SIF Project Registration

Date of Submission

Mar 2022

Project Reference Number

10027292

Project Registration

Project Title

Excess Gas Turbine Energy Generation

Project Reference Number

10027292

Project Licensee(s)

Northern Gas Networks

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

NSmith01@northerngas.co.uk

Project Budget

£141,903.00

Project Summary

This whole system integration project aims to decarbonise the gas distribution operation and reduce cost, with a benefit to the energy consumers in the way of reduced tariffs. We aim to investigate if the power generated from excess gas can be fed back into the grid or stored, improving the coordination between the gas and electric network, and assessing the cost of potential energy demand reduction activities. To design for scalability and harness value from data across organisations, we will determine the digital systems architecture to improve data collection, quality, interoperability and shareability.We are evaluating the introduction of a new product and service that has been proven in the oil and gas sector but is new to the UK energy market. The main users will be gas distribution and transmission businesses. The project entails evaluation of novel approaches to infrastructure investment by taking a systems'view across generation and demand side, determining new financial viability for infrastructure expansion and modernisation.

Preceding Projects

NIA_NGN_431 - Vorte Heating Solution

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Problem Being Solved

As economic activity increases, the demand for energy, the associated carbon emissions and consumers' energy bills also rise. The increased energy demand requires more grid connections than are currently available. And the increased carbon emissions and consumers' bills costs required a rethink of how all sectors of the economy operate and interact amongst each other, especially how excess energy generated by one business could be harnessed to power another to reduce carbon and energy costs. Energy networks are right in the middle of this energy transition. They are seeking ways to not only decarbonise their businesses, but also integrate with adjacent businesses in a whole system fashion.To this end, gas distribution networks (GDNs) in particular, have set very ambitious net-zero goals driven by three themes. First, GDNs have kicked-off major digitalisation programmes that aim to increase the efficiency/effectiveness and reduce the carbon-intensity of GDNs' operations. This entails an increase in the number of digital systems (telemetry/control/workforce enablement) across their networks at the expense of requiring more grid connections than currently available, along with the new connections' cost, and an uplift of the network's electricity consumption profile to power the increased number electronic systems required. Second, GDNs aim to take their operations off-grid as much as possible or achieve 'net-zero' by tapping into renewables and provide a secondary fallback resilient power source. But renewables are intermittent, and their geo-location doesn't match the footprint of GDNs networks. Third, GDNs have set the even more ambitious challenge to provide energy back into the grid to address its constraints and/or reduce the cost of energy back to the consumer. So how could GDNs achieve their ambitious goals to power the digitalisation agenda, achieve net-zero, and feed energy back into the grid? The solution is to identify future power requirements from digitalisation, design the corresponding architecture, and explore reliable renewable energy to power this modernisation. Such a solution has been developed by Revolution Turbine Technologies' (RTT) which produces scalable, affordable, and reliable zero-emission electric power using excess pressure in flowing gases. However, the technology has originally been designed to operate in offshore remote oil and gas production sites and the opportunity is to undertake R&D and adapt RTT's technologywithin onshore GDNs to tolerate methane-hydrogen blends and operate efficiently and reliably over a wider range of pressures and flow rates vs. the ones found in GDNs

Project Approaches And Desired Outcomes

The Big Idea

This is a strategic network innovation project needed to achieve the multi-vector transition to net-zero across gas and electricity. The aim is to determine the techno-economic viability of installation of non-intermittent (resilient) renewable power generation technologies in GDNs, to deliver on the three ambitious themes discussed earlier; first, to decarbonise operations via digitalisation, Our digitalisation strategy at NGN is actually very simple, to build a digital platform that meets the needs of the present without precluding the needs of the future. This enables short term focus against a long term vision. Second, to take the GDN off-grid, and third, to provide energy back into the powergrid if possible. The project also evaluates which digital technologies will be needed to guarantee scalability of this vision.Previous generations of mETS have been successfully deployed in oil and gas offshore platforms in Angola and Mexico generating 400W of electricity in each case. The third generation of the technology is under development at pilot level. RTT embarked on a 2-year project to improve the efficiency of the mETS through redesign of the nozzle and turbine blades, to increase the output to 1kW without significantly increasing required pressure and gas flow rates, and to add smart functionality enabling multiple turbines to be operated in parallel where higher power outputs are required. All intellectual property (IP) associated with RTT mETS is owned by RTT. The global IP portfolio includes granted patents in the USA, Canada, UKand Malaysia.

This discovery phase will inform and provide the direction to identify power demand requirements, for different locations and asset-types within the GDN. On a micro scale, examples include individual isolated IoT sensors/gateways. On a larger scale, entire telemetry and control systems across the pipeline network including gas compression/decompression stations. We will also determine under what conditions the GDN will be able to go off-grid and the viability of feeding energy back to the grid, including storing it when in excess.The renewable energy source proposed is RTT's micro-Expansion Turbine System (mETS). The turbine generates electricity through the recovery of excess natural gas pressure (or other available gases). Because there is no combustion, mETS systems are incredibly reliable, even in extremely harsh environments. Excess gas pressure is used to generate net-zero power and the same gas is returned to the system or pipeline from where it originated with the benefit of being at a reduced pressure.

