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

NIA2_NGET0026

Project Registration

Project Title

Energy water nexus

Project Reference Number

NIA2_NGET0026

Project Licensee(s)

National Grid Electricity Transmission

Project Start

March 2023

Project Duration

1 year and 9 months

Nominated Project Contact(s)

Atia Adrees (box.NG.ETInnovation@nationalgrid.com)

Project Budget

£667,543.00

Summary

This project will define technology-based, temporal, and geospatial water constraints to 2050, then use whole energy systems modelling to analyse how these projections (and associated uncertainties) could impact the least cost energy system design. By representing joint probability stress events across the two sectors, this project will also use a Power Factory-based approach to quantify operational constraints faced by the electricity transmission network.

Third Party Collaborators

Energy Systems Catapult

Power Systems Consultants UK Limited

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

The UK Climate Change Risk Assessment 2017 Evidence Report identifies numerous risks to the energy sector from drought and flooding, including coastal change risks to infrastructure. In addition, studies have shown that the least cost net-zero energy systems are likely to have an increased reliance upon water-intensive technologies – such as nuclear, bioenergy, electrolysis, and CCS.

- Droughts affect the cooling of thermal power plants (SMR, AMRs), blue, grey and green hydrogen production (electrolysis 1.4 gallons of water for every pound of hydrogen) and carbon capture and storage.
- Power failures cascade onto issues for the water system.
- Growing energy demands for water transfers
- Use of pumped hydro for energy storage

- Impact of water quality on renewable resources such as hydropower

Yet water availability constraints are not considered within whole energy system designs.

Method(s)

This project will assess the implications of water constraints and the energy-related demand for water on both energy and water sectors, with subsequent focus on the potential implications for energy transmission networks.

A consortium will work to define technology-based, temporal and geospatial water constraints out to 2050 before using the whole energy systems model to analyse how these projections (and associated uncertainties) could impact least-cost energy system design and water sector resource planning. By representing joint probability stress events across the two sectors, this project will also use a Power Factory-based approach to quantify operational constraints faced by the electricity transmission network. The work will provide evidence for identifying long-term risks of climate change related to water constraints on energy systems. By understanding the risks, the project will identify innovations and opportunities that could minimise exposure to costs associated with high water constraints.

Data Quality Statement (DQS):

The project will be delivered under the NIA framework in line with OFGEM, ENA and NGET internal policy. Data produced as part of this project will be subject to quality assurance to ensure that the information produced with each deliverable is accurate to the best of our knowledge and sources of information are appropriately documented. All deliverables and project outputs will be stored on our internal SharePoint platform, ensuring backup and version management. Relevant project documentation and reports will also be made available on the ENA Smarter Networks Portal, and dissemination material will be shared with the relevant stakeholders.

Measurement Quality Statement (MQS):

The methodology used in this project will be subject to supplier's own quality assurance regime and the source of data, measurement process and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and economic assessments will also be clearly documented in the relevant deliverables and final project report and made available for review.

Risk Assessment and Audit

In line with the ENA's ENIP document, the risk rating is scored low.

TRL Steps = 1 (2 TRL step)

Cost = 2(£667,544)

Suppliers = 1 (2 suppliers)

Data Assumption = 1 (Defined assumptions and principles)

Scope

Task 1: Data development

The representation of water constraints impacting potential energy system strategy - including spatially disaggregated water availability to 2050, assessment of coastal siting constraints and definition of water consumption characteristics of energy system assets.

Task 2: Database of near term planned energy and water system developments
The database will include major energy generation, transmission, and water transmission projects that are in planning, approved and under construction. Weighting factors will be agreed and applied to those not currently in operation to represent uncertainty of completion. The technologies that are not in planning but have policy-based targets within scenarios will be considered.

Deliverable 1: (Informed by Task 1 and Task 2)

An Excel database containing all data and assumptions collated for this project, including technology water demand characteristics, technology siting locations (excluding Nuclear due to confidentiality), characteristics of peak conditions and near term planned water/energy system developments.

Task 3: Development of peak conditions

This task will encompass conditions that will impose high stress on the energy system as a function of water constraints, energy demands and weather conditions. These will be used to define test conditions to understand the impact of short-term water stress on energy system assets.

Deliverable 2: (Informed by Task 1 and Task 3)
Slide deck and presentation of significant interactions between energy and water systems, their magnitude and the approach taken to integrate within the modelling environments to be used in this project. This deliverable will also present the joint probability peak conditions developed within this work, including the method taken, descriptions of the peak conditions and initial interpretation of their significance.

Task 4: Model net zero energy system scenarios

By combining energy system scenarios with water system scenarios across different extents of climate change and water infrastructure development, assess the climate change impact on water constraints and how these constraints will affect the design and operation of low carbon energy system.

