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

Aug 2024

Project Reference Number

NIA_WWU_02_35

Project Registration

Project Title

Understanding Future Energy Loads from Data Centres

Project Reference Number

NIA_WWU_02_35

Project Licensee(s)

Wales & West Utilities

Project Start

September 2024

Project Duration

0 years and 8 months

Nominated Project Contact(s)

Jake Sami

Project Budget

£152,648.00

Summary

To maintain continuous operation, data centres need a dependable, uninterrupted flow of electricity to power servers, supporting equipment and to provide cooling. At present this electricity is primarily sourced from the local electrical grid with data centre operators using diverse energy sources such as diesel generators to provide backup power. Several data centres are considering onsite power generation using natural gas or hydrogen in an effort to ensure electricity supply and reduce greenhouse gas emissions.

Third Party Collaborators

Apollo

Nominated Contact Email Address(es)

innovation@wwutilities.co.uk

Problem Being Solved

The demand for data centre capacity is expanding rapidly, particularly in the United Kingdom which has the largest capacity in Europe with 400-600 known commercial data centres. These facilities have enormous power demands, collectively consuming 2.5% of the UK's electricity. Accounting for future growth, the energy demands of data centres could make up 6% of the UK's total electricity usage by 2030.

The impact of data centre growth has seen several EU countries, such as Ireland and the Netherlands, take steps to address supply challenges stemming from the sector's expansion. The Irish government is presently deliberating whether to impose limitations on future data centre construction in order to fulfil emission and renewable energy goals.

Numerous data centre operators, including Google and Equinix, have demonstrated their commitment to sustainability by agreeing to The Climate Neutral Data Centre Pact, committing them to achieve carbon neutrality in their data centres by 2030.

This project aims to develop a strategic and technical evidence base for the potential role of natural gas, blend or 100% hydrogen in Data Centres. For utilisation across all GDN's interactions (and future development opportunities) within the Data Centre sector and wider supply chain.

Method(s)

A literature review will be undertaken of hydrogen developments in the UK Data centre industry to understand current ambitions, barriers to deployment, and the geographical implications of using existing gas network infrastructure to supply hydrogen to Data Centres.

The project will undertake a demand assessment from Data Centres across the WWU & SGN footprint, focussing on southwest England and Wales as case studies, to gain a deeper understanding of opportunities and barriers. In turn this can inform the infrastructure requirements and any repurposing of assets for hydrogen around them, with recommendations for further steps to fill evidence gaps.

This project will help inform early thinking around the development of the Data Centres and set the direction for further work in the WWU and SGN network. Learning will be directly applicable to other UK GDNs and associated Data centre infrastructure and supply chain needs.

The findings will be translated into a series of distinct case studies exploring the likely outcomes of converting a number of existing data centres to be powered via gas/blend or 100% hydrogen. A final report will then provide technical background to the analysis carried out, citing relevant resources and assumptions.

Measurement Quality Statement:

· The literature review will establish milestones for the identification, acquisition, and review of relevant data sources, ensuring comprehensive coverage of the research topic.

· The project will employ systematic and rigorous methods for selecting and assessing the quality of literature sources, ensuring the accuracy, reliability, and relevance of the data obtained.

· Quality control procedures will be implemented to monitor the consistency and validity of data extracted from the selected literature sources. This will also be covered by Apollo's QA procedure to ensure the relevant checking and approval process is undertake

· The project will follow established guidelines and standards for data extraction, synthesis, and analysis, ensuring transparency and reproducibility in the review process.

· Measures will be taken to address any potential biases or limitations within the literature sources, ensuring a balanced and comprehensive analysis.

· The project will document the process of literature selection, data extraction, and analysis, providing transparency and enabling future researchers to replicate or build upon the findings.

· Statistical methods and quality assurance techniques will be applied to evaluate the robustness and reliability of the synthesized data, ensuring the accuracy of the literature review's conclusions.

· The project will conduct periodic reviews and evaluations to assess the overall quality of the literature review, identifying areas for improvement and refinement.

· Supporting information, such as data summaries, annotations, and citations, will be provided to enable potential readers to understand the literature sources and their relevance to the review.

The project is rated low in the common assessment framework detailed in the ENIP document after assessing the total project value, the progression through the TRL levels, the number of project delivery partners and the high level of data assumptions. No additional peer review is required for this project.