Innovation Justification

GDNs are already working to harness the power of digitalisation but funding for innovation is needed to move faster and meet net-zero targets in time. To achieve net-zero and enable GDNs to explore the potential to feed renewable energy back into the grid, various systems will need to interconnect. This will increase digitalisation demands and subsequently their power needs. This discovery project proposes to determine the digital and energy requirements, the type of digital architecture, and a green energy technology that converts changes in gas pressure to electric energy to power new devices. Our project will target small pressure step downs, developing low-cost fit-for-purpose technology, and providing either remote, off-grid electricity, and/or the possibility of grid interconnection. In addition, the evaluation and criteria for decision to implement will include both cost and carbon footprint reduction enabled by replacing or supplementing existing sources of electricity with a zero-emission alternative. This techno-economic analysis is crucial.To our knowledge, this specific need has never been addressed with waste pressure recovery technologies, but rather with more conventional approaches. We are only aware of two technologies that are used in the smaller pressure step-down ranges. One of them is Thermoelectric Generators (TEGs), which offer ease of deployment but are unreliable, create significant CO_2 emissions (combustion generators -not net-zero), and are limited to 500W in generation. The other is PVs but are intermittent with higher power cost compared to TEGs and large physical footprint requirements. PVs also have battery and cleaning maintenance issues and are prone to theft.The technology embodied in mETS has been successfully demonstrated in numerous offshore O&G production projects, where local power needs were met by installation of small, zero-emission turbines (Angola-Chevron, Mexico-Pemex, Nigeria-Shell). The extensive R&D which led to these improvements, while intended to meet new challenges in the offshore environment, provided a wealth of new predictivemodelling and performance data which can be put to immediate use in customizing the mETS technology for adaptation to a wide variety of settings,with a wide range of gas pressures, flow rates and compositions, and with varying power output requirements. This knowledge base, combined with the strength of RTT's team and strategic partners, should minimize the technology risk associated with adaptation to enable installation onto the natural gas network system and integrate into the UK energy network landscape.

Project Plans And Milestones

Project Plan And Milestones

The project will be split into 3 work packages (WP), with as many tasks parallelised as much as possible to de-risk delivery. We will operate in an agile manner.

WP1(Milestone1): Power Needs & Requirements (Lead:Digital Catapult, Participants: All)

1. Feasibility study of the existing NGN infrastructure. This will include an assessment of the landscape of the distribution grid, where and how things are laid out. e.g. assets, terrain, remoteness, geology, environment (indoor/outdoor), hazard scenarios etc. (DC)

2.Future NGN network power needs driven by digitalisation requirements (field and back end). This will involve understanding the data requirements in terms of the data sources, frequency, data type, data format, data flow and end points (DC)

3.Power grid demand and constraints & costs to connect (NPg)

4.Gas pressure step down locations and grid interconnections

WP2(Milestone2): mETS Feasibility and Adaptation (Lead: RTT, Participants: All)

1.Understand problem space and make a feasibility analysis of the mETS appropriateness. Capture the business and technical requirements of the use case and application and provide a gap analysis between existing and future needs. (RTT)

2.Identify mETSproduct requirements for deployment (materials & miniaturisation, power yield, component optimisation) (RTT)

3.Map out net-zero power yield potential for whole system integration & develop CAPEX and OPEX life-costs (across different GDN assets -district governor) (RTT)

4.Determine and map out key areas for product development during Alpha phase (RTT).

WP3(Milestone3): Network Digitalisation Requirements (Lead:Digital Catapult,Participants: All)

1.Architecture and design. high level architecture for 2/3 most relevant scenarios which cover topology, environment, application and security.

2.Analysis and estimation of power needs and budget.

3.Recommendation for sensors and instrumentations and indicative cost for 2/3 most relevant scenarios.

4.Assessment and recommendations for integration of mETS solution into the NGN network digitalisation plan.

5.Consumer Engagement Survey (Lead: SDAIS, Participants: All)

Final Deliverable(Milestone 4): Recommendations (Lead:All)

1.Alpha phase justification –'Business Case'

Project milestones

(Milestone1):Completion of Power Needs & Requirements

(Milestone2): Completion of mETS Feasibility and Adaptation

(Milestone3):Completion of Network Digitalisation Requirements

(Milestone 4): Recommendations/Phase Closure Report

Route To Market

An important part of this discovery project will be to determine new digital infrastructure and systems in NGN's gas distribution network to move towards net zero, and future requirements for feeding energy back to the electric grid. In doing so, and after the alpha and beta phases, NGN and Digital Catapult will investigate and test technology options that best fit these needs, including novel offerings from within Digital Catapult's extensive ecosystem of digital technology innovators who might identify a route to market for their innovations in the utility sector. We anticipate there to be more than one product line being offered to NGN as part of the technology stack.On the mETS side, the gas type being transported through the GDN will have an effect on the mETS performance across the product range. The addition of hydrogen will alter the nozzle design and pressure performance requirements and affect the choice of materials. By the Beta phase the RTT mETS will have addressed a gas composition containing at least 20% Hydrogen and work will then be required to enable the same performance and efficiency to be translated to 100% hydrogen operation.This project offers the opportunity to adapt mETS and its underlying technology principles for onshore operations. The material and manufacturing process selection will also give the opportunity for full production and assembly to be based in the UK. RTT will contract with preferred GDN manufacturing partners to produce the mETS system cost-effectively and will utilize global channel partners to facilitate sales and service.Initial market entry will be with the early adopter who has supported RTT through the Alpha and Beta phases. The data at the Alpha pilot trial stage with NGN can be used to demonstrate the usefulness, efficiency, and performance of the innovation to power NGN's digitalisation, net-zero, and whole-systems agenda, and do the same for other UK GDNs, facilitating further deployment discussions within their networks.Assuming completion of the beta phase, we foresee the design and development of various modified mETS product lines covering varying pressure step-down options throughout the GDN. We also anticipate the potential to have developed a bigger-scale and low-cost mETS with more ambitious generation capacity. The aim is to roll out the innovation across all key gas networks and to expand throughout Europe and USA.

Costs

Total Project Costs

141903

SIF Funding

134162

This project has been approved by a senior member of staff

☑ Yes