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

Apr 2019

Project Reference Number

NIA_CAD0035

Project Registration

Project Title

HyNet Expansion Options

Project Reference Number

NIA_CAD0035

Project Licensee(s)

Cadent

Project Start

April 2019

Project Duration

1 year and 3 months

Nominated Project Contact(s)

Cadent Innovation Team

Project Budget

£376,333.00

Summary

The methodology is to assess overall hydrogen demand across the region under a 'high hydrogen' scenario, recognising that this is unlikely to fully come to fruition before 2030. The 'high hydrogen' scenario will include industrial fuel switching, network blending, heavy transport and flexible power generation, but will exclude domestic conversion of existing properties.

Nominated Contact Email Address(es)

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Problem Being Solved

The HyNet project (NIA_CAD0001), is an ambitious plan to decarbonise industrial heat in the NW region through the production of hydrogen with capture and storage of the resultant CO2. This project can be put in place incrementally, with the project phases conditioned by need and the availability of a market framework which allows investment:

• Phase 1 might be 'Industrial CO2 Capture' from existing operations at major industrial sites creating CO2 transport and storage infrastructure in the Liverpool Bay fields.

• Phase 2, which may take place concurrently with Phase 1,would include 'Hydrogen Production' via ATR technology, with the produced Hydrogen being used to supply industry directly, and for blending in the local gas distribution network, creating a hydrogen distribution network.

• Phase 3: 'Expansion of the Hydrogen Economy', will include extension of the hydrogen network to incorporate flexible power generation, further blending and hydrogen supply to industry, transport applications and will include hydrogen storage for demand management

A clear roadmap is needed for expansion of the hydrogen and related CO2 networks. The roadmap is dictated by a combination of regulatory, changes and the timetable for these, as well as technical constraints.

The key technical constraints include the need to demonstrate and secure approval for the use of hydrogen in the network as a blend and demonstrate high hydrogen use in industrial settings. The maximum flow rate in the offshore pipeline from Point of Ayr to the stores is >15Mte CO2 pa, representing 'at scale' deployment. Achieving this annual storage rate requires incremental investment in further on shore pipeline capacity between Connah's Quay and Point of Ayr when the storage rate exceeds ~3.5mte CO2 and further stores will be required once stored CO2 exceeds ~ 200Mte.

This study will assess the expansion of the HyNet hydrogen network recognising possible demand options and the technical, regulatory

and commercial constraints and, in so doing, provide the first assessment that HyNet could make to decarbonisation of the whole NW region. This will help create the long term Business Case for the NW regional cluster, which will be essential in securing support for the development of the region as the lead cluster with CCUS and Hydrogen network infrastructure operating by the mid 2020s. The study will assess the following:

Regional Demand for Hydrogen
• Identify further industrial facilities across the region that offer potential for conversion to hydrogen as a primary energy source and scope for additional readily accessible network hydrogen blending
• Building on the HyMotion study, and other inputs, produce a growth plan for hydrogen infrastructure across the region to support hydrogen transport applications including HGVs, buses, trains and marine applications

Flexible Power Generation
• Determine the options for innovative, flexible generation technologies (for example, aero-derivative gas turbines), which are suitable for fuelling by hydrogen and identify suitable locations where such technologies might be deployed, to include existing power station sites in the region. Identify the market for other, smaller scale power, particularly new CHP facilities, including captive power plants in industrial facilities

Seasonal Storage and Network Expansion
• Examine the fluctuations in system demand from industrial demand, network blending, transport and flexible generation and hence consider the extent of the need for underground hydrogen storage and identify storage options to meet this need.
• Examine the extent of the hydrogen network that will be required to cost effectively connect all of the above opportunities, hence creating an expanding local hydrogen distribution network.

