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

Aug 2019

Project Reference Number

NIA_NGN_239

Project Registration

Project Title

Printable Pressure Sensors

Project Reference Number

NIA_NGN_239

Project Licensee(s)

Northern Gas Networks

Project Start

September 2019

Project Duration

2 years and 7 months

Nominated Project Contact(s)

Keith Owen

Project Budget

£142,025.00

Summary

Currently the costs of monitoring gas pressures within the distribution network are too high and our need to measure more of the network is increasing as we begin to supply different types of gas.

The UK gas infrastructure is becoming increasing complex and as such reliance on data analytics and, in the future, AI systems to inform the decision-making process will continue to grow.
Providing the volume of data necessary to make better decisions will require investment and if current data acquisition systems are deployed [satellite, datalogger with GSM], the cost to industry and our customers would be unacceptably high.
The advent of Internet of Things technology with low power low cost technologies, may provide solutions to this issue and therefore this project aims to explore the capability of printed electronic to embed such IoT sensing technologies into everyday network components to transform our infrastructure into a 21st century Smart Gas Grid.

Nominated Contact Email Address(es)

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Problem Being Solved

Currently the costs of monitoring gas pressures within the distribution network are too high and our need to measure more of the network is increasing as we begin to supply different types of gas.

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Method(s)

The focus of the project falls into 3 parts:

1. Feasibility into whether the creation of a system using HP1 Technologies' (HP1T) flexible, printable, graphene-ink based pressure sensor technology can work alongside one of Radius Systems' (RS) products (likely a 'Top Tee' component)
2. Deliver a fully testing working prototype
3. Deliver a commercial ready product, pre-certification

The final product aims to dramatically reduce the cost of monitoring the network, reduce the cost of maintenance and form the foundation for developing an AI solution to enable analysis of the health of the network to rapidly diagnose the location of any problems.

All these elements will result in network leakages being fixed quicker, leading to cost reductions and less events resulting in a loss of supply thereby providing an increased reliability for our customers. The learnings from a successful project with NGN can then be disseminated across the entire Gas Distribution Network. (GDN).

Scope

The scope of the project is to develop -
a. a working prototype system with RS to measure and monitor pressures within a demo installation by integrating HP1T's printable pressure sensors into a selection of RS Top Tee connectors. The solution will specifically include an electronics and communications component to ease supply chain monitoring, maintenance activities and remote diagnostics for both system performance and levels of gas pressure.
b. Test prototype using compressed air (to avoid the need for ATEX compliance as part of this project) in terms of pressure readings and network connectivity.
c. create a small batch of pre-compliance commercial ready components with RS
d. develop and installation, monitoring and maintenance process that is efficient and technically proven.
e. Monitoring pressures up to 2 bar in a PE network.

Out of Scope
a. Compliance of the system with ATEX and other compliance and regulatory requirements
b. Enabling data that is generated by the sensors to feed into existing NGN systems/relevant 3rd party platforms
c. Integration of temperature sensor capability into system as well as humidity and moisture sensors (and use this data to collaborate with the water companies to monitor water table information). N.B. the system can be equipped with these sensors without further design considerations – i.e. it will be a case of adding capability not designing a new concept all together.
d. Implementation and roll out of a robust underground data platform that can map local networks and provide a multitude of data streams, at thousands of points within the network, in real time (incorporating AI/machine leaning technology)
e. Develop sensor systems for NGN wearables and equipment
f. Integrate underground data platform with NGN wearables and equipment
g. Build wider platform and AI capabilities
h. Adapt system for in home domestic use
i. Adapt system for use in industrial water pipes as well as gas pipes
j. Monitoring pressures over 2 bar in a steel network
k. Design and agree commercial model (if we choose to pursue option (4.) in question 2.9 then this will come into scope

EXTENSION - Due to the issues raised from Covid-19 and the impact on the project partners workforce there was signnificant delay to progress that has required an extenstion to the project in order for it to meet it's desired outputs.

