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 2024

Project Reference Number

NIA_WWU_02_202

Project Registration

Project Title

Green Hydrogen Production Impacts on Water Usage

Project Reference Number

NIA_WWU_02_202

Project Licensee(s)

Wales & West Utilities

Project Start

March 2024

Project Duration

0 years and 7 months

Nominated Project Contact(s)

Eileen Russell

Project Budget

£64,827.00

Summary

The UK has legally binding targets to reach net zero by 2050. It is required for each local authority to produce a Local Area Energy Plan (LAEP) which will outline several pathways to achieve net zero. As we progress into a net-zero society, the energy system becomes more interdependent than ever before. Therefore, it is critical to consider a model where renewable electricity, hydrogen and water are considered as dependent energy vectors.

Current LAEP models consider the electricity required for hydrogen and vis-versa but not the water demand as a third variable. WWU has an existing modelling tool, Pathfinder, that balances supply and demand of the energy system on an hourly basis. This project seeks to further develop the existing Pathfinder model to include the effects of water in the system as part of the wide-scale production of green hydrogen.

Preceding Projects

NIA_WWU_2_02 - Regional Decarbonisation Pathways

SIF_WWU_2_3 - NextGen Electrolysis - Wastewater to Green Hydrogen

SIF_WWU_2_3A - NextGen Electrolysis - Wastewater to Green Hydrogen

Third Party Collaborators

HydroStar Europe

Nominated Contact Email Address(es)

innovation@wwutilities.co.uk

Problem Being Solved

The UK has legally binding targets to reach net zero by 2050. It is required for each local authority to produce a Local Area Energy Plan (LAEP) which will outline several pathways to achieve net zero. As we progress into a net-zero society, the energy system becomes more interdependent than ever before. Therefore, it is critical to consider a model where renewable electricity, hydrogen and water are considered as dependent energy vectors.

Current LAEP models consider the electricity required for hydrogen and vis-versa but not the water demand as a third variable. WWU has an existing modelling tool, Pathfinder, that balances supply and demand of the energy system on an hourly basis. This project seeks to further develop the existing Pathfinder model to include the effects of water in the system as part of the wide-scale production of green hydrogen.

Method(s)

The delivery of this project necessitates a holistic approach, considering not only the current state and influencing factors of water consumptions, but also the newly emerging demands external to hydrogen which are likely to grow in the future and technologies to reduce wastage across the network. This can then be matched to hydrogen demand increases, which considers the different electrolysis technologies.

HydroStar will deliver three key outputs across eight work packages, detailed below:

Data collection of current and forecasted water consumptions.

This will begin with engaging key stakeholders with data which is essential for the project, such as water utilities and local authorities for current water consumption and wastage data, then additional organisations such as Met Office, Natural Resources Wales and NGED for both the future potential climate change effects on hydrogen production and also the availability of other vectors, such as electricity. With data collected, analysis and calculations will be undertaken into future reasonable predictions and unknown effects. Comparisons of actual to predicted data will consider the effect of extreme events to identify times at which there may be constraints in availability of water for green hydrogen production, specifically droughts.

Identify the relationship between water consumption and green hydrogen production.

The theoretical direct consumption of water per kilogram of hydrogen produced is 9 litres, by using the molar masses of the hydrogen within the H_2O molecule. However, it is essential to consider the full production lifecycle instead of the water used directly within the electrolyser when considering the relationship between water consumption and hydrogen production. Arguably the most important factor to consider within hydrogen production is the purity of the water that is needed by an electrolyser, since this can differ largely between electrolysis technologies. Likewise, water consumption of the balance of plant supporting electrolysers is also important, with different methods for cooling representing a factor for consideration. The final stage is to apply the calculated water consumptions to different hydrogen uptake scenarios, particularly with regards to industrial hydrogen usage, blending and transport, since this will dictate the total amount of potential water demand. This can then be integrated with the other water demands experienced by the water network and the potential reductions in supply due to climate change.

Determine the relationship between all energy vectors (water, electricity, green hydrogen) when modelling future energy scenarios that are suitable to be integrated into WWU's 'Pathfinder' model.

HydroStar has extensive experience in the modelling and mapping of different energy vectors for green hydrogen production, having worked on a Department for Energy Security and Net Zero (DESNZ) project which developed a techno-economic model for hydrogen production from fluctuating renewables which was verified by the National Physical Laboratory. HydroStar is also working on multiple projects developing Next Generation technologies such as low cost, high efficiency electrolysers and metal hydride technologies, which provide the company with unique knowledge of the vectors which influence hydrogen production. This will then enable a comparison to be made between the key vectors. The comparison can also be visualised in multiple ways; geographically, in a timeline fashion or using a number of different dashboards. The same calculations can be applied to integrating with the Pathfinder model to compare the different vectors in any manner required, such as per kWh of hydrogen produced.

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.

The Data Quality and Data Measurement Statement are attached as separate appendices.

Scope

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Objective(s)

The objective of the project is to understand current and future water consumption demands, the relationship between green hydrogen production and water consumption, and the relationships between all energy vectors when modelling future energy scenarios; these findings should be collated in a final report and integrated into WWU's existing Pathfinder model.

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.

Success Criteria

A successful project will see the production of a report detailing current and future water consumption demands, the relationship between green hydrogen production and water consumption, and the relationships between all energy vectors when modelling future energy scenarios, and the integration of these findings as parameters in WWU's existing Pathfinder model.

