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 2021

Project Reference Number

NIA_NGN_303

Project Registration

Project Title

IoT Pressure Sensor Pilot

Project Reference Number

NIA_NGN_303

Project Licensee(s)

Northern Gas Networks

Project Start

October 2021

Project Duration

2 years and 6 months

Nominated Project Contact(s)

Keith Owen kowen@northerngas.co.uk

Project Budget

£779,350.00

Summary

In collaboration with NGN, and as part of a recent NIA project [NGN_NIA_239], Renda Systems Limited has successfully developed (to TRL 4) a highly cost-effective pressure sensor system, designed to be incorporated at low cost into the PE Purge Tee assembly.

Next steps and this project proposal

This next phase of work seeks to take the learning and PoC pressure sensor system developed to roll out the developed technology in live field trials, to establish the long-term credibility and capability of this new technology approach to information gathering in the real-world setting.

Third Party Collaborators

Renda Systems

Nominated Contact Email Address(es)

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Problem Being Solved

NGN (and GDN's) are under increasing pressure to lay the foundations for the Energy Systems Transition to low/zero carbon, whilst maintaining customer services and to optimise efficiency. In support of this, NGN aim to apply new digital technologies such as industrial IoT technology incorporating Machine Learning and AI systems that facilitate new insights into the overall management and decision-making processes, substantially reducing operational costs and continually improving performance of the network, for the shareholders and for the customer's ultimate benefit.

NGN has clearly recognised this absolute requirement and commits to an action plan as defined in the NGN's Digitalisation Strategy

2021:

“Northern Gas Networks is not a Gas Distribution Network. NGN is a data management company that delivers a world-class gas distribution service. Data is the most valuable asset we possess.”

To deliver this vision and to extract the operational data that’s required to drive this transformation, NGN have identified the opportunity to rapidly deploy low cost, highly accurate sensor and data analytics systems which is the basis for this collaboration with Renda Systems Limited.

At present, NGN has real-time visibility of network performance via its primary SCADA system. The deployment of such technology remains mostly in the high-pressure systems to manage the intake of gas and management through the NGN networks through to the lower pressure tiers. In the lower pressure systems information from the network becomes less dense and moves from real time to near real time via traditional, data logger technology. This means, therefore, that detail surrounding the performance and behavioural characteristics of the high-pressure system is more acute than at below 7 bar, and more so as the pressures drop to 75mbar and below. This reduced level of information can mean a less effective and efficient response to prevailing conditions than would be desirable, with potential for increased costs, impact on customers and improvement opportunities missed.

Linked to this is the real challenge of the energy systems transition and in particular what this means for our lower pressure tiers as we convert to hydrogen. The established strategy of minimum data density on these systems is unhelpful in this future scenario.

To overcome this shortfall in metrics from the field would be cost prohibitive if utilising traditional datalogger or similar established technologies and would also deliver a networked system somewhat inflexible compared to the need for agile data acquisition, necessary in a changing energy systems transition scenario.

The provision of such data and its interpretation as a management tool, augmented by AI, will both mitigate the deficiencies and enable NGN to rapidly achieve their ambition and benefits derived from full digitisation.

General Examples of Problems and Drivers:

- Current Network management decision models are limited by the data available to support those models. The historical data is at a fairly high level backed up by operational experience, which may not be as current as would be desirable, meaning less well-defined results, with implications for resource time requirements, cost and non-optimum management.

- Limited and largely fixed location visibility of the network and no real time information means loss of efficiency and a resultant opex position maintained to account for a non-optimum solution. For instance, through additional call outs/ad hoc inspections, being reactive rather than predictive.

- The Iron mains replacement programme progresses to replace ageing gas pipelines with hydrogen ready PE systems. This work has a number of years left to achieve PE dominant systems across the NGN networks. This process will continue to need to make good repex decisions on replacement and new asset investments. The availability of real time and predictive information will enhance this process to allow more informed investment decisions to be made.

- The Energy Systems Transition moving to hydrogen systems adds significant complexity as networks are required to manage both a natural gas system and expanding hydrogen system. Advances in the availability of real time information at higher levels of granularity are needed to support the transition utilising analytics to underpin the conversion strategy. Currently the central repository for asset metrics resides within the NGN System Control function in both the real time SCADA system and Low-Pressure networks system [dataloggers]. This restricts the visibly of useful information to NGN network colleagues, thereby limiting their overall situational awareness and ability to respond in advance of a changing situation. This programme seeks to unlock live field metrics and place the information directly in the hands of NGN network teams [as well as maintain information flows into NGN System Control] to support better decision making and a more proactive response to emerging challenges on the network as we begin the move to a cleaner and greener gas network.