Deliverable 3: (Informed by Task 4)
Slide deck and presentation of the whole energy system modelling scenarios and the implications of water stress conditions on the electricity and gas transmission network in GB. This will present the results of whole energy system optimisation modelling and analysis with system transition pathways to 2050, the methodology and key impacts of water constraints on whole energy system design

Task 5: Analyse the impacts
Impacts on electricity transmission network reinforcements. The two scenarios with highest potential reinforcement need will be identified and further power-flow analysis will be carried out. These scenarios will be compared to a base case with no water constraints to quantify the impact on infrastructure.

Deliverable 4: (Informed by Task 5)

Slide deck and presentation of the network analysis and the implications of water stress conditions on the electricity transmission network in GB, including:

- A short list of peak snapshot conditions
- Comparison of network requirements for 2050 for a water constrained network compared to a base case
- Operational impact of peak snapshot conditions.

Task 6: Identify opportunities to innovate
Building on the analysis, identify opportunities and methods to mitigate identified risks for National Grid Electricity Transmission, alongside the wider energy and water sectors.

Deliverable 6: Final Report - The report which will include the background to the work, the methodology, the results, analysis of implications and innovation opportunities.

Objective(s)

The key objectives of this work are

- Qualitative/quantitative analysis of the implications of water constraints and the energy-related demand for water on both energy and water sectors.
- Identification of the key risks to the energy system due to water constraints and identify innovation opportunities.

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 reduce the costs for households. Other considerations including the projects impact on supply, immediate health and safety in the home have been made in carrying out this assessment.

Success Criteria

The project will be considered successful if the analysis successfully represents the impact of water constraints on energy system strategy and identifies innovation opportunities to mitigate key risks to energy system due to water constraints.

Project Partners and External Funding

National Grid Gas Transmission

Potential for New Learning

The UK Climate Change Risk Assessment 2017 Evidence Report identifies several risks to the energy sector from water resources constraints. The studies and analysis have shown that the least cost net-zero energy systems will likely have an increased reliance upon water-intensive technologies. Still, water availability constraints are not considered within the whole energy system analysis. This project will create knowledge around the impact of water resources constraints on energy system infrastructure and operation and identify opportunities to innovate to address the challenges due to water resources constraints.

The learning from this project will be disseminated via the ENA portal and through the stakeholder engagement within the project itself.

Scale of Project

This project is a desk-based research and modelling activity that will provide the transmission networks in the UK with an overview of the impact of water constraints due to climate change on the energy network's design and operation. The analysis will cover the whole of Great Britain. This is a large project. For the first time, water availability constraints will be considered in the whole system analysis to assess the impact of water resource constraints on energy system design and operation. This project has a strong steering committee comprising the National Infrastructure Commission, Climate Change Committee, Infrastructure Projects Authority, Water Resources West and Environmental agency to provide guidance and expertise to support a high-quality, credible piece of work.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

It will be desk-based research and will perform analysis on Great Britain.

Revenue Allowed for the RIIO Settlement

Not Applicable

Indicative Total NIA Project Expenditure

NGET NIA funding £464,992

NGGT NIA funding £135,798

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:

Studies have shown that the least cost net-zero energy systems are likely to have an increased reliance upon water-intensive technologies – such as nuclear, bioenergy, electrolysis, and CCS but water availability constraints are not included within whole energy system designs yet. This project will identify the critical risks to the energy system due to water availability constraints and then, for each risk, identify the innovation opportunities to mitigate them, working closely with the steering committee.

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

Not applicable

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

As this is a low TRL project no cost benefit analysis has been carried out. The project results and framework will enable us to make more robust and informed decisions for network investments.

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

This project develops a model indicating interactions between energy and water systems across the GB network.

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

Not applicable

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

☐ 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 knowledge and learning generated by the project will be equally relevant to all electricity and gas transmission networks. The project will provide qualitative/quantitative analysis of the implications of water constraints on energy system, that will help relevant licenses to make more informed decisions and explore innovations opportunities to mitigate them.

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

Not applicable

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.

A systematic search on the ENA portal and the web has been done to avoid any duplication. This is the first NIA project to explore the interactions between energy and water sector to assess the impact of water constraints on energy systems.

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

This is the first project considering water availability constraints in whole energy system analysis to identify the risks to energy system to 2050 and then highlight innovation opportunities to mitigate them. This project will be delivered in close collaboration with National Infrastructure Commission, Environmental Agency, Climate Change Committee, Infrastructure Projects Authority and Water Resources West to ensure credible and high-quality work.

Relevant Foreground IPR

Foreground IPR will be created in relation to the test results of the methodology on the NGET network. The supplier will contribute the background IPR in the area of whole system model, whilst NGET will contribute background IPR with regards to the relevant electricity

transmission domain knowledge used in the 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 nature of this research means it carries a risk that the research may be unsuccessful or identify unforeseen barriers to implementation and NGET is unable to consider research of this scale as business-as-usual

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 modelling and analysis approach used in this work is relatively new to fully understand the risks associated with the corresponding solutions. In addition, the method being explored in the project is unique and has not been used anywhere commercially. Therefore, considering the risk associated with the success of the project, NGET believes NIA funding is the best route for the project.

This project has been approved by a senior member of staff

☑ Yes