Project Partners and External Funding

The partners for this project are HydroStar and the project is wholly funded via NIA.

Potential for New Learning

The project endeavours to enable networks to understand current and future water consumption demands, the relationship between green hydrogen production and water consumption, and the relationships between all energy vectors when modelling future energy scenarios. The integration of these findings into WWU's Pathfinder model will enable WWU to model future energy scenarios with a whole-systems overview.

Scale of Project

This will be a desktop study.

Technology Readiness at Start

TRL7 Inactive Commissioning

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The project and its generated learnings will be applicable to the entire UK, as it pertains to current and future energy demand modelling, that encompasses all energy vectors (including water as the third, interdependent vector).

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

External: £48,620

Internal: £16,207

Total: £64,827

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 project seeks to model current and future energy demands, including the relationship between green hydrogen production and water consumption, and the relationships between all energy vectors when modelling future energy scenarios. This type of whole systems modelling is not yet available for the networks, and understanding the interdependencies between the energy vectors is essential for accurate future modelling when it comes to decarbonising our energy networks.

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 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 decarbonise heating with minimal gas customer disruption compared to alternative decarbonisation solutions. It is essential that accurate modelling of our current and future energy demands should support this decarbonisation mission, and the findings of this project (in report form and integrated into WWU's Pathfinder model) will enable this accuracy. The realisation of any benefits/savings to consumers will sit with the local authorities utilising the Pathfinder model, and theirs to pass onto consumers.

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

The project and it's learnings on future and current energy demands, including the relationship between green hydrogen production and water consumption, and the relationships between all energy vectors when modelling future energy scenarios, will be applicable to the whole of the UK. The learnings will be relevant for all networks nationwide.

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

There are no roll out costs at present, as this is a research project. The findings will be a report and the integration of the findings as parameters in the existing WWU Pathfinder model.

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 and it's learnings on future and current energy demands, including the relationship between green hydrogen production and water consumption, and the relationships between all energy vectors when modelling future energy scenarios, will be applicable to the whole of the UK. The learnings will be relevant for all networks nationwide intending to model their future energy demands in a way that considers all energy vectors, with water being the third, interdependent vector.

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.

All networks have been made aware of this project; the project is complimentary in scope to NGET's 'Energy Water Nexus' (NIA2_NGET0026) project. The findings of their project will feed into the project to which this PEA pertains.

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

The Green Hydrogen Production Impacts on Water Usage (GHPIWU) project that Wales & West Utilities intend to lead, with delivery by HydroStar, has been identified as having a scope similar to that of NGET's 'Energy Water Nexus' (NIA2_NGET0026) project. Indeed, it is the intention of both projects to use whole energy systems modelling to understand the impacts of green hydrogen production on water availability and usage. The first deliverable of the 'Energy Water Nexus' project is an Excel database containing 'all data and assumptions collated for [the] project, including technology water demand characteristics, technology siting locations […], characteristics of peak conditions and near term planned water/energy system developments.' WWU's GHPIWU project, however, seeks to specifically progress the Pathfinder LAEP modelling tool, thus enabling local authorities to develop their long and short-term strategies for decarbonisation. A major advantage to this project is an interactive platform to ensure local authority understand the

interdependence of the electricity, hydrogen, and water, and what their local area energy plans entail for water demand in their local authority.

According to the Project Eligibility Assessment for the 'Energy Water Nexus' project, the third deliverable is the production and presentation of a slide deck of 'the whole energy system modelling scenarios and the implications of water stress conditions on the electricity and gas transmission network in GB', with the intention of sharing the qualitative and quantitative analyses with both energy and water sectors. Conversely, the GHPIWU project intends to engage with the water sector as a stakeholder for baseline and forward-looking modelling, with the intended user of the project's outputs (the development of the Pathfinder tool) being local authorities and other LAEP initiatives.

The findings of the 'Energy Water Nexus' project will feed into this project.

Additional Governance And Document Upload

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

The UK has legally binding targets to reach net zero by 2050. It is required for each local authority to produce a Local Area Energy Plan (LAEP) which will outline several pathways to achieve net zero. As we progress into a net-zero society, the energy system becomes more interdependent than ever before. Therefore, it is critical to consider a model where renewable electricity, hydrogen and water are considered as dependent energy vectors – current LAEP models consider the electricity required for hydrogen and vis-versa but not the water demand as a third variable. WWU has an existing model 'Pathfinder' that balances supply and demand of the energy system on an hourly basis. This project will progress the 'Pathfinder' model to include the effects of water in the system as part of the wide-scale production of green hydrogen. HydroStar will also produce a report detailing the project's findings, which will be available to, and relevant for all, of the other networks.

Relevant Foreground IPR

The project report and integration of findings into WWU's Pathfinder model will form the foreground IPR.

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

Ofgem published its final determinations which included a variety of provisions to enable necessary development work on Net Zero projects but also to ensure vulnerable customers are thought about in any decision making. This project has the potential to facilitate the energy system transition and is therefore eligible to use the NIA funding mechanism.

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 and there is a risk that if hydrogen is not accepted as a means to heat homes in 2050 that this work is no longer valid. The relationship between water availability and green hydrogen production is a core focus of this project.

This project has been approved by a senior member of staff

☑ Yes