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

Sep 2024

Project Reference Number

NIA_WWU_2_64

Project Registration

Project Title

ALCHEM - (Advanced Low Carbon Hydrogen and Energy Management)

Project Reference Number

NIA_WWU_2_64

Project Licensee(s)

Wales & West Utilities

Project Start

September 2024

Project Duration

0 years and 7 months

Nominated Project Contact(s)

Henry James

Project Budget

£446,480.00

Summary

The UK Hydrogen Strategy emphasises the pivotal role of low carbon hydrogen in achieving net-zero targets, especially in challenging sectors like heavy industry, transportation, and power. Ambitious government targets aim to deliver 2GW of low carbon hydrogen by 2025 and 10GW by 2030.

The only mature technology for producing green hydrogen (no carbon emissions) is water electrolysis, which uses renewable electricity to split water into hydrogen and oxygen. This technology is not only incredibly energy intensive, but also has difficulty using intermittent power such as from wind/solar.

The project addresses both of these challenges through innovative biomass electrolysis technology, which uses liquid waste biomass to produce green hydrogen and green chemicals. Overall this could reduce costs of future upgrades by aiding decision making through evidence-based analysis of gas user requirements and energy flows across the network.

Preceding Projects

SIF_WWU_3_2 (3) - ALCHEM (Advanced Low Carbon Hydrogen and Energy Management)

Third Party Collaborators

KI Hydrogen

Nominated Contact Email Address(es)

innovation@wwutilities.co.uk

Problem Being Solved

The UK Hydrogen Strategy emphasises the pivotal role of low carbon hydrogen in achieving net-zero targets, especially in challenging sectors like heavy industry, transportation, and power. Ambitious government targets aim to deliver 2GW of low carbon hydrogen by 2025 and 10GW by 2030.

One problem with meeting these targets is the current cost of producing low carbon hydrogen, which is three times more than grey hydrogen. A significant cost reduction is imperative to meet targets without imposing burdens on industries, taxpayers through subsidies, or energy billpayers.

Another problem faced by low carbon hydrogen technologies is system inflexibility. The only mature technology for producing green hydrogen (no carbon emissions) is water electrolysis, which uses renewable electricity to split water into hydrogen and oxygen. This technology is not only incredibly energy intensive, but also has difficulty using intermittent power such as from wind/solar.

The project addresses both of these challenges through innovative biomass electrolysis technology, which uses liquid waste biomass to produce green hydrogen and green chemicals.

Although initial focus is on industrial users, if successful this type of generation could benefit rural customers who otherwise would not benefit from hydrogen. Additional electrical network benefits are demonstrated through reduced demand on distribution networks from electrolysers, and the use of curtailed renewables. Overall this could reduce costs of future upgrades by aiding decision making through evidence-based analysis of gas user requirements and energy flows across the network.

Method(s)

This is the second phase of the project, that originally delivered via SIF Discovery SIF_WWU_3_2 (3). This project was successfully completed and proved that by halving the energy required to produce hydrogen, biomass electrolysis drastically reduces the cost to produce green hydrogen to £1.7/kg, compared to the status quo today of £4.4 - 8/kg.

Due to partner requirements for SIF Alpha the project was unable to progress, however the feedback from UKRI on the project was very positive with the monitoring officer stating “Absolutely fantastic project with novel technological scope. Thinking has been done around commercial innovation and there is a clear understanding of future, including partners, activities, and deliverables. Unfortunately, they will not be pursuing Alpha due to a requirement they cannot meet but hope to reapply into Beta”.

The ALCHEM project will employ a comprehensive technical approach to validate the commercial feasibility of biomass electrolysis technology. The method comprises the following key steps:

1. Biomass Feedstock Sourcing and Preparation:
    1. Identify and source appropriate biomass waste from industrial partners.
    2. Preprocess the biomass to understand composition, batch variability, and contaminants for electrolysis suitability.
2. Experimental Setup:
    1. Develop and set up a pre-industrial pilot biomass electrolysis unit in a relevant environment.
    2. Integrate the unit with necessary monitoring and control systems to ensure accurate data collection.
3. Electrolysis Process:
    1. Conduct electrolysis using the prepared biomass under controlled conditions.
    2. Optimise process parameters to maximise hydrogen yield and co-product (CO_2) purity considering electrode materials, catalyst recovery, and pressure.
4. Data Collection and Analysis:
    1. Collect data on energy consumption, hydrogen and CO_2 production rates, purity, and other relevant metrics.
    2. Analyse data to assess the efficiency and cost-effectiveness of the process.
5. Techno-Economic Modelling:
    1. Validate the techno-economic model to project the costs and benefits of scaling up the technology.
    2. Use model outputs to compare biomass electrolysis with conventional hydrogen production methods.

