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

May 2024

Project Reference Number

NIA_NGT0236

Project Registration

Project Title

1mol% oxygen on the National Transmission System

Project Reference Number

NIA_NGT0236

Project Licensee(s)

National Gas Transmission PLC

Project Start

June 2024

Project Duration

0 years and 3 months

Nominated Project Contact(s)

Kirsty Appleby, box.GT.innovation@nationalgas.com

Project Budget

£78,137.00

Summary

National Gas Transmission will submit an evidence case to the HSE to permit us to allow oxygen up to 1mol% on our network. Currently, we are limited by GS(M)R to 0.2mol%. This project will support the development of the Evidence Case by answering key questions around the impacts of oxygen on our network and the assessment of a suitable and practical limit. This exemption will enable biomethane connections to connect to the NTS more readily. This project will support the transition to net zero by removing a significant barrier to the biomethane connections.

Third Party Collaborators

DNV

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

Gas quality standards and network entry specifications are in place to ensure that gas can be transported safely and used by a wide range of end-users in a safe and efficient manner.

Although there have been several studies on oxygen and risk assessments extended for different concentrations, there is not a consensus on optimum concentration limits. Also, these studies have mostly considered the impact of oxygen alone and not provided detail on the potential secondary effects due to the presence of other components in the gas supply.

Additional technical information is required to identify a suitable oxygen limit to support renewable gas introduction whilst maintaining safe and efficient gas transmission and distribution. There is a need to understand the impacts of accepting gas onto the NTS with an elevated oxygen content of up to 1mol%.

Method(s)

Measurement Quality Statement

The measurement approach used to meet Data Quality objectives will be through the identification of high calibre project partners who are experts in their given field. The methodology used in this project will be subject to our supplier's own ISO 9001 certified quality assurance regime and the source of data, measurement process and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and economic assessments will also be clearly documented in the relevant deliverables and final project report and made available for review.

Data Quality Statement (DQS)

The project will be delivered under the NIA framework in line with the agreed Energy Networks Innovation Process document and NGT internal policies. Data produced as part of this project will be subject to quality assurance to ensure that the information produced with each deliverable is accurate to the best of our knowledge and sources of information are appropriately documented. All deliverables and project outputs will be stored on our internal SharePoint platform ensuring backup and version management. Relevant project documentation and reports will also be made available on the ENA Smarter Networks Portal and dissemination material will be shared with the relevant stakeholders.

Scope

There is a need for greater understanding of the impact of oxygen and other contaminants and the potential risks to sensitive sites connected to the NTS. The limit of 1 mol% oxygen has been agreed for pipeline pressures up to 38 barg through the amended Gas Quality (Management) Regulations, and biomethane producers (and others) are interested in understanding the impact of higher oxygen content. An assessment of a suitable and practical limit will support endeavours to introduce a greater proportion of renewable gas into the NTS.

The project is split into three work packages as detailed below:

Work Package 0: Project Management

3 months over the duration of the project

This work package will include kick off meeting, progress meetings, risk management, quality assurance and project close out.

Work Package 1: Impact of Oxygen

3 months

Develop and understand the impact of oxygen on the integrity of our assets and contaminants. To understand the effects of the impact of water and the potential corrosion that might result. To develop computational fluid dynamic models to understand the mixing behaviour of high oxygen content gas. To review a range of possible off-takes and determine sensitivities to oxygen. To investigate the risk and wider impact of uptake of the 1mol% oxygen. To collate information on oxygen limit threshold values that are in operation elsewhere.

Work Package 2: Reporting

1 month

This work package will provide the technical, progress and closure reports required for the NIA funding

Objective(s)

• Pipelines (including the impact of increased levels of oxygen on any liquids or solids which could be present in the pipeline). Liquids to include (but not limited to) glycols, water, condensates, methanol, compressor oil, sealants, valve flushing agents. Solids to include but not limited to mill scale, sulphur compounds, sand, spoil, drilling swarf (and a high-level review of impacts on NORM) including assets:

o Valves (including elastomers and seals)

o Compressors

o Gas turbines

o Meters

o Analysis equipment

• Computational Fluid Dynamics (CFD) studies to assess selected flow situations to determine the extent of exposure to 1 mol% oxygen containing gases.

The key deliverable is a technical report and review to identify impacts of increasing oxygen content in natural gas high-pressure pipeline systems. This will consider the following with regard to increasing oxygen at concentrations up to 1 mol%

1. Are there any network integrity risks associated with increasing the oxygen concentration? If so, what are they, what are the consequences, how will they be manifested, how quickly can the issue be expected to arise and what can be done to detect / mitigate them?

