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NIA Project Registration and PEA Document

Date of Submission

Mar 2014

Project Reference Number

NIA_SGN0002

Project Registration

Project Title

Immersion Tube Preheating

Project Reference Number

NIA_SGN0002

Project Licensee(s)

SGN

Project Start

January 2013

Project Duration

3 years and 6 months

Nominated Project Contact(s)

Martin Chorley, Innovation Project Manager

Project Budget

£882,359.00

Summary

To design, construct and install two innovative pre-heaters with heat output capacities of circa 100kW and 326kW, compliant with UK legislation and standards.

The pre-heaters will be innovative for four main reasons:

- They will operate in a vacuum, i.e. in the presence of low levels of oxygen, which minimises corrosion, extends asset life and the water boils at a lower temperature meaning less energy input is required for indirect heat transfer. As less water is used than in conventional systems, heat can be better directed over a range of loads, resulting in higher efficiency while reducing the physical size to a compact footprint

- Energy inside the system will be transferred indirectly, without the use of pumps or motors, by means of a heat cycle call a thermosyphon resulting in improved reliability with fewer moving parts than conventional preheating systems, therefore maintenance frequency and likelihood of breakdown is reduced

- The compact pre-heating units will reuse process connections and civil supports from existing water bath heaters, thereby reducing complexity and cost associated with pre-heater replacement

- They will employ novel burner design which offers the same efficiency as modular boilers with a simplified industrial design for long life and ease of service. This burner technology has not previously been utilised for gas-preheating.

Nominated Contact Email Address(es)

sgn.innovation@sgn.co.uk

Problem Being Solved

When gas experiences a deliberate reduction in pressure it expands and as a result it drops in temperature. This is known as the Joules-Thomson Effect. Therefore, in order to prevent ice forming inside a pipeline which, in turn, could ultimately lead to a loss of supply, the gas needs to be pre-heated at pressure reduction stations prior to the reduction in pressure.

Conventional pre-heating methods in the United Kingdom (UK) require a choice between age and complexity, using dated water bath heaters (WBH) or complex modular boiler heating systems (MBH). Water bath heaters are inefficient, consume large amounts of fuel gas and consequently have high associated carbon dioxide (CO2) emissions. Furthermore, opportunities to keep maintaining water bath heaters are becoming limited, leading to an increasing risk of network failures. For the past twenty five years, boiler house replacement solutions have offered improved efficiency, but increased complexity has compromised reliability and asset life.

A pre-heater design is needed which reflects the low lifecycle cost enjoyed by water bath heaters, while achieving modern standards of efficiency associated with condensing boiler pre-heat designs. This project intends to address these problems by constructing and trialling a new pre-heat system which intends to improve efficiency, reliability, design life and reduce associated carbon emissions.

Method(s)

This is a technical project to field trial a innovative compact gas pre-heating systems < 350kW on SGN sites. Performance of the prototypes will be monitored for a defined duration over the winter period in order to compare results with existing preheating systems in terms of efficiency, emissions and life-cycle ownership costs including capital cost, installation cost, fuel use and maintenance.

Key stages of the project are as follows:

- Produce an appraised and G17 approved design for a 100kW and 326kW pre-heater.
- Fabricate the heater.
- Receive factory acceptance for the heaters.
- Deliver and install the heaters on one SGN site.
- Commissioning of the heater.
- Provide performance monitoring over the winter.
- Produce a benchmarking report comparing performance against one or more of SGN's existing pre-heater sites.

Scope

To design, construct and install two innovative pre-heaters with heat output capacities of circa 100kW and 326kW, compliant with UK legislation and standards.

The pre-heaters will be innovative for four main reasons:

1. They will operate in a vacuum, i.e. in the presence of low levels of oxygen, which minimises corrosion, extends asset life and the water boils at a lower temperature meaning less energy input is required for indirect heat transfer. As less water is used than in conventional systems, heat can be better directed over a range of loads, resulting in higher efficiency while reducing the physical size to a compact footprint.
2. Energy inside the system will be transferred indirectly, without the use of pumps or motors, by means of a heat cycle call a thermosyphon resulting in improved reliability with fewer moving parts than conventional preheating systems, therefore maintenance frequency and likelihood of breakdown is reduced.
3. The compact pre-heating units will reuse process connections and civil supports from existing water bath heaters, thereby reducing complexity and cost associated with pre-heater replacement.?
4. They will employ novel burner design which offers the same efficiency as modular boilers with a simplified industrial design for long life and ease of service. This burner technology has not previously been utilised for gas-preheating.

