

SIF Project Registration

Date of Submission

Mar 2022

Project Reference Number

10027276

Project Registration

Project Title

Thermal imagery analysis - Condition assessment fluid and pressure

Project Reference Number

10027276

Project Licensee(s)

Northern Gas Networks

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

NSmith01@northerngas.co.uk

Project Budget

£86,138.00

Project Summary

Our Vision is to support hydrogen transition at the lowest possible risk and cost to UK gas consumers as fast as possible to protect our climate. This project will undertake discovery as a primary step to support our vision to provide a network tool and a UK assessment capability. The aim of this is to support a safe, environmental and cost-effective transition by maximizing existing assets informing how much and where legacy PE assets need to be replaced and/or maintained. We do this in a minimally invasive way, scheduled ahead of conversion programs minimising unplanned workloads and time off gas for consumers. The solution uses live access sensing to analyse the internal characteristics of a pipeline transporting natural gas, and simulate changes, typically in the form of deterioration or leakage that may occur through changing factors such as gas type or pressure.

This captured data predominantly will give assurance and provide essential evidence to enable a greater understanding of risks associated with legacy assets. This project would gather underpinning condition sensing data for conversion strategies and build confidence in a common approach between UK networks. The project will aim to test and understand the viability of leakage sensing for conversion assessment to minimise uncertainty around pressure elevation to maximise the retention of current assets. The project supports the evaluation the costs, risks and opportunities of reproping or decommissioning excising gas network infrastructure for use with hydrogen. This supports future energy provision for heating, power and transport, safely, at a low consumer cost and in a minimally carbon intensive way.

We meet the scope by implementing novel sensor and digital assessment infrastructure to improve network planning, modelling and forecasting capabilities around conversion and replacement risk for legacy assets with field gathered datasets. NGN developed and deployed robotics within the UK having operational expertise in solution deployment. Synovate has developed the sensor technology having research capability in thermography, vision, utilities and inspection. National Grid Transmission has developed and deployed robotics within the UKs Above Ground Infrastructure (AGIs) for non-destructive testing and inspection. These project partners are the best to continue this journey as the team holds knowledge and capabilities in sensing, pipeline inspection and hydrogen conversion where NGN have led many packages of work with the H21 and HyDeploy projects for Hydrogen. National Grid UKs Gas transmission operator with unparalleled access to and knowledge on the UKs AGIs.

Preceding Projects

Third Party Collaborators

Synthotech Limited

Synnovate

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Problem Being Solved

Hydrogen is a critical energy solution that will enable the UK's transition to net Zero (UK Hydrogen Strategy, 2021). Hydrogen transition for heating and transport requires assurance for current assets to carry this new gas. As networks adopt hydrogen there are challenges including combustion ranges, combustion characteristics, higher leakage rate potential which may permeate and diffuse differently. Hydrogen's higher leakage potential, wider combustion range and lower ignition energy present new challenges for gas networks.

There is significant ongoing work in H21 to understand the repurposing of gas assets for hydrogen. There is no known live inspection solution that assesses low rates of leakage which may increase after hydrogen conversion. Polyethylene (PE) was first installed UK gas networks in 1969. There are several grades and manufacturers and over the last 50 years there have been significant changes in installation techniques, tooling and fitting designs. A significant factor in the integrity of PE networks is the quality of construction. Modern installation practices (since 1990s) provide a more mechanistic and robust process.

Construction techniques pre-dating this period were varied and susceptible to human factors. Our assumption is that a percentage of the portfolio of network assets require evidential assessment to determine actual and future state characteristics prior to conversion, to decrease uncertainty of costs and associated impacts. We aim to provide a cost effective, minimally disruptive tool for verification of current network assets to carry hydrogen at an elevated pressure. This would balance cost, assurance and risk to provide an efficient and effective transition in the shortest timelines possible. This project will enable better understanding of the challenges that will be faced relating to legacy PE assets and will inform risk, future monitoring requirements and reduce conversion costs.