Constraints and Limitations
• Examine the regulatory options and timeline which provide a market frame to enable investment
• Determine the critical uncertainties and investments required to produce a CO2 transport and storage system which enables the unimpeded growth of the hydrogen network

The cost-benefit case for the cluster
• Determine the incidence of expenditure and assess benefits accruing
• Support assembly of business case for creation of hydrogen and CCuS infrastructure

Method(s)

The methodology is to assess overall hydrogen demand across the region under a ‘high hydrogen’ scenario, recognising that this is unlikely to fully come to fruition before 2030. The ‘high hydrogen’ scenario will include industrial fuel switching, network blending, heavy transport and flexible power generation, but will exclude domestic conversion of existing properties. The project can broadly be split into the following work packages:

1 – Hydrogen Demand Assessment:
• Determine a likely seasonal demand profile for hydrogen if used as up to a 20% hydrogen blend throughout the NW region. Using scenarios developed in the HyMotion study, determine a profile for transport demand for Hydrogen in the NW region. Using the approach developed in the original HyNet study, coupled with assessments in the recent Fuel Switching report issues by E4Tech / Jacobs, determine a profile for industrial demand for Hydrogen.
• Undertake a desktop assessment of flexible low carbon generation technologies through engagement with both technology vendors and operators. This information, including cost information, will be synthesised to determine a suite of the most promising technologies; Identify existing gas-powered flexible generation sites in the NW region, including existing CCGT sites, peaking plant and captive power plants
• Determine a regional level demand profile for hydrogen assuming conversion of current gas-powered flexible generation plant, and, based on FES scenarios, an assessment of likely demand scenarios in 2030, including the construction of any new-build plant to meet increased requirements for flexible power generation

2 – Annualised Demand Profile and Storage Assessment Requirement:
• Combine the flexible generation, distribution network blending, transport and industrial fuel switching profiles to generate an overall hydrogen demand profile for 2030 and consider the limits on expansion thereafter.
• Identify the volume of storage required to cost-effectively smooth the hydrogen demand profile (recognising that the cost-effectiveness of storage will progressively increase). Identify suitable locations for the storage infrastructure, based on an assessment of existing gas storage sites and a desktop geological assessment of potential new sites.

3 – Determination of Hydrogen Production Requirement:
• Determine the amount of hydrogen production capacity required to meet the smoothed demand profile established in Phase 2 and the resultant volume of annual CO2 capture and storage required and assess against existing HyNet CO2 pipeline and storage constraints.
• If total regional demand for hydrogen outstrips CO2 pipeline capacity, identify a range of potential demand scenarios that could be achieved within the constraints (e.g. just distribution network blending, or just industrial fuel switching, or some form of combination).

4 – Determine Hydrogen Network Configuration Requirements:
• Determine potential Hydrogen Local Transmission network configurations that could meet the supply scenarios identified in Phase 3.
• Determine CO2 transport and storage constraints and key investment milestones

5 – Cost Benefit Assessment and roadmap:
• Using existing cost benchmarks for hydrogen production, pipeline construction and storage infrastructure, determine indicative cost benefit assessments for the scenarios identified and developed in Phases 3&4. Benefits should include carbon savings existing the business as usual counterfactual, and hence an assessment of the abatement cost and an estimate of the GVA involved
• Assemble an outline business case for Hynet.

6 – Stakeholder management and reporting
• Help communicate and facilitate the creation of a wider business case for a low carbon industrial cluster in the North West including discussion of possible new market structures.

Scope

The study will be focussed on opportunities in the North West Region, in which Cadent has a current natural gas use of 70 TWh/annum, which is a significant proportion of total gas use across Cadent's entire network and equates to a continuous load of 8,000MWth with a 1 in 20 peak of approximately 20,000MW (although noting that the majority of power stations to be considered in this study are connected to the NTS, and are additional to this figure). Nearby opportunities in the adjoining WWU area will also be considered.
The emphasis of the work will be on understanding the likely demand profile for hydrogen under a 'high hydrogen' scenario and determining whether this can be met from an expansion of the HyNet project, given constraints, particularly in the proposed CO2 transport and storage system.
Whilst the scope of the work is upon Cadent's distribution network, the majority of the work and methods can be applied across other GDN areas (and, to a lesser extent, the NTS) and the work will inform other GDN's planning of strategies in relation to supply of hydrogen supply for flexible power within their networks.

