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

Feb 2018

Project Reference Number

NIA_CAD0020

Project Registration

Project Title

BioSNG City Conversion

Project Reference Number

NIA_CAD0020

Project Licensee(s)

Cadent

Project Start

February 2018

Project Duration

0 years and 10 months

Nominated Project Contact(s)

Cadent Innovation Team, Angus McIntosh (SGN), Ian Marshall (WWU)

Project Budget

£313,333.00

Summary

A number of new low carbon technologies such as anaerobic digestion, BioSNG and hydrogen blending are being developed to contribute to the decarbonisation of heat. Recent work by KPMG[1] has shown that the evolution of the gas network through the use of these green gases is more practical and has lower costs than alternative pathways. However, these new technologies require a paradigm shift in the supply of gas into the network from a few, very large scale inputs to a large number of distributed small inputs.

Nominated Contact Email Address(es)

Innovation@cadentgas.com

Problem Being Solved

A number of new low carbon technologies such as anaerobic digestion, BioSNG and hydrogen blending are being developed to contribute to the decarbonisation of heat. Recent work by KPMG has shown that the evolution of the gas network through the use of these green gases is more practical and has lower costs than alternative pathways. However, these new technologies require a paradigm shift in the supply of gas into the network from a few, very large scale inputs to a large number of distributed small inputs. Current gas network design and operation assumes that gas will flow down network tiers of reducing pressure. The primary problem addressed in this project is how networks will evolve to meet the requirements of consumers when there are a distributed set of gas generators injecting at all tiers of the network. This will result in significant changes to network operation and architecture that present the secondary problem of what commercial structures and relationships are appropriate for a gas network with distributed generation. This project will take a similar approach to the NGN Leeds City hydrogen conversion project to consider the network issues presented by distributed generation by considering the complete conversion of a city to green gas. This will provide information to support the networks obligation to connect BioSNG plants to the network.

http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

Method(s)

This project will assess the feasibility of the complete conversion of two UK cities to green gas. For simplicity, BioSNG will be

considered, but the learning from the project will apply to all distributed gas generation. The project will cover the overall costs, carbon emissions reduction, impact on consumers and regulatory aspects of the conversion. Feedstock availability, BioSNG conversion infrastructure, modifications to gas network architecture including storage considerations, changes to the operation of the network and the potential for new commercial arrangements associated with a low carbon gas network will all be investigated.
The output from the project will be a report detailing how the selected cities heating needs can be met by distributed gas networks. This will provide an invaluable tool for gas distribution network operators, regulators, local and national Government and non-Governmental organisations to plan for a low carbon future and will set out a clear vision of the role that green gas technologies can play in decarbonising heat. The objective of the report is to review a model concept considering the implications of complete conversion. The report will then make a high level assessment of the impact of more realistic heating assumptions on forecast costs and greenhouse gas emissions.

Scope

The proposal is that technical and commercial consultants will work collaboratively with Cadent, SGN, Advanced Plasma Power (APP), and Progressive Energy (PEL) to produce a report setting out the technical, commercial and environmental impacts of converting two UK cities to rely solely on green gas produced by a set of local BioSNG facilities. The project will be broken into six stages as follows:
1. Selection of two candidate cities and analysis of gas requirements.
2. Identification of available sites and feedstock for BioSNG production.
3. Cost benefit analysis of production, network and storage architectures for gas distribution.
4. Research into alternative commercial arrangements for ownership and operation of the gas production and network.
5. Analysis of cost and environmental impact of conversion.
Sensitivity analysis of different options.

Objective(s)

• To assess the feasibility of the complete conversion of two UK cities to green gas.
• To define the overall costs, carbon emissions reduction, impact on consumers and regulatory aspects of the change.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

1. Identification of gas volumes to meet the cities' heat requirements, sources of waste and biomass feedstocks and potential sites for the required BioSNG plants.
2. Comprehensive analysis of gas network architectures for meeting the cities' heat demands which draws conclusions regarding balance of storage requirements and fossil gas for meeting demand variations, required changes in network architecture and/or network operating procedures.
3. Recommendations on appropriate commercial model(s) for integration of BioSNG plants, storage and the gas networks.
4. Calculation of the overall costs, and costs to individual consumers, and the GHG impact, of converting the cities to run solely on BioSNG.