Project Approaches And Desired Outcomes

The Big Idea

Efficient replacement or direct asset conversion to hydrogen offers the possibility of significant socio-economic and environmental benefits for the gas consumer and is a significant opportunity for climate change abatement. Earliest hydrogen transition has huge potential for deep decarbonisation of heat and transport. The pinpointing and reduction of current methane leakage is a priority with a further 30% reduction required by 2030 (COP26). Low-level pipeline leakage may be under-reported using traditional channels such as public reported escapes (PREs).

We have developed a sensor that can detect the presence of these types of leakage. We aim to test the distribution of these on the networks, catalogue and estimate what these mean for a transition in terms of risk to investment cases and the public. Doing so means that we can reduce uncertainty relating to conversion and inform investigation and action requirements for future RIIO price control periods. Early surveillance reduces the constraints imposed operationally for pressure elevation requirements, which are likely to be required to enable conversion.

Through improved planning and asset visibility we build certainty where / why a transitioning gas asset would fail a pressure elevation activity ahead of time. We can then reduce costs and improve base case productivity. This data provides critical information for Quantitative Risk Assessments which are cornerstones of GDNs transition strategies. By supporting transition in cost-efficient manner networks are able to better provide for heat, energy and transport cost competitively and with minimal interruption.

The idea applies a novel leakage detection sensor, based on machine vision, active thermography, and a detection framework to assess defect types and estimate leakage distributions. The sensor is used under live pipeline conditions where a heating element warms pipeline gas and thermal imaging assess the heating rate of leaking defects to estimate a volume and provide a risk score. The identified pipeline leakage, defects and distributions will inform the most cost and societal risk effective replacement, repair or monitoring methodology. This provides a new angle of condition distribution data through direct inspection rather than public reported escapes.

This data and enabling digital technology help prioritise pipeline remediation and replacement investment strategies by enabling the evaluation of both costs and opportunities of repurposing existing asset infrastructure. Information and examples relating to our minimum viable sensor technology, leakage estimation framework and typical detections is provided in the Appendix.

Innovation Justification

The technology is new and novel and therefore uncertain. To build datasets a significant body of field validation experimental work is required. This experimental validation and the data that is produced has significant short- and long-term benefit for UK domestic gas infrastructure, climate pledges, UK engineering & technology and robotics fields. There are a number of technological, commercial and other risks that surround the project.

These risks and the large-scale requirement of data gathering and technical optimisation of a new and novel sensing technology within highly regulated business is challenging and not considered as a business-as-usual activity. The sensor and remote live access inspection robotics that have been prototyped are truly innovative and do not have established commercial or business models. This is a growing field that applies cutting edge technology and research within an extreme environment.

Northern Gas Networks and Synovate have worked together on robotics projects previously. The Synovate team have researched similar projects elsewhere nationally and internationally and a summary of some of these projects is included in appendix 5. Together we have developed a minimum viable product to demonstrate the feasibility of applying live gas leak sensing in-pipe using robotics and de-risk this proposal. To our knowledge this is a world's first and offers a significant value proposition over traditional CCTV inspection systems which has an estimated UK annual market of £20-30M.

We have already developed a range of learning from previous work. Notably we have generated research and learning, independently proving that we can estimate leakage volumes using in-pipe thermography. We have developed sensing technology that can be applied to a natural gas infrastructure and has been proven on actual assets. Synovate have proven experience of the design and development of inspection systems have successfully completed gas network research and development within UK and internationally.

Northern Gas Networks have implemented robotics within their business by upskilling existing workforce. This has been implemented

within the UK national distribution gas assets. National Grid Gas Transmission have completed robotics projects and have a history of managing some of the UKs most critical infrastructure. National Grid have implemented inspection robotics within the UKs national transmission gas assets including AGIs.

