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_NGET0066

Project Registration

Project Title

Use Case & Market Development of Superconducting Technologies

Project Reference Number

NIA2_NGET0066

Project Licensee(s)

National Grid Electricity Transmission

Project Start

August 2024

Project Duration

0 years and 10 months

Nominated Project Contact(s)

Nathan Brown

Project Budget

£235,100.00

Summary

The current energy transition will require the electrification of many energy demand sources, along with a corresponding increase in low-carbon electricity generation. Estimates indicate that by 2030 the UK needs to build 5x as much new electricity transmission infrastructure as has been built in the past 30 years. High Temperature Superconductor (HTS) technology is not currently being used in HV networks across the UK. This project will seek to evaluate the feasibility of HTS technology by defining short-term and long-term use cases for overhead line (OHL) and cable systems as well as delivering a detailed plan for route to business as usual for HTS deployment.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

Achieving the energy transition will require the electrification of many energy demand sources (e.g. heating, transport and industry), along with a corresponding increase in low-carbon electricity generation. To avoid constraining this transition, significant network reinforcement is required to increase the transmission network's transfer capability, which can only be achieved with major infrastructure upgrades. Estimates indicate that by 2030 the UK needs to build 5x as much new electricity transmission infrastructure as has been built in the past 30 years. Traditional approaches to transmission network reinforcement require long lead times, primarily due to planning consents, often driven by the need for new transmission corridors and heightened scrutiny in environmentally protected areas. This risks slowing the rate of infrastructure development and impacting the energy transition. High-temperature superconducting (HTS) technologies have the potential to provide increased power transfer within existing infrastructure footprints. This could reduce the need for new transmission corridors. Furthermore, in the context of new infrastructure, their smaller footprint provides a less environmentally impacting solution which may ease the consenting process.

Method(s)

The project seeks to identify and quantify the baseline barriers to the adoption of HTS technologies, a realistic CBA for the use of HTS technologies, and looking at both the short-term and long-term viability of such technologies. The end goal is to develop a roadmap to roll out HTS technologies where viable. The work will be mainly desk-based, with a series of face-to-face meetings, with multiple stakeholders to understand the full asset lifecycle.

This project focuses on the development, deployment, and through-life management of high temperature superconductors (HTS) technology for power transmission. It aims to identify challenges associated with HTS technology and engage stakeholders to gather insights and experiences. A literature review will be conducted, covering external markets, funding, supply chain analysis, skills gaps, end-of-life considerations, and wider system barriers. Stakeholder engagement will involve interviews, data requests, and workshops to gain perspectives on HTS technology, with a workshop conducted to discuss initial findings and use case development.

The project will define short-term and long-term use cases for overhead line (OHL) and cable systems, drawing from previous HTS projects, findings from Workstream 1, and stakeholder input. Specific applications of these use cases on the GB network will be identified, considering parameters such as cable length, power, voltage, peripherals, and geographical constraints. Cost estimates for conventional and HTS network upgrade projects will be developed, including capital expenditure, development expenditure, and operational expenditure. The viability of HTS across the current and future GB network will be assessed, taking into account factors such as net-zero targets.

The project will be conducting a road mapping exercise to define a detailed route to business-as-usual (BAU) for HTS deployment. Gaps that need to be addressed before HTS rollout can occur will be identified, and the roadmap will be refined based on developed use cases and specific instances of HTS deployment. The project will deliver a comprehensive Preliminary Environmental Assessment (PEA) document, including findings, analysis, recommendations, use cases, associated costs, and cost-benefit analysis. It will also present a roadmap for HTS deployment and provide final reporting of all project results.

Scope

This project aims to provide an enhanced understanding of the transmission network infrastructure upgrade use cases for high temperature superconductors (HTS) technologies and associated cost-benefit assessments. The project is scoped into three workstreams (WSs).

WS1 - Baseline Barriers to Adoption.

- Literature Review of Assests Lifecycle
- Stakeholder Engagement

WS2 – Develop use cases & CBA

- Define Short-Term & Long-Term HTS Use Cases
- Define Costs & Develop Cost Models
- Understanding Wider Impacts

WS3 - Roadmap

- Develop HTS Roadmap
- Final Report

Objective(s)

- Develop CBA for given HTS scenarios to ascertain whether future development & investment is warranted
- Develop an increased understanding of viable short term and long term HTS use cases
- Define a route to BAU for HTS technology highlighting key actions and decision points
- Develop an in-depth understanding of HTS and share the learning with all relevant business units and networks

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An assessment of distributional impacts (technical, financial, and well-being 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 on customers in vulnerable situations. This is because it is a transmission project.