Method(s)

The project is being delivered in three phases in full collaboration between NGN and Renda Systems Limited and with support from other external partners [Radius Systems, Synthotech] for example, which forms one management team able to synchronise and coordinate the work.

The project consists of several phases outlined below and within each of these there are specific work packs to drive progress and meet key deliverables

Further detail on the project is provided below:

Phase 1a: Deployment is at the most advanced stage of technical readiness [following the development of the pressure sensor over the last two years]

This phase will be part funded by Renda Systems Limited to progress the sensor to product stage and full ATEX certification for use on both natural gas and hydrogen systems, and NGN will utilise NIA funding to evaluate this new product on their live gas network to investigate the real-world performance, different deployment densities and logistics of installation.

Phase 1a detail: Deploy a small number of pressure systems designed to ATEX standard on the gas infrastructure at the NGN InTEGReL facility.

Project Duration - 8 months.

Phase 1b: Deployment: Undertake pilot roll out of sensor technology across NGN gas network

Project Duration – 13 months.

Phase 2 and 3 are new innovation activities to complement phase 1 are at a lower level of TRL, funded via the NIA process. Supply chain partners and mobile network operators and other providers will be brought in to provide expert advice and input.

Phase 2. Data Analytics Establish standard dashboard solutions to enhance acquired data for NGN colleagues and develop analytics to extract new insights from the information and highlight network performance characteristics.

Project duration – 8 months (in parallel with Project 1a in readiness for roll out).

Project 3. Sensor Development Using the same secure PE tee assembly-controlled environment to integrate further sensors into the existing sensor footprint, for example, hydrogen, temperature, moisture, flow.

Project Duration – 8 months (in parallel with Phase 1b)

Scope

In Scope

- All deliverables within Work Packs 1 through 6, as provided in the 2.2 Method section.
- This sensor system is for application onto the gas networks operating at medium pressure and low-pressure networks only.
- This sensor system is for application onto PE pipeline networks only
- This project will utilise a small rapid testing loop using air at the with external partner support through Phase 1 and 3.
- Further development of the sensor created under NGN_NIA_239
- Development of a Hosted demonstration dashboard and analytics system
- Development of solutions to incorporate dashboard and analytics into NGN IT systems [working with 3iG]

Out of Scope

- Application onto pressure systems operating above 2bar.
- Application onto the live metallic gas system
- Implementation of the Real time monitoring PoC of the live gas network [Note: would require ATEX certification]
- Implementation of the enhanced sensor developed through WP6 on the live gas network. [Note: would require ATEX certification]

Objective(s)

1. **Phase 1a: WP1 – undertaken full sensor electronic review and update.**

Up to 50 units manufactured for deployment on compressed air test rig. ATEX & H2 certified NB IoT has pressure logging system.

Several sensors created to support the ATEX development cycle to support delivery of ATEX certification. Anticipate no more than 50 devices required to undertake the modifications required and create several finalised examples to put under test at InTEGReL. Develop the existing sensor and electronics prototype and secure ATEX certification for natural gas and hydrogen applications.

2. **Phase 1b: WP2 – develop system installation method.**

A full system installation method suitable for either gas line pipe fitters of a dedicated team of technicians.

Linked to WP1 this work develops the install framework for the sensor system in collaboration with NGN experts.

3. **Phase 1b: WP3 – site deployment (testing & evaluation).**

System performance & reliability will be fully understood. Answers to all questions posed for test case studies. A list of recommended system/design changes before deployment on the live network.

This WP focuses of more in depth understanding and refinement of the system. The units will be deployed in the ground on a test pipeline (using compressed air to remove the need for network team support) at InTREGReL as it will be more efficient from a development perspective (easier to install/uninstall/quickly change elements)

4. **Phase 1b: WP4 – full ATEX design review.**

Review the system design and re-certify to ATEX (if required). Manufacture a number of NB-IoT pressure systems for deployment on live gas networks.

This work pack considers the changes brought about by addition of further sending capability, the alteration of form factor and so on undertaken in WP6, assessing for ATEX certification and moving through that process to achieve a small batch of new sensor systems with more capability for deployment and testing.

5. **Phase 2: WP5 - data storage and visualisation.**

Establish a data packet that can be utilised by existing NGN system. Data storage at NGN. Data visualisation and analysis at NGN.

Create a series of dashboard/visualisations as a demonstration of the data flowing from the deployed sensors. Undertake analysis of the data to identify insights and behaviours. Work with NGN 3iG to determine how this data flows can be brought onto NGN architecture for presentation on internal dashboards incorporating the learning.

