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

Jul 2015

Project Reference Number

NIA_NGGT0074

Project Registration

Project Title

Next Generation Predictive Emission Monitoring Validation (PEMS)

Project Reference Number

NIA_NGGT0074

Project Licensee(s)

National Gas Transmission PLC

Project Start

March 2016

Project Duration

1 year and 6 months

Nominated Project Contact(s)

Matt Williams, box.GT.innovation@nationalgrid.com

Project Budget

£151,000.00

Summary

The measurement of pollutant emissions species from industrial plants, and demonstration of compliance to various standards, is an important consideration for most plant operators. However, measurement of these emissions is a complex and expensive process, especially if continuous monitoring is required.

Therefore if emission levels can be predicted using selected (pre-installed) plant operating parameters, then a significant cost saving can be made compared to a dedicated measurement system. Systems which predict emissions in this way are generally known as Predictive Emissions Monitoring Systems (PEMS)

Siemens Industrial Turbomachinery have developed a prototype PEMS which is a parametric model derived from an underlying chemical kinetics model to predict emission levels using engine control system parameters. Such a system has potential to represent the 'next generation' of PEMS, and may result in significant increases in accuracy over current PEMS systems. The introduction of more intelligent engine control systems also means that PEMS models which are more integrated with the engine controls system are potentially more capable of accurately predicting emissions compared to PEMS models which use parameters significantly 'upstream' or 'downstream' of the engine

National Grid are keen to develop PEMS capabilities as it potentially can yield the following benefits:

1. PEMS represent a significant cost saving over continuous actual measurement
2. The Siemens prototype may provide significantly more accurate results than current systems
3. A 'next generation' PEMS system may help lead to acceptance of PEMS systems in legislation where it is not currently included

Siemens in-house results of the prototype model are encouraging, but a field application test is required to assess the viability of the model over a range of operating conditions.

The scope of this project is therefore to install and run the prototype PEMS system alongside an actual measurement system on an

SGT-400 running at one of National Grid's sites. The results will be periodically analysed and the suitability of the PEMS model assessed. Improvements to the model may result from this testing period.

Third Party Collaborators

Siemens Energy Industrial Turbomachinery Ltd

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

National Grid currently operates a Predictive Emission Monitoring System (PEMS) for all gas turbines at compressor stations on the National Transmission System (NTS). As gas turbine technology develops to meet new EU regulations imposing stricter emissions to air the turbine control systems are becoming more complex. These more complex control systems require more complex PEMS to provide accurate emissions. National Grid wishes to be at the forefront of these developments with a trial of a turbine OEM PEMS.

Method(s)

Siemens prototype Predictive Emissions Monitoring System (PEMS) will be fitted on a National Grid site running an SGT-400 gas turbine over the period of approximately one year. During this period the following will be carried out:

1. The prototype PEMS system is in the form of a software package that will be installed on a PC or laptop. This will require a data link to the engine controls system (note that this only needs to be a one way link – in its current form no data from the PEMS system is transferred to the controls system). In its most basic form, the prototype PEMS system uses parameters from the engine control system in a calculation and prediction algorithm which is then used to predict NOx and CO emissions

2. Measurements and calculated parameters required in the PEMS model can be obtained from the default controls system. Using a stand-alone PC or laptop approach ensures that the prototype algorithm is kept separate from the engine controls system during its validation phase.

3. The PEMS system should be run throughout the period of one year with minimal downtime. The more data obtained, the wider a range of operating conditions the PEMS system can be validated against, providing that continuous actual emissions measurement is obtained at the same time (see note 4)

4. Regularly (preferably continuously) record actual emission levels using a dedicated measurement device. Generally referred to as 'measured' values. Ensure that the results from the measurement device are time-synchronised with the results from the PEMS software. It would be preferable (although not mandatory) to record both sets of results in one location

5. Monitor predicted values using Siemens prototype PEMS system and compare to measured values. Ideally this will be performed remotely. However, should this not be possible then periodic visits to site to obtain the data taken so far will be required

Assess viability of prototype PEMS system and investigate potential for improvement. Viability will be assessed by comparing the difference between measured and predicted values (accounting for uncertainty) and assessing the range of operating conditions the PEMS system has been run over. Potential for improvement could be, for example, improving the constant offset values in the PEMS model as a wider range of operating conditions is obtained (thus 'filling in the blanks' from in-house testing), or improving the software itself to run more efficiently or provide improved user feedback.

Scope

The measurement of pollutant emissions species from industrial plants, and demonstration of compliance to various standards, is an important consideration for most plant operators. However, measurement of these emissions is a complex and expensive process, especially if continuous monitoring is required.

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Objective(s)

The primary objective is to assess the suitability of the PEMS model in predicting NOx and CO emissions over a range of operating and ambient conditions by comparing predicted emissions to actual measured values taken by a dedicated measurement device (commonly referred to as a ‘CEMS’ system).

The results from this project may also be used to improve the current prototype model and provide even more accurate predicted emissions.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

An assessment of the PEMS model based on a comparison to measured values taken over the same period, which should include a range of ambient and operating conditions. Modification to the PEMS model periodically is expected as more data becomes available.

In-house trials suggest that an accuracy of +/-5ppm relative to measured values can be achieved on NOx and CO levels down to 50% loads. It is expected that a similar accuracy can be obtained from the field trial. The stability of the PEMS software should also be assessed, although it is not possible to assign a value to this.

The PEMS should deliver at the emission limit value 95% confidence intervals of a single result that shall not exceed 10% for carbon monoxide and 20% for nitrogen oxides to be in line with the uncertainty requirements of continuous emission monitoring systems in Annex 5 Part III of the Industrial Emissions Directive.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project will be trialed at a National Grid SGT-400 site operating the latest Siemens control system. A successful trial of the system and control system upgrades would then enable implementation across the exisitng National Grid SGT 400 fleet.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

The Siemens PEMS is intended to be used across the fleet of SGT-400s on the gas transmission system.

Revenue Allowed for the RIIO Settlement

(NONE)

Indicative Total NIA Project Expenditure

£151,000

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)

Total savings in the region of £490k

Please provide a calculation of the expected benefits the Solution

If National Grid were required to install CEMS instead of its existing PEMS this would be at a cost of £100k per gas turbine plus annual costs of approximately £30k in service, maintenance and validation. For the seven units Siemens units this would be £910k. The equivalent cost for the seven units if the Siemens system proves successful is £110k+£420k (£420k= additional costs for roll out across 7 Siemens units at an indicative cost of £60k per unit).

£910k-£420k = £490k

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

The method could potentially be used for improved emissions prediction from Siemens SGT-400 gas turbines across the fleet on the NTS; currently seven installations. The principle of operation of the prototype system is applicable all Siemens series of gas turbines including ex Rolls Royce aero derivative gas turbines; the aero derivative section of Rolls Royce being a recent acquisition by Siemens.

There is potential on further development of the product to the ex-Rolls Royce fleet at the end of the project, that 75% of gas turbines (51 units) currently on the NTS would be covered by this new Siemens PEMS.

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

The indicative price for upgrading each SGT-400 with a PEM is £60k per unit; a total of £420k for seven SGT-400s in use on the NTS. If project is successful this will be confirmed by a formal quote. Roll out costs to the ex-Rolls Royce fleet of turbines cannot be estimated at this stage in product development.

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

The learning and knowledge gained from the project could potentially be used for improved emissions prediction of gas turbine driven mechanical drive compressors on gas networks. The learning will be made available via the ENA Smart Portal as well as on http://www2.nationalgrid.com/uk/our-company/innovation/, NIA progress and annual reports will be available as required.

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 linked to the environmental 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