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 2024

Project Reference Number

NIA_NGT0248

Project Registration

Project Title

Electric Drive Opportunities for Hydrogen Compression

Project Reference Number

NIA_NGT0248

Project Licensee(s)

National Gas Transmission PLC

Project Start

November 2024

Project Duration

0 years and 11 months

Nominated Project Contact(s)

Matthew Hammond, box.GT.innovation@nationalgas.com

Project Budget

£439,665.00

Summary

Compression is a key part of operating the National Transmission System (NTS) for natural gas, providing the flows and pressures required to meet demand. As the NTS is converted to hydrogen, compression solutions will be required for both 100% hydrogen and blends of hydrogen in natural gas. It is expected that green hydrogen production rates will vary and therefore variable blends will be seen on the network.

This project will investigate the opportunity for electric drive solutions for managing variable hydrogen blends as well as 100% hydrogen. The project will determine the impact of hydrogen on existing electric drive compression units and assess the opportunity for replacing gas turbines on NTS compressor sites with variable speed electric drive solutions which could be powered by renewable electricity while gas turbines are used as redundancy.

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

The majority of compressors on the National Transmission System (NTS) utilise gas turbines to drive the compressor unit. The gas turbines use natural gas as a fuel producing carbon dioxide. Electric drive systems are used to drive compressors and do not produce any direct CO2 emissions. However, replacing all NTS compression systems with electric drive would be costly. This project looks at the case for strategically replacing gas turbine units for electric drive to realise emissions reductions with a focus on hydrogen and hydrogen blend compression for future network operation.

The introduction of hydrogen into the NTS will drastically change compression requirements. The higher the amount of hydrogen in the

pipeline the more power is required to achieve the same level of compression. Additionally, the fuel gas make up would also change with changing blends, meaning gas turbine systems would be difficult to manage. Electric variable speed drive solutions exist which allow flexible speed and power from the same unit. There is an opportunity for electric variable speed drive (VSD) to be deployed to manage variable blend compression.

Method(s)

The project will include an assessment of the impact of hydrogen on current electric drive units on the NTS. The NTS currently utilises a small number of electric drive systems which will provide useful information and establish a baseline for the rest of the project. This will involve data gathering and sharing and an assessment exercise focusing on operational, materials and safety impact.

The next phase will be a technology review and assessment of available technologies for electric drive compression of hydrogen with a focus on variable compression by engaging Original Equipment Manufacturers (OEMs). This will lead to a review of NTS compression and where electric drive systems could be strategically deployed to reduce emissions and manage variable blends. This will also include a business case for the deployment of new systems.

Conceptual design replacements will be undertaken which will look at the technical, safety and economic case for replacing an existing electric drive and existing gas turbine unit with a variable speed system capable of variable compression. This will also include a conceptual design for the FutureGrid Compression test facility.

The project will result in a technical report summarising the work undertaken and the outputs including business case and cost benefit analysis.

Measurement Quality Statement

The measurement approach used to meet Data Quality objectives will be through the identification of high calibre project partners who are experts in their given field. The methodology used in this project will be subject to our supplier's own ISO 9001 certified 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.

Data Quality Statement (DQS)

The project will be delivered under the NIA framework in line with the agreed Energy Networks Innovation Process document and NGT internal policies. 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.

Scope

The project is split into four work packages detailed below:

Work Package 1 – Impact of Hydrogen on NTS Electric Drive Systems

This work package will determine the impact that hydrogen blends and 100% hydrogen have on existing electric drive units on the NTS. Key activities include:

- Data capture
- Operational impact, materials impact
- Policies and procedures review (gap analysis)
- Safety considerations (Hazardous Areas, ATEX/DSEAR etc.)

Work Package 2 – Electric Drive Solutions for Hydrogen Compression

This work package will assess the options for electric drive solutions for hydrogen, including upgrading existing units where possible and new technologies which could be deployed. Consideration should be made to any technologies that allow for both natural gas and hydrogen duty to save costs in the long term.

Conceptual designs for upgrade works/new units will be developed to demonstrate how upgrades/new units would be installed on a compressor station.