Scope

Stakeholder engagement

Stakeholder engagement will form the foundation of this project and provide the data and insight necessary to inform this work. Successful stakeholder engagement will be crucial to gaining the most value from this project, through the provision of accurate data and insight into the future of the data centre sector. We will complete structured interviews with key stakeholders with expertise in energy network infrastructure, development strategy, and installation, and Data Centre operation, including;

- WWU's 'Asset Data & Strategy', 'Net Zero And Sustainability', and 'Network Analysis' teams
- Vantage Data and other data centre operators across the WWU and SGN network
- Distributed Energy Connections
- National Grid ESO & FSO

The project team propose to complete 10 structured interviews with key stakeholders but are willing to look at more if necessary to obtain the best output from the study. This will be agreed with WWU and SGN upon project award. By reaching out to stakeholders across both network areas we will obtain a more diverse pool
Baseline Review

Literature review of academic journals, industry reports, and institutional publications to understand the following key questions:

1. What is the current state of the UK's Data Centre Sector?

We will first map out data centre locations nationally and across the WWU and SGN region using GIS, looking at how this distribution has changed historically and why, highlighting the varying scales of data centre development from small institution-specific facilities, to regional campus hubs and hyperscale data centres.

We will summarise the existing dominant technologies that determine the bulk of data centre energy requirements, from computing and storage infrastructure, to cooling plant, with a particular focus on the specific resilience and backup power strategies critical for data centre security.

2. What are the key UK energy infrastructure constraints?

Data Centres significant power requirements mean they are often particularly sensitive to network constraints. We will provide an overview of these key electricity constraints, not only looking at system-wide capacity issues, but also highlighting the physical (where is the network?), the temporal (what are the trends and projections of network development?), and the political (what policies and government/operator strategies are emerging that could mitigate or amplify these limitations?)

We will include the current national transmission, WWU and SGN distribution gas networks, mapping out locations for pipework on the GIS map alongside the data centre locations.

3. What are the emerging Data Centre trends?

With data centre power consumption predicted to triple between now and 2030, we will complete an energy demand assessment that will establish an accurate baseline for a range of datacentre scales and typologies. A range is required as the predictions for the change in data centre power consumption vary greatly depending on the size and use - there will be no one-size-fits-all approach.

The total arriving workload and the external environmental factors are the two key inputs that determine the power demand of a data centre, with the IT equipment and cooling systems accounting for 80-90% of the total demand. With up to 80% of energy required by stand by processing units, the splitting of critical and non-critical loads as well as the modularisation of hyperscale data centres could help to load shift or even reduce the overall demand. We will assess the future projected energy demands across the range of potential

data centre industry archetypes.

We will review sectoral and site-specific data to investigate how data centre energy demands are projected to grow over the next 5/10/20 years. This will include a breakdown of the relevant growing technologies (such as AI, IoT, Blockchain and Cloud Computing) that are anticipated to have significant impacts on energy.

We will also summarise how data centres can be co-located with relevant developments to help optimise energy, heat, and cooling requirements within and nearby data centres. This will include district heating connections, industrial process requirements, gas/hydrogen sources and sinks, and micro-clusters.

4. What relevant energy technologies are on the horizon?

The feasibility of blending hydrogen into the existing gas networks has been extensively explored in recent years, though the makeup and delivery of a blended network depends on several factors. We will investigate how the different forms of generated hydrogen can be applied depending on preferred scale, cost, and carbon impact, and summarise how this is projected to vary in the future for the data centre sector in particular.

We will review the available technology that data centres will need to incorporate if they transition over to natural gas/blend/100% hydrogen. This will include natural gas and hydrogen fuels cells as well as hydrogen internal combustion engines.

We will also provide an indication of how a proposed national hydrogen spine infrastructure can be exploited to optimise and co-locate future data centre hubs and their power requirements.

Feasibility of using the gas network

Using the output from the stakeholder engagement and baseline review, the feasibility of using the existing gas distribution network to meet the future needs and goals of the data centre sector will be assessed. This will include the ability to provide a reliable supply of energy and facilitating the sector to reach net zero. We will assess the readiness and capacity of the existing network to meet these needs. This will utilise the GIS map developed to evaluate the location of the existing network in relation to data centres. This will account for the additional demand placed on the gas network and identify where there is suitable pressure and capacity to meet the current and projected needs. We will show this as a separate layer on the GIS map, highlighting areas of the WWU and SGN network that can support the data centre sector. We will also summarise what gas network constraints could affect potential data centre connection.

