national gas transmission

SIF Project Registration

Date of Submission

Mar 2022

Project Reference Number

10021808

Project Registration

Project Title

Gas Analyser Systems for Hydrogen Blends

Project Reference Number

10021808

Project Licensee(s)

National Gas Transmission PLC

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

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Project Budget

£113,414.00

Project Summary

This Fuel Cell gas analyser Sensor (FCS) digitalisation project is a key digital enabler for the gas networks' drive towards net zero and decarbonisation. The net zero programme of work needs to find cheap / accurate, digitally agile sensors for gas quality control analysis, the protection of assets and the provision of accurate calorific values (CVs) for customer billing. Current sensors (e.g gas chromatographs) are considered too expensive and too slow to undertake the work required given the numbers of units potentially required. Net zero gas generation is likely to be highly distributed throughout the network and from numerous localised generation points. The fully integrated FCS system will be connected via the Internet of Things (IoT) directly into the transmission and distribution businesses and their quality control systems and respective billing systems to accurately report on calorific values, Wobbe index information and relative gas densities.

Provision of the monitoring data / information to the IOT will allow better control, transparency and monitoring of gas network data as well as providing customers with accurate local CV's through their smart metering systems.

The Des19ncor and Loughborough University team, have circa 20 skilled engineers and scientists available to work on this project and are best placed to advice on this digitisation discovery project.

Users of the innovation will include.

- Transmission and Distribution gas networks e.g. National Grid and Cadent
- Hydrogen and Bio-methane producers.
- Regulators e.g. OFGEM, HSE etc.
- Customers e.g industrial and domestic.
- Future hydrogen grid testing.

The introduction of blended hydrogen and full hydrogen into the gas networks will require a higher level of real-time quality and CV

controls than currently exist in the networks today. Current systems which mainly rely on 30 year old technology, i.e. gas chromatographs, are slow to report (i.e. ranging from 4 mins to 12 mins) and have old software for reporting which will not be sufficient moving forward.

Network users will need the following to control the network adequately as they move forward to facilitate Net Zero.

- Accurate contact gas sensors which are sufficiently inexpensive to place c 00,000's into the network.
- To connect these sensors through the IOT to digital control and reporting systems.
- Local calculation of CV's at governor sites for accurate customer billing and the ability to connect sensor results to smart metering systems.
- Digital systems connected to sensors to report on embrittlement, permeability and vibration.

VIDEO - https://www.youtube.com/watch?v=WGo15qU_KK8&list=PLrMOhOrmeR6ktSag0RbT7zPNVn0p1P2f6&index=24

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Problem Being Solved

The gas industry worldwide has no sensing devices that are Internet of Things (IoT) networked and can economically measure mixed natural gas, bio-fuels and hydrogen gases in a highly distributed format, to provide the quality control and calorific values (CV), sufficient to protect assets and drive billing. A Fuel Cell gas analyser Sensors (FCS) is being developed to measure all these gases cost effectively in near real-time to provide quality control (i.e. Wobbe Index / relative density) and accurate CV's and potentially ISO 6976 calculations. This will move the industry away from a relatively low number of chromatography sample points and the use of weighted CV averages for billing purposes to accurate CV's based on point of use data available via IOT sensors.

FCS could potentially be much cheaper to buy, install and operate over the whole life cycle - up to 20 times cheaper than current technology with readings delivered near real-time data rather than the existing 'fast' 4 minutes. The current gas network has relatively few gas injection points and deploys expensive large scale measurement devices at these points. It then uses a weighted average to deduce a combined calorific value for charging purposes. Net zero gas production could result in 00,000's of locations where hydrogen and bio-gases are being created and measurement is needed. This diverse gas injection environment will create a similar demand for gas sensor units in the UK alone and perhaps 50 times as many worldwide.

FCS uses open software, has a proven technology and has recently passed its proof of concept with Innovate UK but now needs to be assessed for distributed use on the gas network. If successful the opportunities are as follows.

