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

Jul 2024

Project Reference Number

NIA2_NGET0067

Project Registration

Project Title

Investigating Coastal and Estuarine Climate Risks on Electricity Asset Management (ICECREAM)

Project Reference Number

NIA2_NGET0067

Project Licensee(s)

National Grid Electricity Transmission

Project Start

July 2024

Project Duration

1 year and 7 months

Nominated Project Contact(s)

Tinashe E Chikohora

Project Budget

£697,852.00

Summary

NGET are collaborating with leading innovators to assess how future sea level rise, increased coastal storm activity and salt marsh encroachment will affect the vulnerability of NGET assets. By bringing together expertise in flood and erosion monitoring and forecasting, the project will establish where or what assets are at risk and how or when action is likely to be required, informing risk mitigation approaches and strategies. This major advancement will be achieved through the combination of market-leading sensors, and state-of-the-art asset-scale numerical coastal flooding and erosion models to deliver actionable insights to NGET's existing geographic information system (GIS) and other applicable platforms. The project will assess climate change future risk, inform damage costs estimation, and related cost-benefit analysis of potential mitigation measures and strategies.

Nominated Contact Email Address(es)

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Problem Being Solved

NGET owns and maintains the high voltage electricity network in England and Wales with a large number of these assets located in coastal areas. Predicted sea level rises and increased coastal storm activity will make these coastal sites and assets more vulnerable in the future.

National Grid is currently facing two major challenges:

- Current Shoreline Management Plans (SMPs) indicate that many coastal and estuary sites and assets, will be at a heightened risk not only from flooding but also from coastal erosion. Sea level rises and increased storm activity are already leading to prolonged periods of flooding and accelerated erosion, which are damaging transmission assets including towers, potentially resulting in their failure, collapse or inaccessibility. There is a significant risk to tower foundations observed in coastal locations due to increased erosion and degradation of concrete footings. The expansion of salt marshes and changes to intertidal zones also increases the risk of salt deposition and the corrosion of assets.
- Projected SMP and coastal management strategies may result in changes to the coastal environment which could lead to some asset locations becoming untenable in the medium to long term.

National Grid has an obligation under its network operating license to maintain the security of supply within prescribed standards. The cost and difficulty of replacing a failed asset or rerouting complete sections of a route is a significant undertaking. Understanding the current and future risks is essential in planning which assets should be protected and which routes should be moved, and when. Moving or redirecting undersea or overland assets in order to mitigate future risks is challenging with significant costs and long timeframes. Early engagement and longer-term planning is crucial in managing these risks.

Method(s)

The project will deliver forecasts of the magnitude and extent of damage in and around assets caused by flooding and associated scour, as well as the probability of incidents occurring. Real-time actionable insights will be gained from the use of a variety of relevant sensors including:

- flood level sensors
- salinity sensors to monitor corrosion potential
- still image cameras to support visibility of flood and erosion perils
- exposure and vulnerability maps for NGET coastal assets.

The project will produce sensor and forecasting data that enables a national-scale, multi-hazard assessment of the risks posed by coastal flooding and erosion to electricity transmission assets. This will also allow an assessment of the future risk posed by climate change and provide a cost-benefit analysis of potential mitigation measures. Using these data, risk heat maps and maps of future shoreline position and salt marsh encroachment can be visualised in NGET's existing GIS.

The specified data will provide the following novel insights:

- Detailed asset-based maps to assess future hazards and their potential damage (shoreline retreat, flood inundation, scour or salt marsh encroachment), establishing which assets are at a risk and the type of reinforcement required.
- Forecasted time profiles of when severe impacts are likely to occur, the total damage costs and cost-benefit ratios, ensuring efficient and optimal mitigation response is initiated before network resilience deterioration.
- Maps of the hazards surrounding assets to assist in finding suitable new locations for vulnerable assets.
- Near-real-time alerts flooding and scour to identify assets of critical concern.

Sensor-derived near-real-time alerts and data.

These new data will provide NGET with the national-scale evidence required to prepare for and respond to future changes in sea level and storm activity, ultimately building climate resilience to transmission assets.

