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

Mar 2019

Project Reference Number

NIA_NGGT0146

Project Registration

Project Title

Captivate – Proof of Concept

Project Reference Number

NIA_NGGT0146

Project Licensee(s)

National Gas Transmission PLC

Project Start

March 2019

Project Duration

1 year and 8 months

Nominated Project Contact(s)

Mathew Currell

Project Budget

£1,249,221.00

Summary

The use of a alkaline hydroxide (Mg) can be utilised in an appropriate reactor to produce a carbonate in the presence of CO2. This effective sequestration technique could have large implications for National Grid's compressor fleet.

The programme will look to test the trial unit to validate the initial claims.

Preceding Projects

NIA_NGGT0135 - Techno-Economic Feasibility of Solid State CO2 Capture

Third Party Collaborators

Cambridge Carbon Capture

Premtech Ltd

MacKinnon Construction Ltd

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

Carbon dioxide is a greenhouse gas the release of which is widely considered to be the leading cause of a global temperature increase commonly known as global warming. At current rates of emission, models by the Intergovernmental Panel on Climate Change (IPCC) suggest that a global temperature increase of between 1.1 and 5.4°C is likely by the year 2100.

National Grid (NG) owns and operates large scale plant that produce operational emissions, which in turn is detrimental to the environment. Cambridge Carbon Capture (CCC) is developing a technological solution to industrial CO2 capture & storage that may help to mitigate some of these operational emissions.

CCC are developing a 'Carbon Capture and Use' process which aims to profitably tackle CO2 emissions through a mineralisation process which, in addition to capturing CO2, produces several valuable by-products including a building material.

The work proposed in this project aims to provide National Grid with a potential solution for reduction of carbon emissions associated with National Grid gas transmission sites such as boiler houses and compressors. This work follows on from a previous NG NIA feasibility study (NGGT0135 - Techno-Economic Feasibility of Solid State CO2 Capture) into the potential use of this technology.

Method(s)

The project is split into the following four stages:

1. Factory building, commissioning and testing of CCC's containerised demonstrator.
2. Trial Site Selection and Conceptual Design – site selection, surveys, conceptual design, drawings, FPSAs (Formal Process Safety Assessments), and stakeholder challenge and review.
3. Detailed Design –detailed design drawing pack and report, G/35 approval and appraisal of design, digital rehearsal, and feasibility study for larger scale application.
4. Installation and Demonstration – the implementation, demonstration, and assessment of the technology in a containerised unit on an operational gas site.

Scope

Carbon capture is the process of capturing carbon dioxide from a source such as exhaust gases to prevent the release of large quantities into the atmosphere. Conventionally, the carbon dioxide is captured using adsorption technologies after which it is released and compressed. The captured carbon dioxide is then stored underground in large geological formations. The main reason that this method of carbon capture is not yet implemented on a large scale is due to the energy and cost involved; for example, capturing and compressing carbon dioxide can increase the energy requirements of a coal fired carbon capture and storage plant by 25-40%.

Project History:

2015 - CCC launched a "CO2 Capture through mineralisation" NIA project combining InnovateUK and NIA funding. The purpose of this project was to demonstrate the technical feasibility and performance of the Carbon Capture process for shale gas CO2 scrubbing.

2016 - The project is completed and demonstrated the feasibility to develop a scalable commercial scrubbing system. Outputs led to plans for development of a containerised 'first of kind' CCC process plant for use at demonstrator Shale Gas site.

2017 - "Carbon Capture, Sweetgas2" NIA project is considered to remove CO2 and possibly other contaminates from methane rich gases from unconventional sources. The funding for this would have been through a combination of InnovateUK, NIA and private funding. Due to a change in innovation funding governance, this project was placed on hold.

2018 – National Grid wanted to evaluate CCC's CO2LOC technology and launched an NIA project (NIA_NGGT0135) to conduct a feasibility and techno-economic assessment (TEA) and life cycle analysis (LCA) of the CO2LOC solid CO2 capture process and compare it to other carbon capture utilisation and storage (CCUS) technologies.

This proposed NIA project utilises the learning from the initial techno-economic feasibility report into solid state CO2 capture that CCC carried out for NG in 2018. This techno-economic feasibility study suggests that the mineralisation approach taken by CCC to reduce National Grid's operational emissions is a potentially viable option to help reduce our overall environmental impact.

In November 2018, the department for Business, Energy and Industrial Strategy (BEIS) published an action plan for the deployment of carbon capture and storage in the UK. This action plan sets out how government and industry can work in partnership to get to a stage where carbon capture can be deployed at scale by the 2030's with the first industrial scale deployment occurring by the mid-2020's.

The output from this project may feed into a future project to implement this technology on a larger scale at a National Grid compressor station. This will have the aim of reducing operational emissions and increase the useful life of an asset.