- Accelerate the move to Net Zero by acting as an enabler for blended H2 and bio-gas controls.
- Bring a benefit to energy customers by reducing operating costs.
- Through large and immediate data acquisition facilitate predictive asset management controls for such things as embrittlement, permeability and gas quality controls.
- Deployment of the FCS at step down governor sites could see the end of weighted average CV's for fiscal billing and enable point of delivery CV's to the customer (e.g. connecting the FCS near real-time data up to smart gas meters).
- For large industrial users the FCS could be deployed locally to assist with transition de-blending and production control.

Project Approaches And Desired Outcomes

The Big Idea

We have developed the Fuel Cell gas analyser Sensor (FCS), which is a low cost contact gas measurement device, to a stage where system has been demonstrated in a lab environment. We are requesting Discovery SIF to test the feasibility of developing the FCS, to a demonstrator prototype, where the data can be assessed against the end customer needs and is capable of actual deployment, initially at an offline test facility and subsequently on an active gas Offtake site, alongside existing gas sensor arrays. This will enable the main innovation, which is to be able to detect and accurately analyse multiple gas sources, including hydrogen and new bio-gases, into one, low cost product that provides near real-time data to an Internet of Things (IoT) environment.

The FCS technology is currently sitting at TRL 4 and the Proof of Concept has been demonstrated to National Grid Gas Transmission in parallel gas testing alongside 2 gas chromatographs in a lab environment. Loughborough University and Des19ncor Ltd have filed 2 patents for the FCS, with the first patent being granted and the second awaiting approval. We are continuing to accumulate claims and will be filing these in due course to protect our IP. These patents allow us to invest in the technology without fear of duplication. Des19ncor Ltd. has also secured an exclusive licence for the FCS from Loughborough University to commercially exploit the technology worldwide. Our intention is to use the licence to manufacture and sell units both in the UK and worldwide. Loughborough University is a world class research centre in the development of fuel cells and their applications with a team of over 20 academics available to assist.

Our FCS differs from current gas sensors in the following ways:

- Technology is robust / reliable, fuel cell technology is nearly 100 years old and is tried and tested.
- Sensing outputs originate from actual gas contact measurement providing near real-time data.
- Each fuel cell inserted into the product is factory set for a specific gas type and doesn't require re-calibration.
- The prototype is approx 1/20th the price.
- Small size and cost means the unit is capable of rapid and multiple deployment.

FCS will be connected to the IOT and provide a fully integrated solution to quality/asset managers, billing managers and consumers.

- Open software systems provide greater flexibility for the end users and gas consumers.
- Connections possible to machine learning artificial intelligence systems

Innovation Justification

Des19ncor employed a Loughborough University PhD Research Assistant for 6 months to conduct an extensive research project looking into the available gas sensing technology for the UK and worldwide. The high level findings were as follows.

The gas sensing market is controlled by a small number of large players e.g. Emerson, Orbital, ABB, Siemens.

The UK gas industry currently relies on gas chromatographs (GC) for gas sensing, quality control and calorific value (CV) calculations, these systems are slow to operate and are not digitised. All chromatographs rely on flaming the gas and have to be calibrated for the specific gas types and need re-calibrating frequently. Additionally, two GCs are required if hydrogen is blended in the gas network.

National gas distribution companies use some non contact sensors on parts of their network for quality control e.g. GasPT / GasPTi from Orbital which use the speed of sound and Raman technology which uses lasers passed through the gas stream to deduce the results. Both of these technologies have drawbacks, either deducing gas percentages from look up tables, or not capable of hydrogen sensing, but neither are currently being used to calculate CV's for billing purposes because they are non contact systems and don't meet the regulatory requirements. Neither of these systems are likely to prove acceptable and/or quick enough to cope with the rigorous requirements of the new blended hydrogen / bio-gas systems envisaged for the Net Zero transition. Blended hydrogen mixtures are likely to be highly volatile during transition as the levels of hydrogen placed into the network rises from a few % to 20% and the need for fast local quality control becomes paramount.

As hydrogen is not currently transported through the gas network (apart from the very small amounts allowed to date) there has been no need for this technology. Business as usual activities focus on the current natural gas only GCs and as such this is why innovation funding is required to promote the understanding and demonstration of future technology within the gas sensing sector.