The monitoring and forecasting data will provide National Grid with the tools they need to prepare for and respond to future changes in sea level, storm activity and salt marsh encroachment, ultimately building climate resilience into transmission assets.

Scope

The project is seeking to identify vulnerable sites marked for relocation, not only substations but towers or tower route locations and will be delivered under seven work packages (WPs):

WP1: Future shoreline erosion
Utilise models of shoreline retreat that incorporate climate projections relating to sea level and storm activity to forecast the long-term shoreline position around assets:

- Source and process light detection and ranging (LiDAR) and other remotely sensed data for all substations and towers within 500 m of current shoreline.
- Apply climate projections at each of these asset locations.
- Forecast decadal change in shoreline position to 2100 for all substations and towers within 500 m of current shoreline.
- Validate as appropriate.
- Generate timeline of RAG status for all substations and towers within 500 m of current shoreline based on future proximity to shoreline.

WP2: Future coastal flood inundation
Simulate the future risk of asset flood inundation based on climate projections of future changes in sea level and storm activity:

- Source sea level data for all substations and towers within 500 m of current shoreline.
- Derive AEPs for all substations and towers within 500 m of current shoreline.
- Generate typical storm event curves for all substations and towers within 500 m of current shoreline.

- Apply climate projections based on UKCP18 RCP8.5 to the event curves.
- Source and process LiDAR data for all substations and towers within 500 m of current shoreline at 5 m resolution.
- Run Floodmap+ simulations.
- Generate a table to provide asset requirements feeding into WP6.

WP3: Phase 1 of monitoring asset flood inundation, scour and corrosion potential
Use market-leading connected level and salinity sensors and still image cameras to test different parameters for detecting and alerting against risks to NGET assets in near-real-time. Data and learning from WP3 will support planning for further sensor rollout (See WP6). Learnings from WP3 will provide insight into the technical requirements for further rollout.
Data from sensors will further inform modelling approaches:

- Preliminary site visits to confirm technical and consenting requirements.
- Project coordination including land ownership/management identification and liaison, permitting, H&S paperwork curation/coordination.
- Sensor installations.
- Sensor hardware delivered on a managed service basis (level monitors, still-image cameras, connected salinity sensors and/or anemometers with wind direction and speed).

WP4: Future coastal scour
Forecast the depth of scour at tower locations based on Work Package 2 projections of future changes in flood inundation:

- Source and process land cover, LiDAR, flood data for all towers within 500 m of current shoreline.
- Process climate projections at each of these tower locations.
- Forecast erosion depths at tower locations within 500 m of the current shoreline at 5 m resolution.
- Validate as appropriate.
- Generate timeline of RAG status for all towers within 500 m of current shoreline based on erosion depth within footprint.

WP5: Future salt marsh encroachment

Forecast future salt marsh encroachment at tower locations, and thus the risk of corrosion to tower legs and conductors:

- Track evolution of salt marsh shoreline at locations of all substations and towers within 500 m of current salt marsh shoreline.
- Calibrate and validate, as appropriate.
- Forecast expected salt marsh encroachment at these tower locations.
- Generate timeline of RAG status of corrosion risk for all towers within 500 m of current salt marsh shoreline based on future proximity to salt marsh.

WP6: Phase 2 rollout of monitoring asset flood inundation, scour and corrosion potential
Using learnings from WPs 1-5, scope the business as usual (BaU) rollout of sensors (nature and number of sensors and sites to be instrumented) for delivery upon project completion:

- Identify the nature and number of sensors and sites to be instrumented following project completion and as part of BaU implementation.

WP7: Cost-benefits of mitigation options
Forecast future damage costs to assets to provide a cost-benefit analysis of different mitigation strategies to identify the optimal time for reinvestment or reinforcement:

- Generate projections of estimated annual damage costs for all for all substations and towers within 500 m of current shoreline.
- Calibrate and validate outputs.
- Provide a timeline of cost-benefit ratios for different mitigation measures for all for all substations and towers within 500 m of current shoreline.
- Detail cost-benefit analysis of potential mitigation measures and strategies.

