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 2017

Project Reference Number

NIA_NGGT0118

Project Registration

Project Title

Compressor Data Analytics

Project Reference Number

NIA_NGGT0118

Project Licensee(s)

National Gas Transmission PLC

Project Start

November 2017

Project Duration

0 years and 11 months

Nominated Project Contact(s)

Jeremy Hunns, Edward Wamala,
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Project Budget

£306,544.00

Summary

The continuous and reliable operation of the compressor fleet is essential for the delivery of gas across the NTS on behalf of customers. The compressor units must start when requested and deliver their duty when required. A major disruption to the operation of the unit occurs if the compressor trips either during start-up or during operation. Depending on the network demand, flow patterns and criticality of the compressor station a machine trip or failure to start may in the worst case lead to network disruption and supply/demand management charges such as buy-backs. This project aims to better predict trips and failure to start (i.e. before they occur) to enable greater corrective action to be taken to prevent the trip and failed start.

DNV GL has conducted a pilot/feasibility study with the cooperation of National Grid, to have an initial look at data analytics on monitored data for single type of compressor unit. This study showed encouraging results for the successful prediction of running trip and failure to start for fuel system issues. If an estimated 75% of such trips were prevented this would have had a significant impact on improving MTBF and start reliability figures for this type of unit.

Machinery malfunctions may often have leading indicators and patterns in data may predict failure, but often the interpretation of the patterns and data required is highly complex and a compressor engineer may not be able to identify these or manage the volume of data unaided. It is proposed that data analytics and pattern recognition may, together with domain expertise (machine problem knowledge) by compressor engineers provide a new and enhanced method of improving compressor reliability.

Further being able to pro-actively address trips and failures to start is a difficult task as maintenance procedures and processes and the age and complexity of some of the equipment can make prioritisation of tasks difficult. By targeting the maintenance to solve the issues which directly affect reliability should increase the efficiency of maintenance budget use. Increased reliability should help reduce operational costs caused by trips.

Third Party Collaborators

DNV

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

Compressor units across the UK are used to manage the flows of gas across the National Transmission System on behalf of customers. Each compressor unit comprises a gas generator, gas turbine and gas compressor and is complex and sophisticated machine. If a compressor unit trips off during operation or fails to start on demand then the impact on the network may be disruptive and costly. A large amount of data is collected continuously about the operating characteristics of each compressor unit while it runs. National Grid would like to better understand how this large volume of data can be more effectively analysed in order to predict, avoid and mitigate against trips and failures to start, thus improving the reliability of the compressor fleet.

Method(s)

The method is to use data analytics and pattern learning on already collected machine data to predict fail to start and running trip events. National Grid has condition monitoring systems on all their compressors. These systems collect and trend machine operating parameters from the sensors attached to the machines. These systems have been installed for many years and this historic data captures trips and failed starts. More recently failure and maintenance log data has been incorporated into the database.

For this project a single type of gas turbine compressor has been selected as a test case because good running and trip data is readily available for this subset of the compressor fleet. The project would aim to;

1. Retrieve machine condition data from the on-site monitoring systems
2. Retrieve maintenance records from site for correlation
3. Produce a list of machine faults and trips which are to be considered for the prediction
4. Data cleansing/QA/verification
5. Add complexity/character to the data, this could include;
   - Alarm settings
   - Alarm status
   - Margin to alarm / trip
   - Time in alarm
   - Rate of change
   - Baselines and deviations
   - Pre/post maintenance performance
   - Recent MTBF and start probability values
   - Run behaviour
6. Determine trip and start prediction on above data
7. Testing of predictions
8. Define rollout for an online system
9. Report on the effectiveness of data analytics at reducing running trips and failures to start and recommendations for implementation of a compressor fleet wide solution.

Scope

The continuous and reliable operation of the compressor fleet is essential for the delivery of gas across the NTS on behalf of customers. The compressor units must start when requested and deliver their duty when required. A major disruption to the operation of the unit occurs if the compressor trips either during start-up or during operation. Depending on the network demand, flow patterns and criticality of the compressor station a machine trip or failure to start may in the worst case lead to network disruption and supply/demand management charges such as buy-backs. This project aims to better predict trips and failure to start (i.e. before they occur) to enable greater corrective action to be taken to prevent the trip and failed start.

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Objective(s)

To develop, trial and evaluate data analytics to provide prediction notification of running trip and fail to start for compressor units.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

This proposal has a phased approach and depending on the success of the stages determines which phase it continues to;

1. To gathering, cleansing and combining relevant sets of the compressor operating data
2. To analysis the data and develop algorithms
3. To determination of trip and fail to start predictions and test these against the data
4. Define the scope of work for roll out to the compressor fleet and a real-time/on-line prediction tool

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project involves desk based analytics, a site survey to gather maintenance information about the compressors and a trial of the solution in the monitoring system to pilot the online findings.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

Desk based work at DNV GL Warrington, UK
Trial based work at NG compressor stations, UK

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£306,544

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)

At this stage it is not possible to estimate the number and typical nature of trips that will be avoided as this will be an output of the research project. However cost savings will come from a range of different elements:

Firstly, if a second machine (which may be at another location) must be brought online to replace the loss of the first unit and network reconfigurations such as equalizing of pressures, opening and closing valves, extra fuel usage, cancellation of maintenance etc. made to manage and accommodate this change, the total cost may be of the order of £10,000s per trip.

Secondly, maintenance engineer call outs to manage, diagnose, resolve and clear the trip or failure to start are expensive and disruptive to planned maintenance activities at other sites/on other units. The estimated cost of this activity and disruption, including engineer time, overtime and time-in-lieu, and OEM support is around £3,000 per trip but depends on a large number of factors.

Thirdly, identification of a trip before it occurs, in which damage to the unit would have been incurred, will allow a controlled shutdown of the unit to be made instead of a trip by a safety device. Controlled shutdown has a significant operational benefit in that the time before the unit can be restarted is reduced by up to 24 hours compared to a trip, giving the System Operator greater flexibility over their operating strategy and the Transmission Owner more time to manage the resource and equipment to repair the trip efficiently.

Finally, in the worst-case scenario where the loss of the compressor unit leads to disruption to the flow of customer gas and supply/demand intervention is performed by the System Operator, the cost of this "Buy Back" option could run to several £million per day for duration of the failure that the unit remains critical to the network for.

By facilitating a transfer to proactive rather than reactive trip management both the System Operator and Transmission Owner will benefit from greater operational flexibility, reduced network management and maintenance costs, and a reduced compressor unit redundancy requirement and associated capex and opex cost reduction if units can be decommissioned without replacement. For example a single replacement compressor train may cost of the order ~£10M (machine train only - total cost of replacement will be significantly higher and depends on a very wide range of factors.)

Please provide a calculation of the expected benefits the Solution

N/A

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

The solution will be demonstrated for single type of compressor unit within the National Grid fleet, but the method is intended to be machine/platform/OEM independent so that it can be applied to all machines on the transmission network. National Grid Gas Transmission is also the only network licensee to operate compressor units.

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

Currently the rollout costs cannot be reliably estimated because will depend significantly on the outcomes of the research and on the type of compressor selected for the trial.

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 from the project will allow National Grid to operate its compressor units more reliably and perform maintenance more efficiently. This will lead to reduced network costs and less potential for disruptions to customer gas flow through the National Transmission System.

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

☑ 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