This project has not currently progressed in line with the original registration. As stated above, we planned to fabricate two prototype sites (100kW and 326kW). Unfortunately, the Project has now changed due to a number of technical site issues with both sites. In regards to the 326kW site, a site appraisal has resulted in a decision to rebuild the entire site and as a result the prototype unit would no longer meet the anticipated flow requirements. Therefore, all costs associated with the 326kW site have been removed from the project and a decision has been made not to progress with any further work in regards to this site.

Additional time and cost is required to complete the 100kW site. The Project team has experienced delays due to technical issues in developing the alarm configurations, however this has now been resolved and the necessary changes are in place to complete and commission the site. Following the commissioning of the site significant learning will be realised. In particular, these benefits will be around the qualification of modelling and predictive analytics that was originally based on a mathematical modelling design using the inputs and outputs from the proposed Project sites.

It is determined that the success criteria can still be achieved from completion and commissioning of the 100kW site. The results will then be used to advance developments in all current and future preheating units produced by the Project Partner. It is believed that the learning taken from this Project will support all Gas Distribution Networks (GDN) preheating operations across GB.

Objective(s)

The key objectives of this project are outlined below:

- Fabricate a 100kW and a 326kW compact natural gas pre-heating unit that are compatible with the UK gas distribution system.
- Install and field trial the two prototypes on SGN sites.
- Demonstrate that the new pre-heaters have better thermal efficiencies than current pre-heating systems.
- Demonstrate that the new pre-heaters can successfully repurpose existing civil and process connections to reduce installation costs associated with pre-heater replacement.
- Demonstrate that the new pre-heaters have less CO2 emissions than other systems currently available.
- Quantify anticipated lifecycle cost savings through a combination of reduced failure, reduced installation cost, improved serviceability, improved design life and higher efficiency.
- Produce a report detailing the results of the trials.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

In order to quantify the benefits of this project, performance comparisons will be made against an existing pre-heating plants operated by SGN to examine efficiency, emissions and life-cycle ownership costs including capital cost, installation cost, fuel use and maintenance.

The project will be deemed to be successful if the field trials enable assessment of the extent to which the new pre-heaters;

- Are compatible with the UK gas distribution system.
- Have better thermal efficiencies than the current pre-heaters onsite.
- Have a lower installed capital costs than modular boilers as a replacement option.
- Have lower operating costs than other systems currently available.
- Show a marked reduction in fuel usage.
- Show marked reduction in carbon emissions.
- Improve system reliability and design life as compared to modular boiler pre-heating plants.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

This project now calls for only one field trial, 100kW and 326kW, at SGNs Lochmaben site. The performance of the prototype installed will be monitored in order to ensure they are tested in realistic conditions. Following project developments, it has been realised that one trial is necessary in order to benchmark performance and generate learning.

Technology Readiness at Start

TRL7 Inactive Commissioning

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The new preheating system will be trialed on one pressure reduction stations located within our Scotland network.

Revenue Allowed for the RIIO Settlement

Under RIIO-GD1 SGN have been allowed a total £218m for work to upgrade and improve the Local Transmission System, £18m of which will be specifically spent on replacing existing pre-heating systems. In addition to this, an allowance of £136.8m has been made to reduce the gas shrinkage in the network. Poor fuel economy of existing pre-heating systems contributes significantly to gas shrinkage.

While no savings on this expenditure are expected during project implementation, there is potential for this technology, if proved successful, to result in considerable future savings in the capital and operational costs associated with preheating, while improving durability and design life.

Indicative Total NIA Project Expenditure

The initial cost of this project was funded from SGN's Innovation Funding Incentive (IFI) in 2012/13. The outstanding expenditure is expected to be £882,359, of which 90% is allowable NIA expenditure (£794,123).