Closure: Project completion
Completion of NGET project including progress and closure reports and related activities, as required by NIA governance.

Objective(s)

Work Package 1

- Determine high-level user requirements, including:
  - Sites to be simulated based on data availability from various sources
  - Forecasting and data requirements
  - Model outputs.
- Understand the nature and availability of data from NGET.
- Forecast the long-term shoreline position at coastal assets.
- Completion of work package data documentation, summarising what was delivered, how and why, and information to support NGET in accessing the data.

Work Package 2

- Determine high-level user requirements of user.
- Understand the nature and availability of data from NGET.
- Utilise current Previsico model to simulate the future risk of asset flood inundation at coastal assets.
- Completion of work package data documentation.

Work Package 3

- Determine high-level requirements of user, including:
  - 6 proof of concept (POC) sites to be monitored
  - Sensor data requirements
  - Alert requirements
  - Data access requirements.
- Understand the nature and availability of data from NGET to inform sensors siting and consenting.
- Plan the sensor network, completing paperwork and sharing information as appropriate to facilitate acquisition of site access and installations permissions (from NGET and wider stakeholders e.g., environmental regulatory bodies, third party landowners etc.).
- Purchase sensor hardware and setup sensor dashboard for the 6 POC sites.
- Install devices at the 6 proof of concept sites and provide access to sensor dashboard.
- Provide sensor application programming interfaces (APIs) and/or datasets as appropriate.
- Complete work package data documentation.

Work Package 4

- Determine high-level requirements of user.
- Understand the nature and availability of data from NGET.
- Forecast the depth of scour at agreed tower locations based on Work Package 2 projections of future changes in flood inundation.
- Completion of work package data documentation.

Work Package 5

- Determine high-level user requirements.
- Understand the nature and availability of data from NGET.
- Track the evolution of salt marsh shorelines to forecast the future encroachment at agreed sites.
- Completion of work package data documentation.

Work Package 6

- Utilise learnings from WPs 1-3 to scope the BaU rollout of sensors.

Work Package 7

- Determine high-level user requirements.
- Forecast future damage costs to agreed assets.
- Conduct a cost-benefit analysis of different mitigation strategies.
- Completion of work package report, including forecasted future damage costs to agreed assets, and cost-benefit analysis of different mitigation strategies.

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 an overall positive impact on consumers in vulnerable situations. The assessment has identified that this project will look to enhance network resilience, least cost decision making, transmission capability and operability that will ultimately reduce exposure costs for households.

Success Criteria

The quality and performance criteria for the project's outputs and deliverables must/should satisfy essential high priority requirements for the project to be successful:

- Integrate with existing GIS systems where possible.
- Provide outputs at a number of levels of granularity ranging from individual towers to assets within defined geographical areas.
- Provide an output for operator review (e.g. mapping layer or output report).
- Provide the operator with an assessment of risk locations and associated timelines.
- Provide information and a predictive approach for projecting dates where engineering intervention may be required.
- Identify optimal intervention methods subject to risk.
- Provide risk and cost of failure data as well as cost of mitigation data.
- Incorporate potential impact of increase in saline deposition arising from expanding salt marshes.
- Facilitate a coordinated approach to interacting with other stakeholders (including the Environment Agency) regarding planning for resilience of Critical National Infrastructure (CNI).
- Provide a simple and informative output for operator review.

Project Partners and External Funding

Other networks e.g., SPEN and ESO are interested in collaborating on this project.

Potential for New Learning

- Influence of coastal hazards on critical infrastructure.
- Risk quantification for electricity transmission assets.
- Best approaches to mitigate damage and prevent outages caused by coastal hazards.
- Ability to identify regional areas most susceptible to power outages caused by coastal hazards.
- Understanding of reassurance thresholds for identifying areas at increased risk.

Scale of Project

There is great potential to scale up monitoring and forecasting to all assets, both coastal and inland. Monitoring and forecasting can be scaled up to all NGET assets to explore multi-hazard risks posed by storms. The costs in the work packages can be scaled up according to the number of assets. The current scope is limited to consideration of assets within 500 m of the current shoreline and of the current salt marsh shoreline.