Objective(s)

The overarching objective of this work is to provide an assessment of the potential expansion opportunities for the HyNet project to provide wider decarbonisation benefits across the North West region. This objective will be delivered in the form of a report, setting out a range of practically achievable potential supply and demand scenarios, a cost benefit analysis of each in the form of carbon abatement cost assessments. The results of the work will be used to help secure Regional and Government stakeholder support.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The success criteria for the project can be summarised as follows:
• Determination of flexible generation technologies which are suitable for fuelling by hydrogen;
• Determination of hydrogen demand under a regional 'high hydrogen' scenario and storage requirements to optimise smoothed supply profile
• Determination of range of demand scenarios if total supply is constrained by CO2 pipeline
• Determination of network configurations required to meet demand scenarios and cost benefit analysis of each.

Project Partners and External Funding

This project will be undertaken by Progressive Energy funded via NIA

Potential for New Learning

This project will enable Cadent to undertake stakeholder engagement to demonstrate a long term decarbonisation pathway at a regional level. It will therefore help to create the evidence base for a successful bid to make the Merseyside region the leading industrial cluster for CCUS deployment. The approach will be replicable in other regions, including Humberside in Cadent's East Midlands network.

Scale of Project

The project will be a desktop study. The project will encourage use of the network by organisations and individuals seeking to use hydrogen as a fuel for power generation. As a consequence, a greater number of customers will connect to the network, therefore reducing costs for all network users. Furthermore, as wider sectors of the economy start to depend upon the network, this will build the case for its longevity. A project of this scale is required to provide sufficient evidence to inform decision-making by Cadent and all other GDNs

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

This study is focused on the North West of England but will include all of Cadent's area.

Revenue Allowed for the RIIO Settlement

Not Applicable

Indicative Total NIA Project Expenditure

£376,333.33

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 HyDeploy project suggests that 20% H2 blend would enable 29TWH of low carbon heat, saving the consumer £8Bn compared to other decarbonisation routes such as heat pumps. On a wider scale, the 2050 energy scenario report by KPMG (NIA_SNG_00064) suggest the conversion of the heat network to Hydrogen compared to electrification could save the consumer £7,000 to £9,500 each or £152bn to £214bn for GB.

Additional substantial benefits will accrue from the decarbonisation of a proportion of the power sector using low carbon hydrogen from the HyNet project and the availability of hydrogen for transport use.

Please provide a calculation of the expected benefits the Solution

This is a research project

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

The potential of hydrogen to decarbonise multiple sectors of the economy is significant. The method can be replicated at any location in which low carbon hydrogen is available in bulk. In most cases, this will require access to CCS infrastructure (to capture and store the CO2 from hydrogen production from fossil fuels). This includes the 6 industrial areas under consideration by Government as industrial CCuS clusters. In the shorter-term for demonstration projects, electrolysis may be a viable technology for hydrogen production and therefore the method could potentially be applied across the UK in respect for smaller scale projects.

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

The cost of rollout will be clearer once the research project concludes.

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

This project will consider how the HyNet project can be expanded to substantially decarbonize the NW region across multiple sectors. It will provide analysis of the costs and benefits of this to support a regional cluster assessment and will also provide recommendations on how the future network will need to be configured to most cost-effectively supply hydrogen to a range of demand points.

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 relates to decarbonising the gas network at the lowest possible cost which is central to Cadent's innovation strategy.

☑ 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.

This is a FOAK project using low carbon hydrogen to supply a wide range of sectors, including flexible power generation. No such study has been undertaken before in a large populous industrial area

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

HyNet is being structured as an innovative but deliverable project and has not included longer term envisioning. However, as part of the ongoing government policy focus in this area and the likelihood of a future competition to identify a regional cluster for construction of the UK's first CCUS project, it is relevant to determine the long term expansion opportunities which combine a number of innovative elements, including the design of a new hydrogen distribution system which supplies innovative flexible hydrogen generation, hydrogen fueled transport, industrial plant and a hydrogen blend to the existing gas system

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 will provide the necessary analysis to identify the opportunity for the development of a wider hydrogen economy in the NW region. If achieved this would provide a quantum leap for the UK gas industry and cannot be seen as business as usual.

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

This project is genuine innovation and will uncover new commercial and technical opportunities which in turn will have an impact upon regulatory and operational regimes within the industry.

This project has been approved by a senior member of staff

☑ Yes