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 introduction of this newly developed pre-heating system has the potential to deliver large financial savings on many fronts including asset life duration, capital expenditure (capex) and operational expenditure (opex), against current pre-heating methods as outlined below. Please note this is based on an average UK pre-heater duty of 355kW.

- Improved asset life compared to MBH (30-40 years instead of replacement every 15 years).
- Reduction in installation cost compared to MBH (70% of £188k).
- Improvement in efficiency and fuel use compared to WBH (50% of £10k) and MBH (15% of £7k).
- Reductions in failures/unplanned maintenance (75% of £2k).
- Elimination of third party maintenance (100% of £2k).

Please provide a calculation of the expected benefits the Solution

The introduction of this new project technique if implemented successfully will provide financial benefits. The current cost associated with installing a new modular boiler pre-heating system on an existing site is around £190k per unit, for units with a 15 year lifespan. The current annual operational cost for fuel is circa £10k per unit and for maintenance is circa £4k per unit. The financial benefits of this are:

Capital Expenditure Cost Benefits :

Unit Cost Benefits:

£375k (base cost per 30 year, assuming 15 yr life)) – (£55k method cost per 30 years, assuming 30 yr life) = £320k lifecycle cost saving per pre-heater package

Installation Cost Benefits:

£190k (base cost) - £55k (method cost) = £135k installation cost saving per pre-heater package

Operational Expenditure Cost Benefits:

Annual Fuel Cost Benefits:

£10k (base cost) - £5k (method cost) = £5k operational fuel saving per immersion tube pre-heater installed

Annual Maintenance Cost Benefits:

£4k (base cost) - £0.5k (method cost) = £3.5k annual maintenance cost savings

From the above calculations it is estimated that SGN and other Network Licensees could potentially have capital cost savings of £135k per pre-heat unit installed in place of a modular boiler system and ongoing saving of around £8.5k per unit per annum. As the pre-heater design is modular, there are no single ends of life events which are in contrast to boiler houses which have a design life of 15 years. The use of durable materials such as stainless steel and the modular design are anticipated to reduce total lifecycle costs.

SGN have 55 planned pre-heating replacements during the next 8 years and it is estimated that 20 of these could be replaced using the immersion tube system. Based on the assumptions above, it is estimated that there could be a potential saving of around £2.82m during RIIO-GD1. However, this estimate is subject to a large sensitivity margin since it is based on averages and also depends on the actual outcomes of the project.

It must be noted that these figures are based on averages and the size and complexity of pre-heaters can vary from site to site. The main focus of this project is to test the technique and it is fully understood that not all pre-heaters will be the same capacities as the ones used in this project.

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

SGN are to replace 55 pre-heating units at sites across both our Scotland and Southern regions throughout the next 8 years. It is conservatively estimated that 20 of these have the potential to utilize the Immersion Tube Pre-heating system.

The size of the UK gas network has a 4:2:1:1 split between National Grid, SGN, Wales & West and Northern Gas. Based on this split it has been assumed that National Grid will have approximately 40 pre-heating units and Wales & West Utilities and Northern Gas Networks around 10 each which could potentially be replaced using the immersion tube system during RIIO-GD1. Therefore, the total number of pre-heating units which could be replaced using the new immersion tube system in the new formula period is 80.

It must be noted that these figures are based on averages and the size and complexity of pre-heaters can vary from site to site. The main focus of this project is to test the technique and it is fully understood that not all pre-heaters will be the same capacities as the ones used in this project.

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

It is estimated that there are 80 preheating units across Great Britain (GB) which could potentially be replaced using this compact pre-heater design in the next price control review. The cost of purchasing and installing this innovative pre-heater replacement is around £450k per site. As a result, it is assumed that it would cost around £36m to roll out this new technology during RIIO-GD1 as opposed to using current pre-heating technology, which would be in the region of £45m with a shorter anticipated asset life.

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 this project will benefit Network Licensees as it will provide them with an evaluation of existing conventional pre-heating systems against the potential benefits of the proposed system. If successful, the learning from prototype testing and comparison against conventional methods of pre-heating will allow Network Licensees to make an informed decision on whether they would like to acquire and utilise this new technology and anticipated savings in lifecycle costs to benefit their networks.

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

- [x] Yes