Key activities include:

- Use of existing units for hydrogen compression – limitations, uprating, upgrading etc.
- Technology review of new electric drive solutions for hydrogen compression
- Concept for upgrading an existing unit
- Concept for replacing an existing unit
- FutureGrid testing opportunity

Work Package 3 – Electric Drive Compression Strategy for the NTS

NGT have an Asset Strategy and Compressor Asset Management Plan (C-AMP). Asset Strategy includes the decarbonisation of the compressor fleet and has looked at electrification as a possible solution for natural gas compression. This work package should review current Asset Strategy and feed into the C-AMP with potential investments suitable for hydrogen and hydrogen blend compression.

Key activities include:

- Current Asset Strategy review and benchmark against other TSOs approaches
- How compressor fleet could be configured with a mixture of gas turbines and electric motors
- How compression would be managed for blends/100% hydrogen with a theoretical mix of GTs/electric motors
- Business case development for strategic deployment of electric drive compression for blends/Project Union

Work Package 5 – Reporting

Key activities include:

- Technical report detailing project findings, including CBA
- Technical summary
- ENA Closure Report

Objective(s)

The objectives of this project are:

- Assess the impact of hydrogen blends on existing electric drive units, including the impact on compression and cooling systems.
- Review technology available to upgrade existing units for hydrogen duty
- Review available electric drive compression technology for hydrogen duty
- Develop a conceptual design for upgrades of existing units to ensure hydrogen compatibility
- Develop a conceptual design for replacement of existing electric drive/gas turbine units with new hydrogen compression units

- Assess the opportunity for replacing gas turbines with electric drive systems on the network.
- Develop a compressor strategy for NGT for the deployment of electric drive units for hydrogen compression.
- Determine the opportunity for testing a variable speed drive system at the FutureGrid facility.
- Inform NGT Asset Strategy and Compressor Asset Management Plan teams of findings

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 on customers in vulnerable situations. This is because it is a transmission project.

Success Criteria

The following key criteria need to be met for the project to be considered successful:

- Objectives met to time and cost.
- NGT gain an understanding on the impact of hydrogen on existing electric drive compression units
- NGT gain an understanding of possible modifications to existing units and new solutions for electric drive hydrogen compression
- A strategy is developed considering how electric drive compression could play a part in the future of the NTS

Project Partners and External Funding

Lead Network: National Gas Transmission plc

Supplier: Genesis

Potential for New Learning

The project will provide the parties with an understanding of the impact of hydrogen on electric drive compressor units, the best available technology for variable hydrogen compression and the benefits for replacing gas turbine units, including the technical requirements and economic assessment.

The findings from the project will be uploaded to the ENA Smarter Networks portal and will be shared internally via a project stakeholder group.

Scale of Project

The project will involve desktop research drawing on hydrogen and compression expertise of Genesis. Compressors are key assets for the NTS and knowledge of the impact of hydrogen and subsequent solutions or changes to be made will be useful in enabling hydrogen blends and Project Union. The strategic element of the project will demonstrate the benefits of electric drive solutions for hydrogen compression and how this should tie in with NGT's existing strategies for RIIO-3 and beyond.

Technology Readiness at Start

TRL1 Basic Principles

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

United Kingdom – Warwick, Aberdeen

Revenue Allowed for the RIIO Settlement

None – hydrogen focused innovation project.

Indicative Total NIA Project Expenditure

Total project cost: £439,666.67

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 provide insight into how hydrogen in the NTS will affect electric drive compression systems, as well as what technology is available to manage variable hydrogen blend compression. A cost benefit analysis of deploying electric drive solutions will be produced. Additionally the environmental benefits of replacing gas turbine with electric drive will be assessed. Compression will be key for operating hydrogen networks, so NGT need to understand the impact of hydrogen on existing compression assets, new technologies to support hydrogen compression, and an appropriate strategy for compression.