Data Quality Statement

The project will ensure data quality through the following measures:

1. Data Integrity:
    1. Implement automated data logging systems to minimise human error.
    2. Use calibrated and certified instruments to ensure accurate measurements.
2. Data Storage:
    1. Store all collected data, including raw and processed datasets, in a secure cloud database to ensure resilient storage and remote access.
    2. Maintain comprehensive metadata records to provide context and facilitate future access.
3. Data Validation:
    1. Perform regular quality checks and cross-validation against reference standards.
    2. Engage third-party auditors to verify data accuracy and integrity.

Measurement Quality Statement

To meet data quality objectives, the project will adopt the following measurement approach:

1. Standardised Procedures:
    1. Use standard operating procedures (SOPs) for all experimental activities to ensure consistency.
    2. Document all experimental setups, methodologies, and calibration routines.
2. Techniques and Tools:
    1. Employ high-precision sensors and analytical instruments to measure key parameters.
3. Traceability and Accuracy:
    1. Maintain detailed records of all measurements and calibrations to ensure traceability.
    2. Implement redundancy in data collection to enhance accuracy and address any anomalies.
    3. Use event driven data capture and storage to ensure full traceability between events.
4. Comparability of Results:
    1. Benchmark results against on-site green hydrogen production using commercial-standard water electrolyser.
    2. Ensure transparency by making data, methodologies, and findings available for review by Wales & West Utilities.

By following this rigorous methodological framework, the ALCHEM project aims to generate reliable, high-quality data that can support the commercialisation of biomass electrolysis technology.

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

WP1: Biomass pretreatment experimental development

- Scale a consistent and efficient biomass pretreatment process that enhances the yield and quality of biomass feedstock for electrolysis.
- Run a 100L thermal reactor continuously to breakdown the biomass to feed into the biomass electrolyser with successful validation through repeated experiments.

WP2: Biomass electrolysis experimental development

- Develop a pre-industrial pilot scale biomass electrolysis unit that operates reliably and efficiently, producing hydrogen at a lower energy cost compared to water electrolysis.
- Produce 1 kgH2/day at >99% purity at a minimum 300 mA/cm2 current density running at 1.2 V. Demonstrate consistent operation over multiple test cycles and compare directly against a traditional electrolyser at the same scale.

WP3: CO2 Co-Product Separation

- Efficiently separate and measure CO2 as a valuable co-product of the biomass electrolysis process.
- Achieve a CO2 purity level of at least 90%. Validate the CO2 separation process through analytical testing.

WP4: Carbon Impact Life Cycle Assessment (LCA)

- Conduct a comprehensive third-party LCA that quantifies the carbon footprint and environmental benefits of the biomass electrolysis process.
- Commission a detailed LCA report showing a significant reduction in carbon emissions compared to traditional hydrogen production methods, targeting a reduction of at least 95% with a potential of a carbon-negative process if the CO2 is stored.

WP5: Validated Techno-Economic Analysis (TEA)

- Develop and validate a robust TEA model that accurately assesses the economic viability of biomass electrolysis at scale, taking into consideration upstream sourcing costs and any downstream product purification and pressurisation.
- Produce a TEA report demonstrating cost-competitiveness with traditional methods, achieving a projected cost of £1.7/kg for green hydrogen and £80/tonne for CO2.

WP6: Safety Assessments

- Conduct thorough safety assessments to identify and mitigate potential hazards associated with the biomass electrolysis process.
- Complete comprehensive safety assessment reports meeting all relevant safety standards and regulations. Implement risk mitigation strategies that result in no significant safety incidents during the project.