The CO2LOC Technology:

The fundamental philosophy of the CO2LOC process is to utilise carbon dioxide by turning it into a substance with a valuable use. After extensive research, CCC have decided that reacting CO2 with magnesium hydroxide (brucite) is the best option for several important reasons:

1. Magnesium is abundant in the earth's crust so it would be feasible to dig up enough to return the CO2 in the atmosphere to pre-industrial levels.
2. Brucite reacts quickly enough with CO2 for the process to operate at ambient temperatures and pressures which keeps the capital cost of equipment low.
3. The various hydrated magnesium carbonates that form are excellent candidates for use in the construction industry which is by far the greatest user of materials.

The purpose of this project is to complete the build and commissioning of Cambridge Carbon Capture's containerised carbon capture demonstrator and install, commission and run trials on a National Grid gas site. This containerised demonstrator unit will be used to assess the technology's ability to remove CO2 from flue gas (combustion) emissions and the suitability of the process for adoption on other gas transmission sites.

By completing the design processes and reviews to National Grid standards, the interfaces, implications and challenges (safety and technical) will be understood and addressed. The project will use the demonstrator unit to assess the feasibility of upscaling the technology for use on larger scale sites such as compressor stations.

Objective(s)

The objective of this project is to complete the build and commissioning of CCC's containerised carbon capture demonstrator and install, commission and run trials using boiler-house flue gases on a National Grid gas site. The output from this project may feed into a future project to implement this technology on a larger scale at a National Grid compressor station.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

To deliver the conceptual and detailed design, implementation, and demonstration of the carbon capture process on a National Grid gas site.

Project Partners and External Funding

Main Project Partners – Cambridge Carbon Capture Ltd, Premtech Ltd and Cullum Detuners.

External Funding – Nil.

Potential for New Learning

The outcomes from this programme may change the approach to emission capture across the energy network in its entirety.

Scale of Project

Trial in a working environment.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

National Grid Site – yet to be determined.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£1249221

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)

The main aim of this technology is to eventually capture operational CO2 emissions on a large scale. The biggest source of CO2 emissions from NG plant is compressor stations. In 2017/18, the combined CO2 emissions from all compressor stations totaled 594,000 tonnes. Each tonne of CO2 emitted costs NG approximately £45. Therefore:

594,000 (tonnes) x 45 (pound) = £26,730,000

The £26,730,000 figure is what that this technology would look to significantly reduce.

Please provide a calculation of the expected benefits the Solution

This programme is to trial the feasibility and effectiveness of a small-scale demonstrator at an NG site. Therefore, no accurate estimates can currently be made until we prove the concept that this technology can capture operational emissions in a mineralised form in a real-world environment.

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

Subject to this project being a success and that the technology can be suitably scaled, this kind of carbon mineralisation technology could theoretically be implemented on any site with operational emissions – including both transmission and distribution assets.

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

The costs of implementation on another site are currently unknown.

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

Due to the infancy of the technology, carbon mineralisation isn't a process in which any transmission or distribution network currently adopt. This programme could fundamentally shift the approach in which all network licensees take to help tackle reductions in operational emissions.

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

This project aims to contribute towards the transition to a decarbonised energy system.
☑ 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.

We are aware of two NIA projects 'Domestic Carbon Capture' and 'I&C Carbon Capture' with Scotia Gas Networks (SGN) which are feasibility studies looking at concepts for small-scale carbon capture at the point of use on a domestic (e.g. boiler) and industrial and commercial (I&C) scale.

The SGN projects are different conceptual studies to the Captivate project which is looking at carbon capture using the CO2LOC technology which has already been through a feasibility study and will be installed at National Grid Gas transmission sites such as boiler houses and compressors.

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

Conventionally, the carbon dioxide from emission sources is captured using adsorption technologies after which its then released and compressed. The captured carbon dioxide is then stored underground in large geological formations. The innovation in this project is to capture the CO2 from the emission source, mineralise it and turn it into a useful product.

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

The effectiveness of this method of capturing carbon emissions from flue gases has only been proven in a laboratory environment and not in a real-world application. To make a viable business decision as to whether this mineralisation method is effective, a trial is required to complete the build and commission of the demonstrator plant and evidence will need to be provided; this is the aim of this programme. The use of the NIA framework will mitigate the financial risk to the business of this unproven application and will ensure the end results are available to all stakeholders.

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 effectiveness of this method of capturing carbon emissions from flue gases has only been proven in a laboratory environment and not in a real-world application. To make a viable business decision as to whether this mineralisation method is effective, a trial is required to complete the build and commission of the demonstrator plant and evidence will need to be provided; this is the aim of this programme. The use of the NIA framework will mitigate the financial risk to the business of this unproven application and will ensure the end results are available to all stakeholders.

This project has been approved by a senior member of staff

☑ Yes