Project Partners and External Funding

Advanced Plasma Power
Progressive Energy Limited
Cadent
SGN
Wales & West Utilities
Consultants - Element Energy and DNVGL
Total external costs - £235,000
Internal costs - £78,333
Funding for the project will be provided by the Network Innovation Allowance.

Potential for New Learning

No significant research has been undertaken to date on the costs, benefits, impact and feasibility of converting an existing gas network in a UK city to a distributed generation model.
This research will produce a detailed design with an impact assessment that can be replicated across similar UK city networks. It will provide outputs which are similar to the Northern Gas Networks Leeds Citygate project, to allow the practicality and economics of conversion of city networks to hydrogen or to BioSNG to be directly compared.
This learning will be disseminated through a project completion report which will be presented to Government and to relevant non-governmental organisations, industry and academia.

Scale of Project

Phase 1 - Selection of Candidate Cities
The project partners to select the cities that will be used for the study. This will be based on the following criteria:
1. A size that enables the issues to be explored and allow comparison to the area of Leeds used in the NGN hydrogen conversion study;

2. Located within the Cadent and SGN network areas;
3. Has a gas network that is suitable for full BioSNG conversion;
4. Is close to sufficient quantities of waste and biomass residues to produce enough BioSNG to meet gas demand;
5. Has potential for access to infrastructure to allow storage of gas to smooth seasonal and diurnal variations in gas demand; and
6. Provides a good image for marketing of results.
After the cities have been selected the consultant will produce a summary of their gas demands to help inform the next phase.

Phase 2 – BioSNG Production Information
The consultant will work with project partners to identify the following:
1. The range of gas volumes likely to be required to meet the cities' demands.
2. Sources of waste and biomass that can be used for BioSNG production
3. Sites around the cities that are suitable for BioSNG facilities; are close to the gas networks; and are likely to secure planning permission.
4. The extent to which linkage into future CO2 transport and storage infrastructure is important/feasible.
This work will be led by PEL and APP but the consultant will be closely involved to advise on network issues and understand the constraints over BioSNG availability as this will be important in the next phase.

Phase 3 – Cost Benefit Analysis of Network Architectures
This phase forms the heart of the project and requires the consultant to work with the project partners to carry out a detailed analysis of different options for meeting the cities' heating needs solely by a network of BioSNG plants. This will require:
•High level analysis of different network designs for injection of BioSNG into the networks from each site.
•Review of network infrastructure to identify possible changes, such as ability to compress gas in lower tiers that may improve performance or reduce costs.
•Assessment of potential options and role for storage of gas to meet diurnal and seasonal variations in demand locally or on a remote basis.
•Comparison of require size of storage versus the peak BioSNG generation capacity.
•Assessment of resilience of gas supply in relation to planned and unplanned failures of network, storage and BioSNG generation.
•Identification of possible changes to network operating procedures that would be required to manage a network using BioSNG and/or storage.
•Production of a high level model to analyse options.
•Selection of preferred option on basis of cost, energy consumption, resilience and safety.
The work will be led by the consultant with support from the project partners. Regular workshops will be held to review progress and provide feedback.

Phase 3 b - Sensitivity
The consultant should use the high-level model to evaluate alternative scenarios including:
• The BioSNG solution if there is a high uptake of heat pump and heat network within the cities leading to a reduction in gas demand.
• The impact of a large improvement in home insulation.
• The ongoing availability of fossil gas from the National Transmission System for network resilience.
• The ongoing availability of fossil gas from the National Transmission System for meeting seasonal variations.
Some other scenarios may be identified and prioritised during the project but the overall number will be limited to six.
The sensitivity analysis will be carried out by the consultant with support from the project partners

Phase 4 – Commercial Arrangements
There are a number of commercial structures that could be used to convert a city to BioSNG, akin to the models considered for conversion to hydrogen. Currently, BioSNG and gas storage facilities would be owned and operated by unregulated independent developers and the network by gas distribution companies.
Separately, Cadent has commissioned work from Ernst & Young to analyse different options for encouraging the development of BioSNG. This will set out some possible commercial arrangements for the delivery of BioSNG. The consultant should review this report and then:
• Identify potentially four different commercial models for the conversion of a city to BioSNG.
• Evaluate how gas consumers and other stakeholders will be charged under each scenario.
• Assess the advantages and disadvantages of each option.
This phase will be led the commercial consultant with support from project partners.

