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## NIA Project Registration and PEA Document

### Date of Submission

Apr 2017

### Project Reference Number

NIA\_NGN\_204

## Project Registration

### Project Title

H21 – Strategic Modelling, Major Urban Centers

### Project Reference Number

NIA\_NGN\_204

### Project Licensee(s)

Northern Gas Networks

### Project Start

April 2017

### Project Duration

3 years and 1 month

### Nominated Project Contact(s)

NGN - Stella Matthews, NGGD - Lorna Millinton

### Project Budget

£440,000.00

## Summary

Network analysis, as per the original H21 Leeds City Gate study, of 4 NGN networks (including Leeds). Further analysis, dependent on appetite of the other GDNs, of up to 14 other networks areas of large population spread throughout Great Britain. Providing costing and demand data towards the conversion of these areas from natural gas to hydrogen as well as options for strategic UK roll out.

### Nominated Contact Email Address(es)

innovation@northerngas.co.uk

## Problem Being Solved

The H21 – Leeds City Gate Project assessed the feasibility of converting a major city's gas network from natural gas to hydrogen. The project demonstrated the feasibility of the hydrogen conversion concept, developed detailed cost estimates for the conversion of the Leeds area and an estimate of the costs for an incremental roll out of hydrogen conversion nationwide.

The H21 Leeds city gate project identified (Section 10) the next steps required to move this concept towards a policy decision through a series of strategic projects aimed at filling critical evidence gaps, this was referred to as the 'H21 roadmap'.

To execute this H21 roadmap will require a combination of large scale NIC type projects, a government led program of research and a suite of smaller NIA projects. These projects will ensure the UK gas networks will understand the impact of hydrogen conversion in four key areas:

1. Application and impact of new equipment within the network. This will ensure a future conversion to hydrogen comprises the optimised selection of assets utilising the best technologies from around the world in the interests of gas customers.
2. Transportation of a different form of gas, i.e. 100% hydrogen on existing licensee assets
3. Operation of the network and its configuration when transporting 100% hydrogen.
4. The commercial impact of a hydrogen conversion and the alterations required to current commercial practices across the gas industry e.g energy efficiency losses across hydrogen production assets, different leakage model impacts etc.

This work will support the requirement for government to make firm energy policy decisions by the early 2020s. Without this suite of projects the opportunity for 100% hydrogen to play a significant role in future decarbonisation pathways may not be realistically considered. This could have a significant impact on UK gas customers if alternative non-optimized policy decisions are subsequently put into force. This NIA project will focus on section 16.3 of the H21 roadmap.

As part of the H21 Leeds City Gate Project network analysis was undertaken of extended Leeds LP and MP gas distribution networks supplying 100% hydrogen. This included three core activities. Firstly, an assessment of the reinforcement and supply requirements to keep the pressure and velocity constraints within the area of conversion (Leeds) to within regulatory limits maintaining supply to all customers under theoretical 1:20 winter demand conditions. Secondly, establishment of a demand profile for a 1:20 day and an off-peak day required to determine the design parameters required for the hydrogen production, storage (both for H<sub>2</sub> and CO<sub>2</sub>) and transportation infrastructure. Thirdly, to determine an appropriate conversion strategy including sectional isolations and end point connections for the hydrogen transmission system.

As stated in the H21 Project roadmap (section 10) there is a requirement to extend this unique network analysis to further city networks. This will resolve and support strategic questions concerning how a hydrogen conversion would be incrementally rolled out with regards to economic and constructability constraints for 100% hydrogen UK city conversions. It will also allow other UK GDNs to develop their own modelling expertise for 100% hydrogen conversions ensuring robust dissemination of knowledge from the original H21 Leeds City Gate project. Finally this project will support development of potential work, which would fall outside business as usual, for the R10-GD2 period which may be requested by OFGEM / BEIS to support the decarbonisation strategy. The project will provide robust data for the design of the expanded production, storage and transportation infrastructure across the major areas of population within Great Britain.

## Method(s)

To enable a broad geographic spread containing most of the major population areas within Great Britain and to allow for the largest number of networks that can be practically and accurately modelled within the time frame of this NIA it is proposed that each GDN puts forward the two largest networks (by population/demand) for each of the LDZs they own. NGN will undertake an additional analysis of 4 models covering 53% of its total gas customer population.

With NGN network analysts providing support and training to resources from the other GDNs out of its H21 project office it is proposed that National Grid would analysis 8 major centers (their section of Greater London accounting for two of these), 2 for Wales and the West and 4 for SGN. These 18 networks would represent a significant proportion of the gas customers of Great Britain (between 33 and 41% of the population) and would provide sufficient analysis to determine large scale rollout options for a UK wide hydrogen conversion. It is proposed that each GDN carries out the network analysis of their own networks with their staff resourced from their current network analysis trained staff. This will

- 1) Reduce the number of new staff required within the core H21 project team with the large training component involved
- 2) Provide accurate results in as short a time frame as feasible
- 3) Facilitate the spread of the modelling experience gained during the first phase of H21.

This modelling will be supported and coordinated by a dedicated project lead based out of the H21 office.