The project innovators have capabilities to support full scale deployment:

- Ability to provide a long-term assessment of the future type of hazard and its potential damage to coastal assets (shoreline retreat, flood inundation, scour and salt marsh encroachment), establishing which assets are at a risk and the type of reinforcement required;
- Ability to assess when severe impacts will occur, the total damage costs and cost-benefit ratios for coastal assets, ensuring efficient and optimal mitigation response is initiated before damage impacts network resilience;
- Ability to assess the hazards surrounding assets to assist in finding suitable new locations for vulnerable assets;
- Ability to optimise operational response to coastal hazards and identify tipping points for assets of critical concern through the provision of near-real-time alerts.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The scope of work is targeting NGET coastal assets located in England and Wales. Other operators i.e., SSEN, SPEN, UKPN and NGED are interested stakeholders to the project.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£596,732.00.

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:

Use of the solution will increase the resilience of critical infrastructure, therefore reducing the likelihood of outages caused by extreme weather e.g., flooding. Operatives will require appropriate training to use the solution and visibility to documentations accepting the new methods to improve technique adoption rate. Outcomes include;

- Reduced outages, increasing the reliability of supply.
- Customers living in the vicinity could also receive risk-based alerts.
- An evidence-based approach to interacting with other stakeholders

New practices/methods facilitated by the solution in the form of data and reports will reduce the likelihood of environmental incidents. Resources will be required to train staff to adopt the new practices. Outcomes include;

- Reduced likelihood of environmental incidents associated with flooding, erosion and salt marsh encroachment.

New practices/methods facilitated by the solution in the form of data and reports will deliver more proactive maintenance. Documentation would need to be prepared to recognise the new practices as acceptable means for conducting maintenance work. Outcomes include;

- Procedures for conducting repair and maintenance work can be planned strategically, improving H&S.

Increased awareness of the project findings in operational teams would allow for adoption of learnings from the project. New policies and standards may also be required to facilitate this change. Reduced number of outages and energy service losses. This means that less NGET resource is required to manually analyse weather and asset data. Outcomes include;

- Reduced risk to the asset portfolio through an assessment of where the risk lies, why there is a risk, and when an intervention is likely to be required.
- Optimised operational response through monitoring sites on a national scale. For example, it will offer an improved regulation of substations through reduced need for flood response measures.
- An evidence-base for identifying optimal mitigation strategies, such as site protection civil works or asset re-location, through a multi-hazard assessment combined with a cost-benefit analysis.
- Informed by early warnings, mobile assets can be moved, mitigating flood impacts and losses.

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

There is a real risk of investing hundreds of millions in constructing new assets in areas where there will need to be tens of millions to keep protecting and uprating resilience.

Baseline:

- Current SMPs indicate that many coastal and estuary sites and assets, will increasingly be a heightened risk
- Coastal management strategies may result in changes to the coastal environment which could lead to some asset locations becoming untenable
- Predicted sea level rises and increased coastal storm activity will make these coastal sites and assets more vulnerable in the future
- The potential impact of uncontrolled flooding is estimated to have a high likelihood of causing £6m of damages.
- Significant investments to protect the site costs at an average of £5m to £10m for a substation flood defence.

Method:

- Identification of vulnerable sites marked for relocation and this covers not only substations but towers or tower route locations.
- The project's work package 7 insights will support the assessment of future risk and the cost-benefit analysis of potential mitigation measures and strategies.

Benefits:

- Reduction in damage to assets, (multi-hazard assessment)
- Reduction in operations costs to the network, optimal operational response
- Reduction in time taken to restore assets.
- Increase in (climate change) network resilience, optimal intervention measures.
- Improvement to security of supply.
- Understanding of risk – where, why, what & when.

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

This project is potentially applicable to all TNOs, DNOs and any other critical infrastructure network owners.

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

Similar project costs can be expected should a licensee wish to roll out the Method across their network. A licensee could expect costs in licences and rental costs on a scale depending on the number of physical sensors and data sets required.

