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

Feb 2016

Project Reference Number

NIA_NGGT0087

Project Registration

Project Title

Selective Catalytic Reduction (SCR) Pre-FEED Environmental and Technical Study

Project Reference Number

NIA_NGGT0087

Project Licensee(s)

National Gas Transmission PLC

Project Start

February 2016

Project Duration

1 year and 1 month

Nominated Project Contact(s)

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Project Budget

£647,500.00

Summary

The entire existing fleet of standard Rolls-Royce RB211 and Rolls-Royce Avon gas turbine driven compressors will ultimately be non-compliant with tightening environmental emissions standards without accepting derogations severely restricting running hours or restricting operating life (‘emergency 500 hours use’ or ‘limited life derogation’).

National Grid has sought, in general, to address the issue of environmental improvements through the installation of new electric Variable Speed Drive (VSD) compressor equipment or new Dry Low Emission (DLE) gas turbine drivers. These two technologies have been generically identified as BAT for the gas transmission system for some 10 years, in agreement with the UK environmental regulators. Retrofitting of DLE systems to existing turbines may not be viable because of the age of the assets (up to 40 years) and other alternative emissions control techniques, such as water or steam injection, are periodically reviewed (most recently in 2015) and have limited applicability and potentially introduce a number of operational difficulties.

The use of catalytic technologies for new build gas turbines has previously been considered and rejected as a candidate BAT option for mainstream applications as they are largely unproven in gas transmission applications and do not offer the potential for realising the wider benefits that can be achieved when installing new compressor machinery train (e.g. increased operating efficiency and better compressor matching to site duty).

However, given the cost challenges imposed on National Grid through the RIIO process and scale of the challenge to meet emissions targets, National Grid recognised that catalytic technologies needed to be reviewed again as a potentially cost effective and emissions compliant retrofit option.

Other European Transmission Network Operators (TNOs) have commenced pilot projects to trial catalytic

reduction technologies, and National Grid has commenced its own innovative project to install an oxidation catalyst system for carbon monoxide (CO) control at the Aylesbury compressor station.

The BREF author's position on catalytic control techniques for mechanical drive gas turbine applications is less clear; there remain a number of challenges to address, in particular relating to the variable load and exhaust temperatures which typify gas transmission operations.

In light of the findings of initial studies carried out by GTAM, the potential environmental benefits which could be realised from an SCR solution, when combined with a potentially lower project cost compared to new build, would indicate that SCR could be a candidate BAT option in some circumstances. It is thus appropriate to consider detailed engineering and environmental assessment to confirm, or otherwise, its potential viability for implementation. However, there is at present insufficient information to address the remaining uncertainties and further study is required.

Third Party Collaborators

AAF International

Costain

Nominated Contact Email Address(es)

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Problem Being Solved

Tightening environmental legislation* means that existing RB211 and Avon gas turbine compressors will be non-compliant without restrictions on running hours or operating life. Recent environmental improvements implemented across the fleet have generally used electric compressors or Dry Low Emission (DLE) gas turbine drivers. Alternative emissions control techniques, e.g catalyst systems have previously been considered and rejected as unproven by GTAM.

Stakeholder feedback, OFGEM funding restrictions, the Aylesbury upgrade and experience of other European gas TNOs have required this position to be re-evaluated. Recent re-assessment of Selective Catalytic Reduction (SCR) following the principles of Best Available Techniques (BAT) suggests SCR may be a viable option for retrofitting to control oxides of nitrogen (NOx) emissions, but:

- SCR for gas transmission remains unproven, a small number of pilot schemes are being tested in Europe.
- SCR has not been considered against National Grid's engineering and safety standards
- European regulatory position ('BREF') is unclear on SCR for this sector
- High level discussions with technology providers suggest a number of technical challenges for the successful integration of SCR on the NTS e.g. managing variable exhaust gas temperature.

Factors including age, variability, location, environmental sensitivity and network criticality of assets, constrain the number of potential NTS sites for SCR use.

* The Industrial Emissions Directive (IED), the BAT Reference (BREF) Associated Emissions Levels (AELs), the EA/SEPA annual emissions network review and forthcoming Medium Combustion Plant Directive (MCP)

Method(s)

Initial studies indicate that catalytic reduction technologies are a potential candidate BAT, but that there is a deficit of information relating to technical and integration aspects on the gas NTS and also in determining which sites may be suitable. The methodology for the pre-FEED feasibility technical and environmental study includes the following elements:

- Carry out a detailed assessment for base case and SCR fitted compressors using the Compressor Machinery Train BAT tool, including data review and collection.
- Obtain additional baseline information on engine emissions via specialist emissions testing.
- Determine and assess site-specific and network technical requirements and operational parameters.
- Analysis of SCR technologies against procurement framework and engineering suite of documents.

Engage SCR manufacturer/supplier to develop outline conceptual scheme design.

Look for lessons learnt from pilot schemes in Europe.

Identify candidate site(s) for pilot project and short list though environmental site sensitivity assessment.

Assess commercial and procurement options for any pilot project.

Make recommendations on the overall viability of the scheme.

