national gas transmission

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

Jan 2014

Project Reference Number

NIA_NGGT0020

Project Registration

Project Title

Variable Envelope Compressors

Project Reference Number

NIA_NGGT0020

Project Licensee(s)

National Gas Transmission PLC

Project Start

December 2012

Project Duration

1 year and 10 months

Nominated Project Contact(s)

Owen Ariyo (box.GT.innovation@nationalgrid.com)

Project Budget

£140,000.00

Summary

Pipeline compressors can be put in two categories based on their prime movers; gas turbine driven and electric driven. The gas turbine driven compressor comprises a gas turbine prime mover, the gas turbine, which drives a de-coupled power turbine and process compressor (the “gas compressor”). The electric driven compressor comprises a variable speed electric motor directly coupled to the gas compressor.

National Grid’s fleet of gas compressor trains feature predominantly single stage, centrifugal compressors that do not include any additional technology for varying the envelope of operation besides speed control. Compressors are designed to operate within limits known as the “envelope” of operation. When gas flows are stable or predictable, they operate comfortable within these limits. The National Transmission System (NTS) has begun seeing increasing short term changes in gas supply and demand patterns. Hence, some compressors due to their location on the NTS frequently operate around those limits.

A requirement for the gas compressor to operate around or outside one or more of its limits has traditionally been met by either a re-wheel (changing out the compressor impeller) or by installing a more adequately sized machine (driver plus compressor). Requirements for compressor unit re-wheels have been identified in a few NTS compressor stations in recent years. However, due to the high capital cost, equipment downtime required and the risk posed by supply / demand volatility few gas compressors have undergone re-wheeling.

The consequence of running the compressor around the limits of its envelope is highly unstable or inefficient operation in which could result in:

- Increased fuel utilization
- Reduced Machine Life due to vibration

- Increased risk of equipment breakdown

- Difficulty in commissioning and operating new compressor installations.

This research and feasibility project investigates the technical and commercial feasibility of installing gas compressors which are capable of varying their performance envelopes to allow efficient and stable operation in response to swings in gas supply and demand.

Third Party Collaborators

Frazer-Nash Consultancy

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

Currently if a compressor operating on National Grid's gas pipeline network is required to operate outside its boundaries this can either be met by a re-wheel (changing out the compressor impeller) or by installing a more adequately sized machine (driver plus compressor). Both options are high capital cost, involve equipment downtime required and pose a risk associated by supply / demand volatility.

Method(s)

The project is comprised of two key parts:

1. Research methods for varying the performance envelope of centrifugal compressors. Including technology readiness, mechanical design, and engaging the original equipment manufacturers (OEMs).
2. Establish feasibility of applying methods and identify a viable candidate compressor train to trial the technology.

Scope

Pipeline compressors can be put in two categories based on their prime movers; gas turbine driven and electric driven. The gas turbine driven compressor comprises a gas turbine prime mover, the gas turbine, which drives a de-coupled power turbine and process compressor (the "gas compressor"). The electric driven compressor comprises a variable speed electric motor directly coupled to the gas compressor.

National Grid's fleet of gas compressor trains feature predominantly single stage, centrifugal compressors that do not include any additional technology for varying the envelope of operation besides speed control.

Compressors are designed to operate within limits known as the "envelope" of operation. When gas flows are stable or predictable, they operate comfortable within these limits. The National Transmission System (NTS) has begun seeing increasing short term changes in gas supply and demand patterns. Hence, some compressors due to their location on the NTS frequently operate around those limits.

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The consequence of running the compressor around the limits of its envelope is highly unstable or inefficient operation in which could result in:

1. Increased fuel utilization
2. Reduced Machine Life due to vibration.
3. Increased risk of equipment breakdown.
4. Difficulty in commissioning and operating new compressor installations.

This research and feasibility project investigates the technical and commercial feasibility of installing gas compressors which are capable of varying their performance envelopes to allow efficient and stable operation in response to swings in gas supply and

demand.

Objective(s)

The focus of this research project is to investigate methods for varying the performance envelope of centrifugal compressors, primarily adjustable inlet guide vanes.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

An assessment of suitable solutions for increasing the “envelope” of operation which could be feasibly applied to compressors on National Grid’s fleet.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The two stages of this project -research methods for varying the performance and establish the feasibility of applying methods are designed to investigate a broad range of potential solutions of the fleet of NTS compressors.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL6 Large Scale

Geographical Area

The project will be largely desk based at this stage with access to compressor sites as required.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

IFI - £91k
NIA - £49k

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)

Anticipated benefits include:

1. Reduced fuel cost (from reduced energy consumption and overhaul / maintenance) as compressors operate more efficiently over a wider envelope. Using Hatton compressor (3 x gas turbine driven compressors) operation between 2009 – 2011 operation as a test case the cost benefits of installing variable envelope technology can be illustrated:
2. Increased machine life (from reduced requirement for repair, overhaul and maintenance). When the compressor is operated for prolonged periods in choke this leads to machine vibration which can be reflected to connecting pipework causing early fatigue failure in both machine and pipework. An added benefit from ability to operate over a wider range is the use of single machines instead of two machines in parallel, over a wide range of gas process conditions. The benefit is reflected in increased machine life. Since major compressor train component overhauls are carried out at 25,000 life-hour intervals, this has the potential to increase the time-between-overhauls.
3. Capital cost savings due to avoidance of requirement for compressor re-wheel.
    - The cost of a compressor re-wheel based on estimates in NTS Planning Guidelines and known historical cost data is ~ £1.3m per wheel
    - Timescales quoted by service providers for carrying out one compressor re-wheel is usually four weeks in total with a requirement for two National Grid technicians supporting the work
4. Increased unit / station flexibility as compressors would be used effectively and reliably over a wider range of gas process requirements including commissioning of new compression units.

Please provide a calculation of the expected benefits the Solution

Base Cost - It costs approximately £1.35m to re-wheel a compressor. To re-wheel each compressor units three times costs £8.1m.

Method Cost – Estimated cost and install of identified variable technology assumed to be £1.5m per retrofit unit. Adding on the requirement to conduct one re-wheel per compressor gives a method cost of £5.7m.

Estimated cost savings due to avoidance of re-wheel and install of identified variable technology - £2.4m

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

The project is looking for solutions appropriate to the NTS compressor fleet.

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

This research and feasibility study will review existing technology and fitness for purpose on National Grid's gas compressor fleet. Therefore the full implication of rolling out new technology can not be accurately quantified; estimated roll out at £1.5m per unit.

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

Learning will be used to inform asset investment decisions going forward. National Grid Gas Transmission is the only licensee operating this type of machinery.

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 fits within Capacity and Capability under the Reliability 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