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

Jun 2014

Project Reference Number

NIA_NGGT0058

Project Registration

Project Title

Variable Envelope Compressor Economic Study (VECES)

Project Reference Number

NIA_NGGT0058

Project Licensee(s)

National Gas Transmission PLC

Project Start

August 2014

Project Duration

1 year and 4 months

Nominated Project Contact(s)

Dominic Feenan, box.GT.innovation@nationalgrid.com

Project Budget

£48,000.00

Summary

When compressors are installed, their size and configuration are based on analysis of the network at that time using current and future gas supply and demand information received from the gas market. Inevitably, as the many factors involved in that analysis change, this means that what was appropriate during installation may not be ideal many years later.

Preceding Projects

NIA_NGGT0020 - Variable Envelope Compressors

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

The flow of gas on the Gas Transmission System is facilitated by a fleet of 71 compressors at 24 compressor sites. Placed across the country, these compressors move the gas from entry points to exit points on the gas network - and ultimately to customers' homes and businesses.

The Gas Transmission System was originally designed for stable, 1 in 20 year forecast peak demand. Gas generally entered the Gas Transmission System from stable, predictable supplies like the UK Continental Shelf (UKCS commonly referred to as North Sea gas). Declining UKCS supplies in recent years coupled with continued gas demand has seen the introduction of new supplies located in more southerly areas of the system, such as Liquefied Natural Gas (LNG) import terminals, causing flow patterns to change significantly. Into the future, new storage sites are expected to be developed together with new interconnector routes between other European countries and the UK, and possibly new sources of gas within the UK, such as shale gas.

As North Sea gas sources contribute less, and LNG sources (importing in South Wales and the South East of England) contribute more, compressors which had previously experienced relatively stable operation are now experiencing frequent and significant changes in duty.

New demands of flexibility are being placed on the network and these impacts are expected to increase over the next two or three decades as we progress further to a low carbon energy sector. Fast response gas fired power stations are set to become the flexible generation source to cope with wind intermittency and peak demand. Fast electricity generation responses are likely to cause large, frequent and rapid fluctuations in gas demand, with these changes being met by diverse supplies connected to the Gas Transmission System.

There is an ever-increasing requirement for short duration reconfiguration of the Gas Transmission System. This is likely to lead to a growing number of compressors operating in inefficient areas of, or even outside, their design envelope for an increasing amount of time.

Much of this resilience requirement could be met by compressors that are more inherently flexible. Previous projects have identified that the technology to introduce variable envelope technology is feasible; this project wants to investigate the economic feasibility of such technology to inform investment decisions going forward.

Method(s)

Stage 1 – Visit and interview the operators of the two facilities that operate variable envelope centrifugal compressors on natural gas systems. These visits and interviews will identify the economic as well as the technical reasons for installing the technology as well as establishing first hand experience of constructing, operating and maintaining the technology.

Stage 2 – Using the planned construction project at either Huntingdon or Peterborough as a case study, establish what economic benefits could be gained if this technology was employed on National Grid facilities.

Scope

When compressors are installed, their size and configuration are based on analysis of the network at that time using current and future gas supply and demand information received from the gas market. Inevitably, as the many factors involved in that analysis change, this means that what was appropriate during installation may not be ideal many years later.

To ensure that a compressor continues to operate efficiently and within its envelope, against a backdrop of changing supply and demand patterns, National Grid's adopts the following strategies:

1. **Changing the network conditions**. One tool that could be used, where a compressor supports export from a supply terminal, is the use of locational energy trades. Locational energy trades may be used to manage short term issues by increasing or reducing nominations at Entry and Exit Points by buying gas into, or selling gas out of, Gas Transmission System linepack. This impacts on customer behaviour and is an intervention in normal market operations.
2. **Reconfiguring the network.** Where possible, for example, using a nearby compressor station can reduce the requested duty on the affected one. This is usually only feasible with compressors that are not in line on the transmission network; and where this is possible, only a portion of one compressor station duty can usually be taken up by a different compressor station.
3. **Re-wheeling the Compressor.** This involves carrying out mechanical modifications to the compressor components in order to alter its capability.
4. **Introducing a new compressor train (i.e. a new compressor plus drive components).** This involves designing a new compressor train because the new throughput requirement of the compressor is associated with significantly different power requirements such that a new driver which is adequately matched to the new compressor is required.

These options are all used within the Gas Transmission System to manage network constraints depending on the severity, response time, cost versus risk, impact and resilience. The relative merits of each suggest that a solution which provides a low cost, low risk, and quick response is needed to manage changing system constraints. Using Variable Envelope Compressors to vary compressor capability could provide such a solution.

Objective(s)

Establish if there is a substantial economic business case for utilising Variable Envelope Compressors on the UK Gas Transmission System.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

This project will:

- Obtain the working knowledge of the operators of the two facilities that operate variable envelope centrifugal compressors on natural gas systems. This will identify the economic as well as the technical reasons for installing the technology as well as establishing first hand experience of constructing, operating and maintaining the technology.
- Use the planned construction project at either Huntingdon or Peterborough as a case study and establish what economic benefits could be gained if this technology was employed on National Grid facilities.

The project has been broken down into two high level stages. If following the meetings with the operators the viability of variable envelope compressor in terms of financial and/or technical is not proven or has realisable potential the project will be halted.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

If this project is successful the use of Variable Envelope Compressors on the Gas Transmission System will be investigated further. If the overall project is feasible this technology could be rolled out on all future compressor replacement and new build projects.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The majority of this project will be desk based but visits to Canada and Slovakia will be required to visit the operators of this equipment.

If fully successful this technology could be employed across all UK Gas Transmission new builds of compressor stations with the potential for investigation into retrospective installation feasibility.

Revenue Allowed for the RIIO Settlement

None.

Indicative Total NIA Project Expenditure

For the stages described and current scope of the project the total project cost is estimated at £48,000 covered by NIA funding.

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:

n/a

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)

The cost benefits of introducing this technology are to be confirmed as part of this project. If building of one new compressor unit could be avoided this would result in a savings in the region of £35 million.

Please provide a calculation of the expected benefits the Solution

N/A - At this stage, this project is a research project.

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

This new technology, if fully successful, could be rolled out to all of the Gas Transmission compressor construction projects.

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

The cost of the technology is to be determined as part of this 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

If the technology is viable the learning could be used by all Gas Transmission operators who have natural gas compressors. Currently this is National Grid Gas Transmission only for the UK.

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

This project will deal with one of the Strategic challenges National Grid Gas Transmission faces and will be assigned to the Strategic theme.

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

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.

n/a

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

n/a

Relevant Foreground IPR

n/a

Data Access Details

n/a

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

n/a

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

n/a

This project has been approved by a senior member of staff

☑ Yes