIA Expenditure (NIAEt) for the project is £359,080. 90% (£323,172) is NIAt 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 project will assess whether, by providing more accurate and relevant weather data, a more efficient and cost-effective process could be used to design and construct overhead lines in the North of Scotland. Reducing the resultant costs associated with renewable energy transmission could assist in the SSEN Transmission RIIO-T2 business plan goal to transport the renewable electricity that powers 10 million homes, contribute to national Net-zero targets, and provide benefit to customers

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

The primary impact of this project on consumers in vulnerable situations is its potential to reduce the cost of electricity transmission in the North of Scotland.

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)

Not applicable.

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 RIIO-T2. Any reduction in design capability (removal of overdesign) could therefore result in significant cost saving for customers.

SSEN Transmission have 54.5km of wood pole OHL, and 27km of steel OHL currently contracted at a pre or early design stage.

OHL design is a complex process with widely varying inputs. Benefits and construction costs will therefore vary by project, so assumptions have been used for the purposes of this CBA as follows;

For wood pole OHL, the benefits of reduced ice loading would result in increased span.

- Raw construction cost / km = £0.3m
- Average span with existing ice loads = 80m
- Estimated average span with new ice loads = 95m
- Estimated potential cost savings /km (60% of construction cost * reduced number of structures) = £0.03m
- Estimated potential cost savings on contracted pre design wood pole OHLs 54.5km = £1.55m

For steel OHL, the benefits of reduced ice loading would primarily result in lighter structures and foundations, but only where the wind and ice weather case results in higher transverse loads than the wind weather case. Benefits and construction costs vary widely by project, so assumptions have been used as follows;

- Raw foundation and structure construction cost / km = £0.7m
- Approximate reduction in structural loads when maximum design load is wind rather than wind & ice = 25%

• Estimated potential cost savings /km (50% of construction cost * .75) = £0.09m
• Estimated potential cost savings on contracted pre-design steel OHLs 27km applied to 10% of structures = £0.24m

Subject to these assumptions, a reduction in ice accretion could result in benefits of up to £1.8m 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 Method will be relevant to Scottish weather conditions, hence how replicable it is across GB will depend on the geographical location of the other Transmission Network Licensees' systems.

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

The costs of replicating ice accretion maps for the rest of GB are not currently understood. The project will estimate the implications of a GB roll out in its final report.

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 development of the new ice accretion model will inherently develop new learning. Primarily, this will be in the areas of ice accretion modelling, potentially offering a new design basis for overhead lines. It could enable replacement of the ice map in BS EN 50341-2-9:2017.

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.

The ENA Smarter Networks portal has been checked to confirm that there is no duplication.

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

Not applicable.

Additional Governance And Document Upload

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

The application of Numerical Weather Prediction and Ice Accretion models to estimate radial ice accretion is unique within the context of the UK electricity industry.

Relevant Foreground IPR

A final report will be generated through the project process and will be made available on project completion to interested network licensees.

Data Access Details

See Network Innovation Competition (NIC) and Network Innovation Allowance (NIA) Data Sharing Procedure at https://ssen-innovation.co.uk/innovation-strategy/

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

This is a new method which is yet unproved and needs to be better developed and validated to be introduced as business as usual. There are certain risks associated with the acquisition, utilisation and the overall usefulness of the data and techniques in scope which need to be tested first. Due to the low TRL and risks associated with this project, NIA funding is the correct mechanism rather BAU delivery.

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

As noted in the NIA guidance, certain projects are speculative in nature and yield uncertain commercial returns. This is the case with this project. There is a commercial risk that the solution trialled in the project is not adopted at the end of the project. This could be because some of the assumptions around the usefulness of the data and the predicted accuracy of the revised ice map might prove incorrect. If the project is successful, it will have proven a technical and novel solution which will propose to replace Figure NA.2 of BS EN 50341-2-9, allowing the application of more accurate radial ice values within the design process.

This project has been approved by a senior member of staff

☑ Yes