Case Studies

In partnership with Vantage Data Centres and other willing participants, we will translate the above findings into a series of distinct case studies exploring the likely outcomes of converting a number of existing data centres to be powered via gas/blend or 100% hydrogen. These case studies will vary by scale, strategy, ambition, and feasibility, in order to ensure the full range of possible future data centre applications is considered - this might include the establishment of a new hydrogen electrolysis plant adjacent to a hyperscale data centre to allow off-grid generation, resupplying a multi-building data centre campus to a future blended distribution network and transferring waste-heat to nearby industrial users via existing pipework, or retrofitting existing gas peaking plant with carbon capture and storage (CCS) to provide co-located blue hydrogen to a university cluster. A minimum of three case studies (small, medium, large) will be delivered. We will look to complete 1 case study from both the WWU and SGN network areas to ensure that the energy demand and network feasibility is assessed across a wider region, allowing for a more granular picture of the UK data centre sector as a whole. Each case study will indicate the likely capital/operational cost, carbon intensity, timescale (both in terms of retrofit requirements, and technology-maturity), and impacts to existing energy networks. We will also provide an indication of project performance via estimated PUE (power usage effectiveness), space utilisation, resilience, uptime, and equipment efficiency metrics, as well as a feasibility summary of each, highlighting the barriers and limitations that will need to be overcome, and an assessment of the feasibility of doing so.

Final Report

On completion of this work a final report will be delivered for WWU and SGN. We will also produce a final report and summary slide pack for public release, omitting any commercially sensitive information and data. All deliverables will demonstrate information in clear graphics and diagrams to enable the resources to be used easily and simply when engaging with stakeholders throughout the project

development and will provide case study outputs in an accessible and interactive format.

The internal report for WWU and SGN will provide technical background to the analysis carried out, citing relevant resources and assumptions to allow WWU and SGN to delve further into the information provided, at a later date should that be required.

There is a lot of ongoing work to identify the most effective route to meet net zero in the UK and this project is one of many projects to evidence the major or minor role hydrogen will have in different scenarios. Repurposing the UK gas networks with hydrogen to support the challenge of the climate change act has the potential to save £millions with minimal gas customer disruption verses alternative decarbonisation solutions

Objective(s)

To understand the potential role the gas distribution network could play in meeting the future energy demands of data centres, both as a source of primary and backup power, by supplying natural gas, blend or 100% hydrogen.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

This project has been assessed as having a neutral impact on customers in vulnerable situations.

Success Criteria

Provide understanding of the role of the gas distribution networks in facilitating the growth and net zero ambitions of the data sector

Project Partners and External Funding

The project partners for the project are Apollo Engineering, the project is fully funded via NIA.

Potential for New Learning

To understand the potential scale and timing of requirements for hydrogen for Data Centres, alongside potential barriers, and challenges.

Scale of Project

This is a desktop study, which is the appropriate level of scale for this project. The project will inform future work, the scope of which is unknown until this project is complete.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

The project is a desktop study and will take place at Apollo Engineering offices.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

WWU External: £38,162

SGN External: £76,324

WWU Internal: £12,721

SGN Internal: £25,441

Total: £152,648

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:

The outputs of this project will identify whether it is currently feasible for the gas network to be repurposed to support the decarbonisation at data centres using either blended or 100% hydrogen.

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)

N/A

Please provide a calculation of the expected benefits the Solution

There is a lot of ongoing work to identify the most effective route to meet net zero in the UK and this project is one of many projects which will assist in this area. Repurposing the UK gas networks with hydrogen to support the challenge of the climate change act has the potential to save millions of pounds with minimal gas customer disruption verses alternative decarbonisation solutions.

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

The findings will replicable across the whole of GB

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

This project is a desktop study looking at demands of data centres, rollout costs are not considered.

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

- [ ] 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)
- [x] 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 demand for data centre capacity is expanding rapidly, particularly in the United Kingdom which has the largest capacity in Europe with 400-600 known commercial data centres, so learnings from the project will be relevant to all 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?

- [x] 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.

All networks have been made aware of this project and no concerns of duplication have been raised.

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

A range of case studies will be developed to look at the implications of using different energy vectors for data centres. This will look at different sized data centres and consider the resulting CAPEX/OPEX, carbon intensity, scale of change, likely timescale and associated impact on the gas network

Relevant Foreground IPR

The report published will form the foreground IP for the project.

Data Access Details

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:

· A request for information via the Smarter Networks Portal at https://smarter.energynetworks.org, to contact select a project and click ‘Contact Lead Network’. WWU already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.

· Via our Innovation website here

· Via our managed mailbox innovation@wwutilities.co.uk

· Details on the terms on which such data will be made available by Wales & West Utilities can be found in our publicly available “Data sharing policy relating to NIC/NIA projects” here

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

The methodology undertaken in this project is deemed a beneficial part of the network conversion to a blended or 100% hydrogen network. This is not yet BAU activity for the GDNs.

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 project would only be undertaken with support from NIA funding, it is in the interests of gas customers, the regulator and the UK government and the realisation of any benefits are outside the control of the gas networks. There is no allowance in BAU business plans for this type of work.

This project has been approved by a senior member of staff

☑ Yes