Project Plans And Milestones

Project Plan And Milestones

WP01: Problem Definition

Project Team shall focus on the generation of common problem statements around the data and assessment requirements for predominantly legacy PE and leakage using novel sensing.

WP02: Definition of Solution Value

Project Team shall assess the solution values for the identified problem statements. Where possible we will use accepted methods such as the RII02 benefits model, the green book guidance or the ENA whole system cost benefit model.

WP03: Facilitation of Common Understanding

Project Team shall run stakeholder events to disseminate knowledge and build common understanding of legacy PE, in-pipe sensing, leakage modelling and how these will impact hydrogen conversion process and planning. This will be fed from, and feed into, our problem definitions.

WP04: Constraint's Identification

From the problem definitions, solution values and facilitation events we will build a picture of the constraints and propose solutions. These will include regulatory, technical, commercial, operational and social / change constraints.

WP05: Define Assumptions for Test

Project Team shall evaluate the learning from WP 01, 02 & 04 and will create a prioritised framework of constraints and assumptions that we will plan to test in the Alpha stage. We will seek to gain insight from multiple stakeholders to for a robust case to test underlying requirements.

WP06: Report on Discovery

Project Team shall report on the discovery stage and consolidate the learning from the discovery and prepare evidence.

Route To Market

We believe that there are many routes into the market from the learning, innovations and networks that would be fostered from this project. The minimum viable product (MVP) would be a leak detecting thermographic pushrod camera and supporting digital infrastructure; allowing gas transportation networks to pinpoint, digitise and evaluate condition and leakage risk for primarily PE assets.

Northern Gas networks are the first UK gas distribution network operator to embed pipeline maintenance within their business, having implemented the System Two Assess and Seal Solution (STASS) since 2017 to repair leaking cast iron joints. Leakage condition assessment provides a transformative method to simulate hydrogen networks and builds upon our aim to continue to work in new areas ambitiously.

Synovate have the expertise in inspection data, thermography, image analysis, tailor inspection parameters for other networks, materials, tooling & methods, generations of material and pipeline gasses. If successful post Beta, Synovate will enable UK procurement through its partner organisation Synthotech who have an established and dominant presence for manufacturing and distributing traditional CCTV cameras for gas inspection and a growing international distributorship. Synthotech are an approved supplier to all UK gas network operators and many of their sub-contractors, having existing supply chains already supported with marketing, training and aftercare that are like those required.

With regards to Northern Gas Networks, the outputs of this project are anticipated to become business as usual by focussing on internal engagement with various stakeholder groups to ensure that data is not only collected by utilised and leveraged to deliver significant impact values across the following primary business areas:

- Customer Operations – Improved REPEX productivity, Improved leakage repair efficiency, reduced customer disruption, reduced excavation footprint, reduced Opex expenditure

- Asset Risk, Strategy & Investment
- Network Planning & Design
- Environment & Sustainability – Methane Emission Reduction
- 3iG – Digitalisation Strategy

The project will build data sets and field verification of the sensor and allow for miniaturisation of the active detection methodology. Synovate's go-to market product strategy would be for methane leakage detection of low-pressure pipes as this is anticipated to be a larger anticipated market for hydrogen conversion product development.

By working closely with Operational Teams to capture data across the multiple use cases, we will build evidence of benefits for investment cases as well as a data sets testing the possibility to identify leakage internally and at scale

Current Hydrogen conversion strategies pose various unquantified risks for NGN, the wider gas industry and "UK Plc", due to the associated uncertainties, we believe that the earliest possible generation of supporting learning has the potential to begin to quantify and significantly reduce such challenges and increase productivity.

There is no known competition of this value proposition, due the novel technology associated with sensing for low pressure gas leakage detection via use of thermography. There are many leakage detection solutions either acoustic or above ground but none that pin-point leakage internally at low pressures in live gas assets.

Costs

Total Project Costs

86138

SIF Funding

71182

This project has been approved by a senior member of staff

Yes