Objective(s)

• Create a printed sensor which is adapted and characterised to become integrated with existing 'approved' network components.
• Identify the best way to integrate the sensor into the component.
• Design the supporting electronics to operate the sensor
• Design the most effective way to communicate and store the data from the device, in particular to be able to transmit data through ground and above the surface without the need for excavation. Also, the incorporation of NFC technology
• Design a way to encase all elements into the component.
• Select a battery that will provide an adequate long lifespan to the system (circa 10 year)
• the final developed product to be a low-cost pressure sensitive device

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

a. New device can reliably communicate when polled when buried
b. New device accuracy is +/-2%
c. Battery life is =>10 years
d. Cost of new device is <£100
e. Device is developed to be taken through ATEX certification

f. Radius willing to adopt new technology in their product line-up and wish to expand the line
g. Reliability of the device is equal to the lifespan of the batter pack
h. Batteries packs can be easily and quickly replaced [no dig]

Project Partners and External Funding

• Northern Gas Networks
• HP1 Technologies

Potential for New Learning

Yes - Improved network visibility.

This project will provide NGN (and as a consequence the GDN's) with understanding of the feasibility of integrating printable pressure sensors into a large number of key points within the network (Low Pressure to start with then assessment of Medium and Intermediate pressure versions too).

It will also ultimately aim to deliver the foundation for a digital underground sensor platform that can map and analyse gas pressures (and later, moisture levels, temperature and many more elements) at any part of the network in real time.

Scale of Project

Cost – The resulting product will provide capital cost savings for NGN in deployment of future monitoring systems, operating and maintenance costs in the form of early identification of network failures and quickly locating areas or failure. In time the aggregated data gathered by the system will be able to provide a much clearer understanding of the gas network, which could result in a wide range of cost saving benefits.

• Resources – The resulting system will make the identification of network failures much quicker to identify and locate. Therefore, resource will be able to be deployed much quicker in order to mitigate the potential problems. The system will also result in lower cost resource requirements for pipeline monitoring when compared with the current data loggers used.

• Systems – The resulting system will not only provide an immediate system improvement but also provide the basis of a platform on which to build on other capabilities, such as moisture or vibration monitoring. The resulting data will be able to be used to create significant system improvements in a cost-effective manner.

• Processes- NGN's process of improving the speed at which problems can be identified and located will create a more efficient repair and maintenance process. In time the data generated will be able to be used to create predictive maintenance programs to further improve the process of maintaining and operating the gas network. These capabilities have the potential to be provided across the GB network.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

This project focuses on the area covered by NGN

Revenue Allowed for the RIIO Settlement

No

Indicative Total NIA Project Expenditure

External Costs - £115,000,
Internal Costs – £37,025
Sanctioning costs - £142,025

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 aim of this Pilot is to develop new monitoring capability through the merger of existing but separate technologies. The first technology are the everyday plastic components we obtain from Radius systems [fixtures and fittings] which are deployed in the field, mostly below ground.

The second is a relatively new and novel technology that creates electronic circuits via a printing process. By bringing these two technologies together we aim to develop new monitoring capability for the gas industry at a time when increased complexity is driving increased reliance on information and the acquisition of data from the field, to make better informed decisions.

The new technology we wish to develop will make use of the "internet of Things" communication system, which is ultra-low cost and low power. The ambition of this project is to modify a Top-Tee connection, a very common component and regularly in use, such that it can broadcast the main pressure without the need to a datalogger or annual site visits. This will expand the opportunity for NGN to invest in a higher density of pressure monitoring to then visualise and understand our network to a level not currently possible.

Please provide a calculation of the expected benefits the Solution

The target capex cost for the new technology is to be less than £100 per unit (on top of the existing cost of the network components). That is inclusive on the new technology and any external structures to support the communication route to surface level. In addition, the device will be designed with a 10-year battery life with remote firmware upgrades.
The Totex cost to be considered in relation to remote pressure data capture using IoT sensors also relates to the initial Capex investment in equipment. However, it only requires the subsequent Opex cost to for IoT data transfer which is at a reduced cost. The low power nature of the technology doubles existing battery life removing the requirement for a 5 yearly change program.