2. What are the effects of contaminants, such as water or water/ glycol mixture, oils and liquid hydrocarbons and elemental sulphur? If so, what are they, what are the consequences, how will they be manifested, how quickly can the issue be expected to arise and what can be done to detect / mitigate them?

3. Previous studies have concluded that the risk is minimal in a ‘dry network.’. However, the NTS may, in pockets, not be a dry network; what are the risks?

4. Our current thinking is that any high oxygen content gas will be rapidly mixed with low oxygen content pipeline gas passing the NTS entry point. What are the consequences of injecting high oxygen content gas into an effectively static system? How effectively will any slugs of high oxygen gas be blended out once flow restarts?

5. What types of offtakes from the NTS would be sensitive to elevated oxygen content and why (e.g. storage, power stations, sites that use gas as a chemical feedstock)

6. The initial applications for high oxygen content derogations are for small volume biomethane connections. Are there any foreseeable risk of larger scale NTS entry points seeking increased oxygen concentrations? (Would there be any commercial / operational benefit to suppliers of gas as either LNG or by pipeline of an increased oxygen concentration limit leading to an elevated oxygen concentration more widely across the network (albeit still within the 1 mol% limit)? Would there be any elevated risk as a result of operating the NTS more generally at oxygen levels up to 1 mol% oxygen?

7. Are there any threshold values between 10ppm, 0.2mol% and the 1% upper limit where the effect of oxygen on the assets or on connected parties changes significantly?

In addition to undertaking research to address the above questions, it will also be considered if there are any geographical constraints that may impact on a possible change to higher oxygen content.

Also, from the measurement and management of gas in the network, DNV will investigate if there are any challenges with gas quality measurement by GC methods that could impact on the accurate determination of calorific value, and if the presence of oxygen will influence the emissions and overall operation of the compressor fleet (and any gas preheaters) for gas transmission assets.

Information in the deliverable report to be cross-referenced to technical data or based on current industry positions. Information to be sourced from UK, wider Europe and other geographies.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An assessment of distributional impacts (technical, financial and wellbeing related) for this project has been carried out using a bespoke assessment tool, which assesses the project as having a positive, negative or neutral effect on consumers in vulnerable situations. To help inform the assessment, this tool considers the categories of consumers identified in the Priority Services Register. This project has been assessed as having a neutral impact on customers in vulnerable situations. This is because it is a transmission project.

Success Criteria

- Delivery of a comprehensive report within 3 months of project commencement, detailing the effects of accepting gas up to 1mol% oxygen on the higher-pressure tiers of the gas networks.
- Project findings to inform the wider Evidence Case which will be submitted to the HSE.

Project Partners and External Funding

Lead Network: National Gas Transmission Plc

Supplier: DNV

External Costs: £58,603 to cover the cost of the DNV study

Internal Costs: £19,534

Total £78,137

Potential for New Learning

This project will provide an understanding of the impact of higher oxygen concentrations on the NTS.
This includes considering the impact on our assets, assess selected flow situations to determine the extent of exposure to 1 mol% oxygen containing gases, and other specific questions around the impact on any sensitive customers.

The outputs of the study will then inform the development of an Evidence Case to the HSE to allow us, and potentially the Distribution Networks to offer 1mol% oxygen at the higher-pressure tiers of their networks

Scale of Project

This project is determining the impacts of oxygen across the entire NTS. The alternative would be an individual site-specific project and analysis, and HSE exemption for each biomethane connection.

The outputs of the study will then inform the development of an Evidence Case to the HSE to allow us, and potentially the Distribution Networks to offer 1mol% oxygen at the higher-pressure tiers of their networks.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

United Kingdom, Warwick

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

External Costs: £58,603 to cover the cost of the DNV study

Internal Costs: £19,534

Total £78,137

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:

A key issue for biomethane to be acceptable for grid injection is the removal of hydrogen sulphide; oxygen is added to improve the absorption rates to ensure suitable for grid injection. Subsequent removal of that oxygen is costly and can present a material barrier to project viability. National Gas want to enable and support the transition to Net Zero by making access to the NTS more economically viable for the biomethane industry. Delivery of the 1mol% oxygen level would be positive from a customer satisfaction point of view and demonstrate a commitment to facilitate sources of sustainable gas connecting to the NTS.

We propose to submit a class exemption to HSE to enable NGT (National Gas Transmission), and the Distribution Networks to offer 1mol% to the higher-pressure tiers of their networks. The outputs of the study will inform an Evidence Case for submission to HSE.

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

This project does not directly affect vulnerable consumers. However, in facilitating biomethanes connecting to our networks, we are enhancing security of supply in the UK. The National Transmission System (NTS) is a key UK infrastructure for the transport of Gas to consumers, including those considered vulnerable.