The Project will be carried out in defined training and development stages as per the below:

1. A kickoff meeting the network analysts chosen by the GDNs for discussion/training.
2. Confirmation and acceptance of the configuration of analysis models (i.e. scope and size of networks which will be modelled by each GDN)
3. Configuring each networks model to run 100% hydrogen analysis, e.g. reinforcement and supply options.
4. Determine 1 in 20 Peak requirements for each network using the network analysis models
5. To determine annual energy requirements (TWh) for each network using MOSA area / degree day analysis as per the original H21 Leeds City Gate Project.
6. Design of robust and economic isolation, conversion and restoration zones to assess operational requirements (additional valves, locations for mains squeeze offs/bagging, additional supplies (either permanent in the form of new district governors or temporary in, for example, the form of bottled or natural gas supplied by tanker to district governors))
7. To provide a time line and cost estimate for each networks conversion.
8. Following completion of the analysis different scenarios will be developed for incremental conversion of the UK gas grid to hydrogen considering upstream and downstream practical constraints.

The network analysis carried out using the GDNs choice of NA software (supported as required by the software owners) – currently Synergi for NGN, WWU and SGN and GBNA for NG, on their FY5/FY10 models for the networks selected.

## Scope

Network analysis, as per the original H21 Leeds City Gate study, of 4 NGN networks (including Leeds). Further analysis, dependent on appetite of the other GDNs, of up to 14 other networks areas of large population spread throughout Great Britain. Providing costing and demand data towards the conversion of these areas from natural gas to hydrogen as well as options for strategic UK roll out.

**Following the registration of the NIA project, NIA\_NGN\_204 H21 – Strategic Modelling, Major Urban Centers. The project has experienced timeline setbacks, resulting in the original delivery date being no longer attainable. To ensure the original project aims and objectives are met, it is necessary to extend the project timeline until 31/03/2020.**

## Objective(s)

- Provide a robust and practical reinforcement, isolation, conversion and restoration methodology for 100% hydrogen gas distribution networks supplying a wide range of GB cities.
- Provide demand profiles and requirements for an extended range of cities spread throughout Great Britain to facilitate the design of the hydrogen transmission, production and storage (both for H2 and CO2) infrastructure.
- Provide indicative hydrogen conversion costs and timescales for each urban area (appliance numbers, isolations/reinforcement requirements etc.) for the gas distribution networks for up to 18 of the most significant population areas of Great Britain.

Provide rollout scenarios for incremental conversion of the UK gas network based on the analysis undertaken.

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

To model an additional 3 NGN networks and expand on the Leeds network previously modelled in the first stage of the H21 project and up to a further 14 networks owned by other GDNs using the same methodology as the original H21 Leeds City Gate project. To collate this information and provide credible UK rollout scenarios for conversion.

## Project Partners and External Funding

National Grid Distribution, Scottish and Southern Gas Networks, Wales and West Utilities

Software providers (DNVGL – Synergy and GBNA)

External project management for coordination/consistency of modelling results for use in rollout scenario modelling, this will include liaison with the CCC building on their recent rollout work.

Kiwa Gastec to undertake the MSOA data comparison as they developed for the H21 Leeds citygate project.

## Potential for New Learning

This will build significantly on the original H21 Leeds City Gate project providing detailed analysis for UK wide 100% hydrogen conversion opportunities, strategies and potential challenges. This work has never been undertaken before within the broader UK networks or globally.

## Scale of Project

To analysis up to 18 major urban centers across the UK gas networks covering between 33 to 41%.

## Technology Readiness at Start

TRL3 Proof of Concept

## Technology Readiness at End

TRL5 Pilot Scale

## Geographical Area

All UK GDN networks

## Revenue Allowed for the RIIO Settlement

None

## Indicative Total NIA Project Expenditure

Max recoverable internal costs: £110k

- D Sadler - Project Lead, 30 days
- NGN H21 Lead - system modeler 100 days - includes support, training design, modelling etc.
- 10 days training per modeler, average of 20 days per model
- NGN - network modeler - 10 days training, 20 days per model (x2 models) = 50 days
- NGD - network modelers (x3) - 30 days training, 20 days per model (x8 models) = 190 days
- WWU - network modeler (x1) - 10 days training, 20 days per model (x2 models) = 50 days
- SGN - network modelers (x2) - 20 days training, 20 days per model (x4 models) = 100 days
- Total GDN days = 520 days

External costs: £330k

- Project meetings / training days (or weeks) - £50K
- Annual Energy Usage per network area (KIWA) - £130,000
- Project management / economic rollout scenarios - £100K
- Modelling software support £50K

NGN external costs:£166.5k

NGGD externals costs: £166.5k

## 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)

This project is one of a suite of projects to enable a conversion of the UK gas grid to hydrogen. Repurposing the UK gas networks with hydrogen to support the challenge of the climate change act has the potential to save £100s billions with minimal gas customer disruption verses alternative decarbonisation solutions.

#### Please provide a calculation of the expected benefits the Solution

Not Applicable, this is an analysis project aimed at much longer term significant savings

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

This method is applicable to all below seven bar parts of the UK gas network and therefore all license holders. A 100% hydrogen conversion could potentially cover all (or very high proportions circa 70% plus) of UK gas customers.

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

Costs for hydrogen conversion have been provided in the H21 Leeds City Gate report, this project will provide more detailed evidence of these costs for a UK wide conversion.

### 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 trialed 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 generated will be undertaken directly across all GDNs making the knowledge transferable and assisting with knowledge dissemination of the original H21 Leeds City Gate project.

### 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 sits centrally to NGNs future of the gas network strategic requirements

- 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 project will build on the original work of the H21 Leeds City Gate project allowing knowledge dissemination and significant enhancements in learning by broadening the modeling to cover significant amounts of the UK gas network infrastructure. Without this it is not possible to determine appropriate rollout conversion strategies, timelines and/or define more stringent economic analysis.

### 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

n/a

### 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**

n/a

**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**

n/a

**This project has been approved by a senior member of staff**

Yes