Project Plans And Milestones

Project Plan And Milestones

Our detailed project plan, is split into 4 main work packages (WP):

- WP1 - Feasibility design stage, exploration to be matched against critical success factors. The output from this WP will be a system architecture and preferred solution report.
- WP2 - Solution Prototyping and fabrication to improve on lab-based prototypes. The deliverable from this WP will be the laboratory prototype and software systems test plan.
- WP3 - Rig testing of the prototype Fuel Cell gas analyser Sensor (FCS) against different gas types and matched against 2 Emerson sensors from National Grid Gas Transmission.
- WP4 - Solution and commercialisation viability report which will include end-user feedback, outline business plans for the Alpha phase and risk matrix / mitigation report.

This project will be led by National Grid and have Des19ncor Ltd and Cadent Gas as project partners. Milestones for Discovery are:

- M1 - Project mobilisation meeting - 1/3/22.
- M2 - Architecture of prototype / system rig design - 11/3/22.
- M3 - Fully assembled prototype / system ready for testing - 31/3/22.
- M4 - Commercialisation prospects meeting - 22/4/22.
- M5 - Provision of end of phase report - 29/4/22. The Alpha Phase of the plan will take the prototype and its digitised system through the various levels of technical readiness (TRL) until we have a first full unit for deployment in late 2023.

Success criteria for the discovery project are:

- Ability to sense hydrogen and C1-C6, C6+ accurately in comparison with gas chromatographs .
- Software and system architecture agreed.
- User feedback of test results is positive. Prince2 project methodologies with Agile Sprints will be used to manage the project and ensure cost, time and quality parameters are met.

Key risks are:

- Time / costs - project overruns or overspends - PM will control these using Prince2 techniques.
- University focuses on project - work will need to be scheduled to avoid issues with holidays.
- Handling of the calibration gases, the University has key processes to manage properly.
- Covid19 national lockdowns re-imposed.

Des19ncor resources for this project total 148 days

- Project Manager 24 days.
- Technical Director 42 days
- Engineering Lead 42 days.
- Software Engineer 15 days.
- University Research Assisstants 46 days.
- University FCS lead 30 days.
- Material and consumable costs £4,500.
- Travel and subsistence £1,600.

Total Des19ncor and sub contractor costs are £99,200.

Major constraints are anticipated to be:

- OFGEM approvals for fiscal billing and gas quality.
- ATEX approvals for network trials

Route To Market

The commercial potential for this product lies mainly in the collaboration agreement that we have with National Grid Gas Transmission

(NGGT), and Cadent Gas and the other distribution network operators who are supportive of this project. They are all keen to understand the potential benefits of the Fuel Cell gas analyser Sensor (FCS) for digital gas quality control systems, which will have to expand to cope with the new distributed nature of net zero gases. Existing technologies will be too expensive to deploy economically and are too slow to manage what is likely to be a very dynamic mixture of gases in the blended supply.

Des19ncor are also being advised by Chris Train OBE the ex. CEO of Cadent Gas so that our project can directly feed into Chis' work for BEIS on moving gas towards net zero and Cadent's Future Billing Project. Our initial commercialisation therefore relies on selling time and products for national trials to transmission and distribution gas networks to test and then develop the product from there.

NGGT have a need to replace approximately 200 analysers throughout the network during RIIO 2 and there are approximately 15,000 gas sensors on the distribution network that would also need replacing to assist in the move towards net zero. Subject to a successful discovery phase NGGT would like to place our Internet of Things (IoT) enabled FCS into an offline test facility prior to trialling the technology at a live site in parallel with existing sensors.

We would therefore build our research and development and manufacturing capability to deliver this testing and development phase. For a full net zero roll out to facilitate hydrogen and bio-gas insertion into the network, Chris Train believes the network could require circa 200,000 to 300,000 sensors throughout the network to control gas quality and provide calorific values for billing purposes. At this stage we will look to licence the product to large UK manufacturers.

This increase in demand for the FCS is likely to occur post 2026, with replacements to existing infrastructure and small scale trials occurring earlier in the cycle in readiness for the growth. This gas sensor market worldwide is worth $1bn and is growing at 6.4% annually.

The non-licensee project partner, has no need for investment either before, during or after the project.

Costs

Total Project Costs

113414

SIF Funding

113414

This project has been approved by a senior member of staff

☑ Yes