Success Criteria

- Develop a wider understanding of the impacts of HTS on the GB network
- Define short-term and long-term use cases for both HTS overhead line and cable systems
- Develop quantitative estimates for the costs involved in HTS network upgrade projects

Project Partners and External Funding

N/A

Potential for New Learning

The project will deliver reports for each of the workstreams within the overall work packages. The reports will describe the work carried out and the results that are achieved. The learning will be the CBA for HTS use cases, the viability, and the impact on GB network. This can be shared with other networks to help them understand if HTS technology would work for them.

Scale of Project

This project is planned to last 9 months.

WP1 – Kick off meeting
WP2 – Barriers to Adoption Report
WP3 – Use Cases, CBA and Carbon Assessment Report
WP4 – Planning Workshop
WP5 – Final Report
WP6 – Conclusions and Recommendations Shared

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The research work will be carried out on the premises of the supplier, Frazer Nash Consulting via a desk-based way of working. The outputs of the project will apply to GB electricity networks.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£225,100

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:

Estimates indicate that by 2030 the UK needs to build 5x as much new electricity transmission infrastructure as has been built in the past 30 years. Traditional approaches to transmission network reinforcement require long lead times, primarily due to planning consents, often driven by the need for new transmission corridors and heightened scrutiny in environmentally protected areas. This risks slowing the rate of infrastructure development and impacting the energy transition. High temperature superconducting (HTS) technologies have the potential to provide increased power transfer within existing infrastructure footprints. This could reduce the need for new transmission corridors. Furthermore, in the context of new infrastructure, their smaller footprint provides a less environmentally impacting solution which may ease the consenting process.

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 project is developing a CBA for certain HTS use cases. Some of the wider benefits we anticipate from this project will be economic and environmental costs associated with HTS. Also, to have a better understanding of any currently missing skills required to facilitate the successful deployment of HTS. This project also aims to provide a structured approach to rolling out HTS.

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

This technology has the potential to be used by all UK-based transmission & distribution companies.

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

It is not possible at this stage to provide a figure. The costs of rolling the new method out would depend on how individual asset owners decide to incorporate them across their networks.

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

Results will be shared with all licensees; however, NGET will focus on transmission assets for this project. It will be the responsibility of others to determine the extent to which the assessed technologies might be directly applicable.

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 is unaware of similar projects being undertaken and as part of the NIA approval process no other networks have made us aware of projects that might result in duplication. NGET has submitted a SIF alpha application that is looking at the standards involved for HTS. We are being intentional and deliberate in both, ensuring they are complimentary and hope both will support a future SIF Beta application. After researching the ENA portal there was a previous project that finished in June 2018. It was concluded that currently, superconducting solutions are significantly more expensive than conventional solutions and for this reason a demonstration project is not recommended. However, it is estimated that the costs for superconducting technologies are falling, and therefore a trial could be in the coming years. This new NIA project will complement the SIF alpha project and provide insight should a SIF beta project be launched.

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

High temperature superconductor (HTS) technology is considered innovative due to several key factors:

- Zero Resistance at Higher Temperatures: Unlike conventional superconductors that require extremely low temperatures to exhibit zero resistance, HTS materials can achieve superconductivity at relatively higher temperatures. This breakthrough allows for more practical and accessible applications of superconductivity in various industries.
- Enhanced Power Transmission and Efficiency: HTS materials have the ability to carry significantly higher current densities compared to traditional conductors. This increased capacity enables more efficient power transmission, reducing energy losses and improving the overall efficiency of electrical systems.
- Compact and Lightweight Design: HTS-based devices, such as transformers and generators, can be more compact and lightweight compared to conventional counterparts. This feature allows for easier installation, reduced space requirements, and increased flexibility in system design.
- Integration with Renewable Energy: HTS technology offers the potential to enhance the integration of renewable energy sources, such as wind and solar, into the electrical grid. By enabling efficient power transmission over long distances and mitigating the intermittency challenges of renewable generation, HTS can support the growth of clean energy systems.
- Advanced Applications: HTS technology opens up possibilities for advanced applications in various fields, including medicine, transportation, and scientific research. For example, HTS magnets can enable more powerful and compact MRI machines, while HTS cables can offer efficient and high-capacity power delivery for electric vehicles.

Overall, HTS technology represents a significant advancement in superconductivity, offering improved performance, efficiency, and versatility compared to conventional materials. Its innovative properties and potential applications make it an exciting area of research and development.

Relevant Foreground IPR

The foreground IPR will be the results of the barriers to adoption report, use cases, CBA and carbon assessment report, and the final report.

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

There are technical risks associated with any innovation project as the proposed solution may not work. The project is anticipated to generate a better understanding and benefit to justify the expenditure. This technology is currently not proven in GB.

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

NIA funding is appropriate as it enables NGET to access learning about new technologies for HTS more quickly than if the market were to explore this potential use case. Without the project it is unlikely that any of the innovation suppliers involved would explore it and the improvements would not become available. HTS is a low TRL technology in many use cases and therefore a high risk and unknown if it will be successful at this stage which warrants innovation NIA spending.

This project has been approved by a senior member of staff

☑ Yes