6. **Phase 3: WP6 – additional sensors & metrics.**

Undertake analysis of the sensor technology with the aim of adapting the NB-IoT pressure sensor to measure additional metrics using suitable technologies. The system design changes required for additional metric measurements will be identified.

This work pack undertakes work to increase the capability of the sensor head and supporting in electronics to enhance improve what is possible. Specific focus will be on adding those metrics industry feel would offer the most value such as hydrogen, moisture (liquids, water) temperature for instance alongside more challenging capabilities such as basic gas composition, flow.

Consumer Vulnerability Impact Assessment

This project will undertake innovation to establish a new form of pressure sensing technology which provides a flexible and cost-efficient means to securing network performance. The project will also identify how to manage data from IoT devices such as these, which over time could number in the thousands but yet are all remotely managed [firmware upgrades, changes to alarm action points and so on]. The project will understand the potential impact of digitalisation and wide scale sensing capability on networks and specifically any impacts, positive and negative for vulnerable customers.

If this project proves successful, and networks begin to adopt this technology to gain a more granular level of information from our MP / LP networks [which is supportive of the energy systems transition in aiding the operational activities required for conversion], then there is potential for a far more proactive response to network issues [due to that improved visibility]. In such a scenario information from this technology can be utilised and cross referenced to the location of those with known vulnerabilities. This would allow networks to better align their response to a network issue and deliver a targeted response to support those very consumers. Precisely what this would look like and how those benefits might be quantified are subject to further innovation should this initial phase of work prove successful.

Success Criteria

The project will be deemed a success if the following are achieved:

Phase 1a

· Up to 50 units manufactured for deployment on compressed air test rig.

· The system must secure a ATEX & H2 certified NB-IoT gas pressure logging system.

· A full system installation method suitable for either gas engineers or a dedicated team of technicians must be created

· This project must fully analyse and comprehend System performance & reliability

· The project must answer all questions posed for test case studies

· The project must develop a list of recommended system/design changes before deployment on the live network.

Phase 1b

· Review the system design and re-certify to ATEX (if required).

· Manufacture a number of NB-IoT pressure systems for deployment on live gas network.

Phase 2

· Establish a data packet that can be utilised by existing NGN system.

· Data storage at NGN

· Data visualisation and analysis at NGN

· Undertake analysis of the sensor technology with the aim of adapting the NB-IoT pressure sensor to measure additional metrics using suitable technologies.

Phase 3

· Undertake analysis of the sensor technology with the aim of adapting the NB-IoT pressure sensor to measure additional metrics using suitable technologies.

· The system design changes required for additional metric measurements will be identified.

Project Partners and External Funding

Who	Contribution	Comments
Hp1Tu [Vendor]	£150K	Funded via Renda Systems Limited towards sensor development to TRL 8 and ATEX certification.

Potential for New Learning

This project will:

1. Establish an ATEX certified system for deployment on live gas infrastructure and develop understanding of the challenges faced with this process.

2. Develop deployment options and working with front line staff, identify the most appropriate methods / techniques and align to training and competency.

3. Create new dashboards and analytical solutions to represent the data broadcast and present a route to adoption of such technology within NGN as BAU.

4. Develop an understanding of how this new technology can be effectively managed in the field.

5. Further evolve the sensor technology to additional capability, thereby enabling greater understanding and expanding the benefits and opportunities for such technology in future.

Scale of Project

This project is limited to a small-scale pilot to first secure full ATEX certification for use on natural gas infrastructure. Once this certification is in place the pilot will then install a small number of devices [no more than 200] across the NGN network

- to validate real world performance [i.e. how does the technology perform when undergoing prolonged exposure to the elements]
- to determine how a cluster of devices can be managed remotely
- how data can be best deployed across the business.

The number of deployed sensors has been selected in order to provide some degree of statistical relevance to the outputs. Fewer than the number identified would not deliver the learning needed in terms of supply chain / product production and install costs, how they deliver service across the range of situations in our networks and how over a year they respond to the seasons.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

This project will be undertaken within the Northern Gas Network's geographic footprint

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

External costs: £550,000

Internal costs: £229,350

Total NIA Project Expenditure: £779,350

Project Eligibility Assessment Part 1

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

The energy systems transition will bring degrees of disruption and major works to convert large swathes of gas infrastructure to hydrogen over a sustained period of time, delivering Net Zero and the UK government's carbon targets. Our current techniques deployed to monitor gas infrastructure at the lower pressure tiers is at a fairly macro level, and relatively high cost, when what will be needed is a far more granular view of pressure [and other metrics] to support Non-routine operations, front line staff managing networks and the conversion process.