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

- Influence of coastal hazards on critical infrastructure.
- Risk quantification for electricity transmission assets.
- Best approaches to mitigate damage, and prevent outages, caused by coastal hazards.
- Ability to identify regional areas most susceptible to power outages caused by coastal hazards.
- Understanding of reassurance thresholds for identifying areas at increased risk.

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.

NGET being the lead network and sponsor of ICECREAM have checked for scope overlaps with wider networks and their related projects like Credo and Credo+ and have confirmed scope uniqueness in terms of intended outputs or objectives.

On the contrary, the overall potential duplication checks have revealed potential complementary and data sharing opportunities.

ICECREAM outputs or methods will be shared with other TOs/DNOs and can serve as inputs at project level e.g., to CReDo+ platform in form of risk models to improve their risk assessments and mitigation analysis.

ESO have expressed supportive interest in ICECREAM and collaborations during the project delivery will keep them abreast with best practise methods involving coastal investments assets risk allocation and associated regulatory investment decision-making.

ICECREAM project came out through a problem statement that was administered and disseminated through the Energy Innovation Centre (EIC) platform and from the onset, intentional engagements to invite expectations from SSEN, SPEN and NGED were conducted.

We are therefore condident this solution has not yet been investigated or employed in the UK at an electricity transmission asset level.

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 effort is one that has not been implemented before. NGET has outsourced services and collaborated with competent suppliers whose pursuit is to eliminate the majority of flood impacts by providing actionable forecasts to those who need them. This requires continuous innovation through harnessing leading data sources and cutting-edge technology to produce quality forecasts for

those at risk of flooding, in this case coastal flooding, scour and erosion.

NGET assets are complex and interconnected with each one carrying exclusive condition and risk data.

Environmental threats are equally as complicated and there are many sophisticated data sets that represent this.

These coastal threats have a unique impact on each asset. There is no capable, market ready solution that can quantify the coastal flooding, erosion or scour threat to NGET assets.

Relevant Foreground IPR

Foreground IPR will be created from the scope and objectives above. In particular;

- Reports - supporting documentation for each work package and the closure report
- Final format data - forecast and sensor data delivered at the end of each related work package
- Data used to produce final format data- all data used to generate the final format data
- Software used in production of final format data - any new software developed to produce the final format data

The suppliers will contribute to the background IPR in terms of knowledge, knowhow, software and data relating to:

- Experience in gathering, integrating data and processing large numbers of environmental datasets.
- Comprehensive understanding of storm-related hazards.
- Experience in rainfall, erosion and flood forecasting.
- Experience in using hazard data to calculate and assess environmental risk and asset vulnerability.
- Experience in communicating and visualising environmental risk and asset vulnerability.
- Capability in numerical modelling and associated coding.
- Experience integrating data from a large number of data sources.
- Development of APIs, User Interfaces, Web application frameworks.
- Simulation and visualisation software for forecasting and assessment of hazards, economic damage, vulnerability and risk to assets posed.
- FloodMap+ simulation and visualisation software for forecasting flooding.
- Access to a sensor dashboard that supports data visualisation, alerting and device programming.
- Erosion, sediment, rainfall, runoff, salt marsh and flood simulation data.

NGET will contribute background IPR in the form of knowledge, knowhow and data relevant to its operation across the electricity transmission network in England and Wales.

The default IPR position will be applied to this project.

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 proposed solution is innovative in nature, with a component level of risk that is unsuitable to BaU implementation straightaway and thus BaU is not the appropriate funding mechanism for this 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 settles in to get support of NIA, in a fully controlled environment where there is no risk of causing network

disruptions/outages while surveys and investigations could also be safely developed.

The business case is such that it wouldn't be funded through BaU due to intrinsic operational & technical risks e.g., siting sensor in the wrong location could impose sensitivity or prevent the transmission of useable data; data needs to be validated and refined upon combining multiple data sets to avoid false positives.

Therefore, NIA, rather than BaU, is the appropriate funding mechanism for this project.

Progressing using NIA funding ensures the outcomes of the project are shared with other network licensees, allowing them to adopt similar practices.

This project has been approved by a senior member of staff

☑ Yes