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)

N/A

Please provide a calculation of the expected benefits the Solution

Value tracking

	Data Point	Data Point Definition
Maturity	TRL2-3	Concept stage for biomethane injection to the NTS
Opportunity	100% or multiple asset class	The project can be applied to multiple injection point

Deployment costs		Deployment costs are not known at the start of the project
Innovation cost	£78,137	The cost includes desktop-based work
Financial Savings		Unknown. But will facilitate savings in future by reducing the need for multiple site-specific HSE exemption requests
Safety	-	Determining the impact of transporting gas containing up to 1 mol% oxygen in the NTS on pipelines, compressors, valves, metering equipment, turbines, and analysis equipment
Environment	-	Enabling the biomethane industry connecting to the NTS therefore facilitating the transition to net zero.
Compliance	Support compliance	

Skills & Competencies no change

Future proof Supports business strategy The study will inform a class exemption, which will allow NGT and the GDNs to offer low carbon fuel

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

The findings of the impact of oxygen on the NTS could be applied to the high-pressure tiers of the GDNs. This will allow NGT and the GDN to consider biomethanes connecting to our networks over the current GS(M)R limit of 0.2mol%. This will negate the need for multiple site-specific studies/ exemptions.

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

N/A. This study is NTS-wide

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 project will inform National Gas Transmission's Evidence Case we propose to submit to the HSE to enable us to facilitate oxygen up to 1mol% on our network. The GDNs currently can offer 1mol% oxygen on their networks up to pressures of 38 barg. The outputs of this study can inform the Evidence case for a 'class' exemption' to enable NGT and the GDNs of offer 1mol% on the higher-pressure tiers of their networks.

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

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.

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

This project will ensure no duplication as it will inform a class exemption to enable NGT and the GDNs to offer 1mol% across the networks. It will therefore avoid multiple site-specific exemption requests. To put into context, NGT have received circa 30 application requests from biomethane sites. It is anticipated all will request the higher oxygen specification. The limit of 1 mol% oxygen has been agreed for pipeline pressures up to 38 barg however no previous studies have looked into NTS pressure range and the effects on our network specifically.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

Other projects by the GDNs have been limited to 38 barg. Where there have been requests for the exemption up to higher pressures, these have been site specific; this project is NTS-wide.

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

This project will determine the impact of oxygen on the NTS. Although there have been several studies on oxygen and risk assessments extended for different concentrations, there is not a consensus on optimum concentration limits. These studies have mostly considered the impact of oxygen alone and not provided detail on the potential secondary effects due to the presence of other components in the gas supply. In addition, the study addresses specific questions around sensitive sites, how slugs of higher concentration oxygen travel through the network, and the impacts on contaminants.

Relevant Foreground IPR

This project will not result in any new Foreground IPR as the study will be carried out using existing methods.

Data Access Details

Details on how network or consumption data arising in the course of an NIA funded project can be requested by interested parties, and the terms on which such data will be made available by National Gas can be found in our publicly available “Data sharing policy relating to NIA projects” at www.nationalgas.com/gasinnovation. National Gas data access is managed IAW provisions under 2.15-2.18 for the current NIA Governance Document.

National Gas already publishes much of the data arising from our NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Data Quality Statement (DQS):

The project will be delivered under the NIA framework in line with the agreed Energy Networks Innovation Process document NGT internal policies. Data produced as part of this project will be subject to quality assurance to ensure that the information produced with each deliverable is accurate to the best of our knowledge and sources of information are appropriately documented. All deliverables and project outputs will be stored on our internal SharePoint platform ensuring backup and version management. Relevant project documentation and reports will also be made available on the ENA Smarter Networks Portal and dissemination material will be shared with the relevant stakeholders.

Measurement Quality Statement (MQS):

The methodology used in this project will be subject to our supplier's own ISO 9001 certified quality assurance regime and the source of data, measurement process and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and economic assessments will also be clearly documented in the relevant deliverables and final project report and made available for review.

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

Currently, NGT can only offer oxygen up to 0.2mol%, as determined by GS(M)R. We envisage new biomethane connections will want to connect to the NTS at the higher 1mol% oxygen (if granted by the HSE.) Investigating the impact of the higher oxygen concentration is not part of BAU.

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 impact of oxygen on the NTS has not previously been investigated. The NIA funded study will enable us to understand the risks of accepting this higher concentration of oxygen on our network, and at the higher-pressure tiers of the GDNs.

The project involves research into the suitability of existing network assets with 1 mol% oxygen found in biomethane. The use of the NTS to transport biomethane is not currently well understood, therefore this project carries risks around the technical, operational, commercial and regulatory considerations for the uptake of biomethane connections.

This project has been approved by a senior member of staff

☑ Yes