The Totex cost reduction via the utilisation of IoT sensing technology is in the region of 95% measured against existing costs. This is based on reduced hardware, power and data transfer costs.

An example of typical Totex benefits over a 10 year period, with a sample size of 1000 monitoring points equates to an existing cost of £1.5m measured against a forecasted cost of £0.1m.

Note, the functionality is reduced on the IoT solution and is not a direct comparator, this is a decision point for acceptability for networks.

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

The system could be easily applied and replicable across all GB networks, once successfully developed, tested and accredited

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

Using the same example of typical Totex benefits over a 10 year period, with a sample size of 1000 monitoring points equates to an existing cost of £1.5m measured against a forecasted cost of £0.1m.

Note, the functionality is reduced on the IoT solution and is not a direct comparator, this is a decision point for acceptability for networks.

£1.4m saving x 8 = £11.2m over 10 years

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

This project will not only provide NGN (and as a consequence the GDN's with understanding of the feasibility of integrating printable pressure sensors into a large number of key points within the network (Low Pressure to start with then assessment of Medium and Intermediate pressure versions too), but also ultimately aims to deliver the foundation for a digital underground sensor platform that can map, and analyse the pressures (and later, moisture levels, temperature and many more elements) at any part of the network in real time.

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

Customer Service and reduced customer costs – The project seeks to continually improve NGN's customer experience by giving NGN increased visibility in real time of the state of the network and where issues might be occurring. As a result, enable the reduction in costs for the end customer.

The Network Licensee's innovation strategy is specifically designed to find new ways to manage its new emerging network management needs as it responds to a change in the mix of types of gas it will supply in the future. This change in gas mix (Natural, Bio-methane and H2) will create the need for new points of supply and change the supply risk in the network resulting from network failure events.

The project's output is specifically designed to address this innovation need in terms of finding a new way to measure gas pressure cost-effectively as part of an integrated communications network.

☑ 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.

A thorough check of the Smarter Networks Portal and external technology search has confirmed that this technology does not currently exist or is being actively pursued.

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

It uses new technology that has been created by HP1T. The sensors can be printed on flexible PET substrate and use a graphene-based ink to measure a range of pressures. Sensors can be completely customised in terms of size, shape, pressure range measured to fit the required purpose

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

Deploying new technology that has not been deployed before does carry inherit risks, however the perceived risks can be mitigated with extensive testing and expert know how. The gas networks already have proven ‘market ready’ technology available to them and can complete this task, albeit at an increased cost and less efficiently that predicted.

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

The project is both R&D and Innovation, it is starting at a risky, yet to be proven state. To make sure that risks can be mitigated and overcome and provide the most effective and efficient platform to deploy such new technology. Commercial risks Low risk. If a successful system is created and is it also possible to be create a system that meets expected cost/pricing profile, then between NGN, HP1T and Radius Systems then, there is, in theory, a clear route to market and commercial success Technical risks Low/medium risk. There is a low risk that HP1T’s sensor technology cannot work well at the required pressures and under the required environmental and operational conditions. The sensor technology has been proven to work effectively in other sectors. There is also a low risk that the sensors can’t be integrated effectively onto a Radius Systems component – mainly due to the fact that the HP1T sensor array and Radius Systems products are made of the same PET material and also that the adhesives expected to be used to create the full system are well known. The communications risk of being able to pass data to and from an underground sensor is mitigated by the work that technologies such as Vodafone’s Narrow Band IoT device network has already completed in this area. Operational risks Low risk. Any operational risks will be mitigated through thorough testing (and future accreditation thereafter) of the system Regulatory risks No risk to the project itself. The resulting product from the project will be fully tested using compressed air. It is intended that the only step required thereafter to get the product ready for real world deployment is ATEX compliance. If the system can pass rigorous testing at the NGN facility using compressed air, it is thought that gaining ATEX compliance will be low risk.

This project has been approved by a senior member of staff

☑ Yes