Application of low cost, simple pressure sensing technologies will allow detailed views of system performance and activity and underpin the required operations to manage networks effectively / better and improve knowledge and situational awareness in future, particularly important for the EST.

How the Project has potential to benefit consumer in vulnerable situations:

Secondary to this opportunity, a more detailed / granular view of our gas infrastructure could prove beneficial to vulnerable customers, supporting front line staff in taking proactive responses to network issues identified by this technology, allowing supplies to be maintained / protected and avoiding potential loss of supply incidents which could prove challenging for vulnerable customers, particularly during the winter months.

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

N/A

Please provide a calculation and/or description of the expected benefits of the solution

The benefits for this technology have been measured against incumbent datalogger technology to gauge advantage. The datalogger technology in use across NGN has a known base cost to install and operate [noting this varies depending on datalogger vendor].

A number of assumptions have been made to determine any benefit such as:

1. The installation cost remains the same for either the datalogger or new innovative pressure sensor [noting the project aims to gain further benefit by reducing install costs further].

2. The new technology battery life will be twice that of existing datalogger capability [and therefore recuing the opex costs to visit to replace batteries]

3. The unit cost for the new technology will be better than half that of existing technologies

4. The data costs for an IoT solution are lower than standard 2G / 3G based datalogger systems

Further benefits are anticipated due to the simplified design making the installation opportunities for this technology more adaptable and agile than exists currently This unlocks further opportunities to support unplanned and planned network operations to provide greater insight into network conditions than would ordinarily be the case.

This project is aiming to create sensor technology sub £200 per unit and to identify the more effective deployment model.

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

The technology being developed is entirely compatible with the other GB gas distribution networks. It is based on a standard PE component widely deployed. As such there will be no blockers to take up across GB should the project deliver the outputs targeted.

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

At this stage of development, it is difficult to determine costs associated with a GB wide roll out. This technology is seen as an additional beneficial tool to deploy on gas networks, rather than replacing incumbent technologies and may be a significant contributor towards effective long term monitoring and planning of network avctivity to enable the energy systems transition. Equally each gas network will have their own digital strategies and priority project which may alter take up of this technology across the GDN's. Implementation roll out costs will be informed by the outputs from eth project and also subject to individual GDN uptake.

Requirement 3 / 1

Involve Research, Development or Demonstration

Projects 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

Involve Research, Development or Demonstration - Please select all that apply

☑ 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 establish a pressure sensing and other sensing capabilities for deployment on a PE MP/LP gas network to enhance the situational awareness of network performance. It will identify a method to install, operate and manage the information flows.

All of this will be applicable to the GB distribution networks.

N/A

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. Networks must explicitly mention similar projects that they have considered and how these differ.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

This is a first of a kind pilot, taking the initial PoC NIA sensor development forward to address the challenges of real-world performance, deployment and management. Project information shared via GIGG [Project Notification Form] and Smarter Networks Portal search.

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

This is a follow-on project to NGN_NIA_239 which created a novel approach to monitoring pressure, developing the technologies across the three discrete stages. This has not been developed, tested or proven previously for use on a live gas network and therefore the technology remains uncertain and requires further which supports both current and future operations through the energy systems transition. The estimated TRL progression for each stage is given below:

Phase	Start TRL	End TRL
1	6	8
2	4	6
3	4	6

Relevant Foreground IPR

This project and the resultant outcomes/deliverables will conform to the default treatment of IPR as set out under the agreed NIA Governance (where the default requirements address two types of IPR: Background IPR and Foreground IPR).

Data Access Details

All data generated by this project is network specific [pressures, locations] and as such does not require any special cleansing. It is not anticipated that there will be any restrictions on data sharing at this stage however any data identified as requiring protections to be applied [for GDPR for instance] will be conditioned appropriately in order to meet the requirement.

For all data access requests, please follow the guidance set out in Northern Gas Networks Innovation Data Sharing Policy https://www.northerngasnetworks.co.uk/ngn-you/the-future/our-funding/

Please identify why the Network Licensees will not fund the project as a part of it's business and usual activities

Further development and roll out of this technology remains at a low TRL level and as such has a higher risk of failure than would be acceptable to adopt a technology in the busines. This is an innovation project to overcome the final hurdles, develop learning and support adoption. No business as usual allowances are suitable to fund development of this type of project.

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

There is a clear risk that this technology may not deliver the performance required to support adoption and roll out onto any gas network. There is a commercial risk that the cost profile of the technology escalates to secure ATEX certification and removes the cost point advantage identified.

There is an operational risk that in the field this new technology may fail, may not perform as required and introduce additional issues to restore, recover the technology from the field.

This project has been approved by a senior member of staff

☑ Yes