The outputs would be a pre-FEED feasibility environmental and technical report which would include discipline based chapters covering the study areas. Specific aspects of the report would include:

An updated BAT model with refined modelling assumptions which would set out the environment-technical cost benefits associated with a possible SCR project of this type.

A conceptual design report detailing the technical challenges and potential solutions, with generic general arrangement drawings and outline design scheme.

Capital and operating cost estimates for a potential BAT solution based on SCR installation.

A site suitability screening matrix, identifying candidate sites / with associated benefits and disadvantages.

Commercial and procurement pack to support possible establishment of a framework of suppliers.

Network Innovation Allowance pack and supporting papers to accompany an application for the project FEED phase, project close out report or board paper concluding why the project is not being progressed further if findings suggest technology applicability is not viable.

Scope

The entire existing fleet of standard Rolls-Royce RB211 and Rolls-Royce Avon gas turbine driven compressors will ultimately be non-compliant with tightening environmental emissions standards without accepting derogations severely restricting running hours or restricting operating life (‘emergency 500 hours use’ or ‘limited life derogation’).

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The use of catalytic technologies for new build gas turbines has previously been considered and rejected as a candidate BAT option for mainstream applications as they are largely unproven in gas transmission applications and do not offer the potential for realising the wider benefits that can be achieved when installing new compressor machinery train (e.g. increased operating efficiency and better compressor matching to site duty).

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In light of the findings of initial studies carried out by GTAM, the potential environmental benefits which could be realised from an SCR solution, when combined with a potentially lower project cost compared to new build, would indicate that SCR could be a candidate

BAT option in some circumstances. It is thus appropriate to consider detailed engineering and environmental assessment to confirm, or otherwise, its potential viability for implementation. However, there is at present insufficient information to address the remaining uncertainties and further study is required.

Objective(s)

The objectives of the study would be to:

- Provide a clearer understanding of the potential technical challenges associated with implementing an SCR project on a National Grid compressor station, and identify initial approaches to overcoming these challenges.
- Develop an outline conceptual design for a scheme suitable for roll-out on an Avon and / or an RB211 on a National Grid compressor station.
- Identify the potential National Grid candidate sites / units where a pilot project could be rolled out and associated integration issues identified based on the outline conceptual design.
- Develop robust BAT models for the comparison of technology options (using the T/SP/ENV/21 process)

Issue recommendations on the overall viability of the scheme, enabling a National Grid project board to complete a stage gate review of the scheme and make a recommendation to proceed to the next stage of the study, namely a full FEED / detailed design study.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

- A shortlist of sites / units identified as potentially suitable for FEED.
- A SCR conceptual design suitable for application on an NTS compressor site.
- Documentation of the understanding of compliance requirements of SCR systems and principal deviations against National Grid's engineering and safety standards.
- A robust BAT model comparing SCR options with 'do nothing' and new build DLE scenarios.
- Documentation of a clear position which either indicates viability of the SCR technology for application on the NTS or a justified rationale concluding that the SCR technology does not bring superior benefits against other options.
- A sound concept design basis for moving rapidly into a full FEED study (assuming viability is proven)
- Defined commercial and procurement options for any subsequent pilot project to provide basis for National Grid Global Procurement to be able to seek the best value catalyst solutions (assuming viability is proven).

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

Desk based research plus limited site survey on one or more NTS gas compressor stations, together with comparison visit to a European TNO compressor site to capture lessons learned.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

UK, with study visit to Netherlands

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£647,500

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)

Should Selective Catalytic Reduction prove suitable for NTS application and be successfully rolled out, conversion of a single unit could potentially generate a capital cost saving in the order of £25m compared to installation of a comparably sized new build DLE gas compressor machinery train (based on total project cost estimate, excluding gas fuel).

Please provide a calculation of the expected benefits the Solution

Example baseline cost estimate (indicative/typical) for replacement of 2 no. Rolls-Royce Avon gas turbine driven compressor machinery train on a single site (total project cost over 20 years).

2 no. new build <50 MW input dry low emission gas turbine compressor machinery: £180m (est.)

2 no. retrofit floor / stack mounted SCR installations on Avon compressor train: £120m (est.)

Potential saving: £60m over 20 years

Note: Further technical and engineering evaluation (FEED study) and detailed design works required after the initial proposed pre-FEED feasibility NIA project.

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

There are currently 41 non-DLE (Rolls-Royce Avon and Rolls Royce RB211) compressor machinery trains in use on the UK gas NTS. Theoretically any of these units could be suitable for retrofit. However, SCR retrofit (if proven as suitable) may not always be the best solution. There are a number of technical, operational and environmental factors which will limit the number of units that are potentially suitable. Furthermore, there are a number of these sites with 'inflight' projects or subject to RIIO funding applications were potential benefits of this technology would not be fully realised. It is estimated that 20% of the available fleet may meet the basic technical and environmental criteria, although there will be regulatory and operational criteria for consideration which will determined final viable numbers for detailed consideration.

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

Roll out would need to be fully costed and approved via the RIIO-T1 2018 reopener and subsequently RIIO-T2.

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

n/a

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

The project is aligned ot our environmental theme and improvements to technology application that will offer potential financial and carbon benefits to customers.

☑ 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