Phase 5 – Cost and Environmental Impact
In this phase the consultant will analyse the preferred network to calculate the cost and GHG impact of converting each city to run solely on green gas. These costs will then be used to calculate the overall cost to consumers of using green gas under one or more of the commercial scenarios identified in Phase 4.
The results should allow a comparison with the figures produced in similar reports reviewing hydrogen conversion.
Additionally, the costs and GHG impacts will also be assessed under the operational scenarios developed in Phase 3.
This phase will be led the consultant with support from project partners.

Report
The key output from the project is a high quality report suitable for publication that sets out the costs and GHG gas impact of converting both example cities to use BioSNG as its sole supply of gas. The report will explain the results of each phase of the project and provide context for the results by comparing them to other technologies for decarbonising heat.

Technology Readiness at Start

Technology Readiness at End

TRL2 Invention and Research

TRL3 Proof of Concept

Geographical Area

Two cities in the geographical footprints of Cadent and SGN

Revenue Allowed for the RIIO Settlement

Nil

Indicative Total NIA Project Expenditure

The total cost of the project is expected to be £313,333.
Cadent - £156,667
SGN - £156,667

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)

If successful this project would result in avoiding significant costs of building new district heat networks or upgrading the electricity system to carry peak heating and cooking demand. In the 2015 NIC submission relating to the Commercial BioSNG Demonstration Plant, the cumulative benefits associated with the roll-out of BioSNG plants on a trajectory to supply 100TWh/a of green gas by 2050 were forecast to be £1bn by 2030 and £46bn by 2050, due to avoided costs of infrastructure.

Please provide a calculation of the expected benefits the Solution

As this is a research project detailed costs will be provided as part of the success criteria.

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

Research project

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

The result of modelling and undertaking an impact assessment on the chosen city networks could be adopted for similarly designed and sized networks across GB.

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

The learning from the project will be clearly set out in a report considering the extreme case of conversion of two entire cities to green gas. Other Network Licensees will be able to use the learning to plan for more realistic scenarios such as the gradual roll out of green gas generation; to assess how best to adapt their existing networks to operate with distributed gas generation; and the optimum mix of storage and peak input from externally supplied fossil gas from cost and GHG reduction perspectives.
The learning shared across the UK energy sector from this project could have a significant impact on UK energy policy over the next 50 years.

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

How to maximise the contribution that renewable gas can make to gas supplies to consumers at an affordable cost without compromising security of supply.
☑ 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.

Collaboration with SGN and WWU

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

BioSNG is a new source of renewable gas. A relatively small scale commercial demonstration plant will be connected to the WWU system for the first time in summer 2018, but this project will look at the implications of connecting multiple large plants to city gas networks with a view to conversion of the entire gas supplies to a city to renewable gas. This will have network design, operation and storage implications which have not yet been investigated.

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

This project aims to address a long term issue; connection of multiple large sources of distributed gas. It is required to investigate the strategic modifications to the network which will be necessary to accommodate such supplies, but it is not a requirement under a BAU scenario, as large scale sources of renewable gas do not exist at present, and the gas networks involved will not benefit commercially from this 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

The support of the NIA is required as this is an enabling research project which would not be funded by gas networks as part of their BAU activities, nor by individual project developers, as they would not have a strategic focus on the impact on the gas network as a whole. As this is a research project the risks are associated with the technology itself not performing as expected due to the early stage of development and deployment, and the commercial risk that the necessary government tariff / support for BioSNG production is not maintained for a sufficiently long period so the technology becomes established and experiences cost reductions.

This project has been approved by a senior member of staff

☑ Yes