WP7: Feedstock supplier and offtaker partnerships

- Shortlist the most suitable potential biomass feedstock suppliers and offtakers at industrial pilot scale and speak with several companies to understand viability.

Objective(s)

The ALCHEM project aims to advance the commercial feasibility of biomass electrolysis technology.

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

To demonstrate the commercial feasibility of Ki Hydrogen's innovative biomass electrolysis technology through experimental validation and third-party assessments.

Project Partners and External Funding

The project partners for this project are KI Hydrogen, the project is fully funded via NIA.

Potential for New Learning

The project will provide learnings relating to economic insights, environmental impacts and safety and regulatory compliance in relation to Biomass production.

Scale of Project

The project will develop and test a pre-industrial pilot scale biomass electrolysis unit and scale the biomass pretreatment process. This is the appropriate scale for this project, following the completion of a SIF Discovery phase. The scale is similar to an Alpha phase completed in SIF. We need to understand the results of this phase before further work can be completed, likely as a SIF Beta project.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

The project is a lab based study and will take place at KI Hydrogen's lab in the Midlands.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

External Cost: £334,860

Internal Cost: £111,620

Total Cost: £446,480

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 UK Hydrogen Strategy emphasises the pivotal role of low carbon hydrogen in achieving net-zero targets, especially in challenging sectors like heavy industry, transportation, and power. Ambitious government targets aim to deliver 2GW of low carbon hydrogen by 2025 and 10GW by 2030.

One problem with meeting these targets is the current cost of producing low carbon hydrogen, which is three times more than grey hydrogen. A significant cost reduction is imperative to meet targets without imposing burdens on industries, taxpayers through subsidies, or energy billpayers.

Another problem faced by low carbon hydrogen technologies is system inflexibility. The only mature technology for producing green hydrogen (no carbon emissions) is water electrolysis, which uses renewable electricity to split water into hydrogen and oxygen. This technology is not only incredibly energy intensive, but also has difficulty using intermittent power such as from wind/solar. This is due to the production of both hydrogen and oxygen, which can cross-mix during the ramping up and down of the electrolyser, forming a potentially dangerous mixture.

The project addresses both of these challenges through innovative biomass electrolysis technology, which uses liquid waste biomass to produce green hydrogen and green chemicals.

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

The UK Hydrogen Strategy targets 6 GW (0.9 Mt/year) of electrolytic green hydrogen by 2030. The recent UK HAR1 (Hydrogen Allocation Round) strike price was set at £241/MWh, equivalent to £8/kg. Electrolytic green hydrogen costs are expected to come down by 2030, with optimistic estimates projecting £4.41/kg. This means to produce 0.9 Mt/year of green hydrogen would cost £4.0 billion/year.

Biomass electrolysis drastically reduces the cost to produce green hydrogen down to £1.7/kg, costing only £1.5 billion/year to meet the UK hydrogen target. That leads to direct savings of up to £2.5 billion/year that would otherwise need to be covered by consumers, producers, and taxpayers through government subsidies.

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

Biomass electrolysis would be relevant to all applicable sites across GB.

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

This is unknown at the current time.

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 learning generated from the ALCHEM project will be valuable for various stakeholders, including Network Licensees, policymakers, and industry participants. Insights from the project will aid Network Licensees in understanding how biomass electrolysis can be integrated into the existing energy grid, enhancing flexibility and reliability.

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 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

The ALCHEM project is highly innovative, offering a novel approach to green hydrogen production that is not a business-as-usual activity. The project introduces a unique biomass electrolysis technology that uses a low-temperature process requiring half the electricity compared to water electrolysis, while producing both green hydrogen and valuable biogenic CO2.

Relevant Foreground IPR

All findings from the project, will be summarised in a report will be 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 project is currently unproven, the business case entails inherent risks, necessitating research, development, and demonstration to establish its effectiveness and commercial viability. The project's potential for substantial cost savings and environmental benefits makes it a transformative technology for the hydrogen market, demonstrating significant innovation in the field.

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 conversion of the GB gas network to 100% hydrogen is a key element on the road towards net zero. A reliable supply is crucial to support the viability of the hydrogen transition. The NIA framework can support works that ensure results that play an essential part in the roll-out of hydrogen.

This project has been approved by a senior member of staff

☑ Yes