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

Although this project does not directly affect vulnerable consumers the energy transition may and as such, we must consider the effect of the work we are doing through the NIA funding. The National Transmission System (NTS) is a key UK infrastructure for the transport of Gas to consumers, including those considered vulnerable. In a scenario where hydrogen replaces methane as a household heat source, it is essential the vulnerable are not excluded by virtue of fuel inaccessibility. In cases where vulnerable consumers already utilise gas it is likely that in a net zero future the optimum option is to provide a consistent energy solution. The transition to hydrogen within the NTS provides continuity of access to the vulnerable of hydrogen as a replacement to methane, with ongoing benefits of efficiency and economy of scale within a closely regulated environment. Ensuring robust NTS assets and consistent hydrogen production options will support the transition of the NTS to hydrogen which in turn supports the availability of gas to the vulnerable.

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

Value tracking

	Data Point	Data Point Definition
Maturity	TRL2-3	The project will focus on commercially available or emerging technologies some of which may not have previously been applied to transmission systems.
Opportunity	100% of single asset class	The project can be applied to all compressor units on the NTS.
Deployment costs	-	Deployment costs are not known at the start of the project but will be defined throughout the project.
Innovation cost	£439,666.67	The cost includes desktop research, technology reviews, stakeholder engagement, vendor engagement and strategy development.
Financial Saving	-	Any financial savings are not known at the start of the project. Savings may

be realised if electric drive units will not need to be replaced for hydrogen duty.

Safety - Safety will be considered for the deployment of electric drive solutions on current compressor stations. The introduction of these units may result in additional safety measures.

Environment - Gas turbine units produce carbon dioxide through combustion of natural gas. Should a number of turbines be replaced with electric drive units, this will reduce emissions. Potential emissions savings will be determined during the project.

Compliance Support compliance The potential emissions reductions could help National Gas meet the Medium Combustions Plant Directive and emissions targets.

Skills & Competencies Individuals The project will inform individuals who are directly involved.

Future proof Supports business strategy The project will help enable hydrogen in the NTS and support the energy transition

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

The findings from the project could be applied to any compressor unit in the UK. There are over 70 compressor units across 24 sites on the NTS. Distribution networks do not utilise compression.

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

At the start of the project the roll out costs are not known. A new gas turbine driven compressor costs around £60m per unit, therefore efforts are ongoing to repurpose existing units. This project will support the case for repurposing electric drive compressor units for hydrogen. The business case and cost benefit analysis of electric drive systems is a deliverable of the project, therefore roll out costs will be known at the end of the project.

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

This project focuses on compression systems which gas distribution networks do not utilise. However, the project learnings will inform National Gas Transmission's Compressor Strategy, which will also inform the gas distribution networks who rely on compression

systems today to increase linepack storage, which will become increasingly important for hydrogen networks.

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.

There will be no duplication of activities done as part of this program. This project will address a gap in National Gas' ongoing innovation work looking at repurposing compression assets.

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 will determine the impact of hydrogen on existing electric drive units for compression, which has not been investigated previously. A technology review of electric drive systems for transmission network compression will be carried out. This work is a counterfactual to the ongoing work looking into repurposing gas turbine systems. Electric drive systems could provide an opportunity to manage variable hydrogen blend compression and reduce emissions from gas turbines whilst they are still utilising natural gas or natural gas blended with hydrogen from the NTS as a fuel gas.

Relevant Foreground IPR

This project will not result in any new Foreground IPR.

Data Access Details

Details on how network or consumption data arising in the course of an NIA funded project can be requested by interested parties, and the terms on which such data will be made available by National Gas can be found in our publicly available "Data sharing policy relating to NIA projects" at www.nationalgas.com/gasinnovation. National Gas data access is managed IAW provisions under 2.15-2.18 for the current NIA Governance Document.

National Gas already publishes much of the data arising from our NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Data Quality Statement (DQS):

The project will be delivered under the NIA framework in line with the agreed Energy Networks Innovation Process document NGT internal policies. 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 our supplier's own ISO 9001 certified 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.

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

Hydrogen is not currently present in the NTS and therefore current compression systems do not have to be capable of hydrogen compression. Hydrogen is being directed as a future energy solution but RIIO-2 business funding does not allow the development of hydrogen ready solutions and therefore this project cannot be undertaken as part of BAU activities.

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 impact of hydrogen on current electric drive systems and available technologies for hydrogen compression have not previously been investigated, therefore early stage research and assessments will carry additional exposure to risk. The NIA funding reduces this exposure to risk.

This project has been approved by a senior member of staff

☑ Yes