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

Dec 2021

Project Reference Number

NIA2_SGN0011

Project Registration

Project Title

Levenmouth Wastewater Treatment Works

Project Reference Number

NIA2_SGN0011

Project Licensee(s)

SGN

Project Start

December 2021

Project Duration

0 years and 8 months

Nominated Project Contact(s)

Stephen Tomlinson, H100 Fife Programme Lead (stephen.tomlinson@sgn.co.uk)

Project Budget

£230,000.00

Summary

The UK's Net Zero emissions target by 2050, Scotland's more ambitious targets of net zero by 2045 and the water industry's commitment to net zero by 2030 presents a significant challenge across all the utility sectors. New decarbonisation opportunities need to be identified quickly and implemented in short timescales to meet these challenging targets.

Wastewater treatment is an energy intensive process and presents an excellent opportunity to explore industrial and commercial decarbonisation aligning with the UK Government's Ten Point Plan for a Hydrogen Town

Nominated Contact Email Address(es)

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Problem Being Solved

The UK's Net Zero emissions target by 2050, Scotland's more ambitious targets of net zero by 2045 and the water industry's commitment to net zero by 2030 presents a significant challenge across all the utility sectors. New decarbonisation opportunities need to be identified quickly and implemented in short timescales to meet these challenging targets.

Aging infrastructure, emissions reduction targets and the need to cater for growing populations means many WwTW are looking to upgrade or increase their capacity. This provides an opportunity for WwTWs to consider not only the efficiency improvements they could achieve by transitioning to pure oxygen-based treatments (rather than air-based treatments), but also how such a transition might support the commercial viability of hydrogen production. If oxygen-based treatments can improve the efficiency of wastewater treatment and deliver significant net savings for water utilities, this could create a secure and growing local demand for the oxygen produced via electrolysis at hydrogen production facilities such as H100 Fife.

Additionally, WWTWs produce large volumes of recycled water (what is typically referred to as “final effluent”) each year, much of which is currently unused and typically returned to the environment under strict consent limits regulated by relevant environmental government agencies. Even though current compliance criteria for final wastewater effluent do not meet the water feed requirements for electrolysers, technologies for complete total solids removal (turbidity and dissolved solids) and ions removal (e.g., hardness, manganese, iron, de-mineralisation) exist in the market and can be deployed for wastewater reuse scheme aimed at hydrogen production. There is a need to assess which technologies could be most cost-effective and efficient at delivering treatment to meet electrolysis feed characterises.

Wastewater treatment is an energy intensive process that needs heat for drying solids. Aerobic and anaerobic processes are used by the industry to purify the effluent water stream. The oxygen produced through the electrolysis of water (a low carbon solution to hydrogen production) could be used for aerobic wastewater treatments. Electrolysis also produces waste heat so applications for the waste energy will be explored.

Anaerobic wastewater treatment processes produce biogas, a mixture of low-carbon methane and carbon dioxide. The biogas can be used as a fuel directly or it could be converted to hydrogen and carbon dioxide – if the carbon dioxide is captured and stored which presents a unique opportunity to become a carbon negative solution. Another option to be explored is to use the carbon dioxide to balance the pH of the water instead of adding purchased acids.

Hydrogen produced via electrolysis from renewable sources such as proposed at H100 Fife can address the challenges and opportunities set out above. The wastewater treatment works in Levenmouth presents an excellent opportunity to explore industrial and commercial decarbonisation aligning with the UK Government’s Ten Point Plan for a Hydrogen Town.

Investigating the opportunities to utilise hydrogen from H100 Fife whilst exploring the impacts on, and resilience of, the electricity system, presents a true whole system approach to integrated net zero solutions

SGN will explore these opportunities in collaboration with SP Energy Networks and Scottish Water .

Method(s)

The project will be in three phases, the methods of each phase are set out below:

Phase 1 – A case study based on Levenmouth Wastewater Treatment Works

The project will gather all the required information about the site, its needs, company’s plans for the site and regional treatment. The desktop study will assess the data and establish the quantity of hydrogen needed, quantity of oxygen needed, electrolyser capacity required and understand the feasibility of final effluent for electrolyser feedstock and feasibility of balancing use of pre-treated wastewater for hydrogen production at scale. The project partners will score the most applicable technologies based on agreed criteria (costs, resilience, ease of retrofitting). An economic Whole Life Cost assessment of top 3 options will be produced. A phase 1 report academically reviewed highlighting the key findings, conclusions and recommendations will be delivered.

Phase 2 – A wholes systems decarbonisation study of the water, power and gas networks centred on H100 Fife and the role of hydrogen in transport

The project will investigate vehicle usage and the practicality of hydrogen use in the area, analyse the impacts of large scale hydrogen production on the electricity system and water resources in the area. The risks and opportunities will be established and an academically peer reviewed phase 2 report will be produced highlighting the key findings conclusions and recommendations

Phase 3 – A study of hydrogen production with Carbon Capture and Storage (CCS) from biogas and replication of the solution across the region

The project will investigate high level options for developing hydrogen hubs in the region centred on anaerobic digestion plant at wastewater treatment facilities which could alleviate local power constraints by using hydrogen as an energy store. The economic assessment from phase 1 will be used for scaling up and replicating across WWTWs in the region and nationally where similar co-location opportunities exist. A phase 3 academically reviewed report summarising key findings, conclusions and recommendations will be produced

A final report collating the findings from the 3 phases will be produced and published

Scope

Phase 1 intends to assess the synergistic opportunities to use both hydrogen as fuel for sludge drying and oxygen on site for aeration and options for wastewater reuse for electrolysis feedstock through H100 Fife. Other opportunities and risks will be identified to give recommendations for future roll out of similar schemes at water utility assets. Phase 1 will address the cost-effectiveness of options identified to provide a representative business case example. To assess the suitability of hydrogen replacing natural gas in Levenmouth WWTW the impact of this demand on the H100 Fife production facility (including the water and power input) will be investigated.

The benefits of phase 1 is understanding the feasibility of the above to generate more value from recycled water by using it for hydrogen production, with hydrogen and oxygen being used as for wastewater processing, and hydrogen storage for power outage incidents/

Phase 2 looks at wider applications of hydrogen use in the East Neuk area. The options for decarbonisation of transport for fleet operations (potentially Scottish Water's fleet) will be investigated. Technology options will be considered alongside local opportunities, vehicle types and refuelling requirements. Phase 2 will then look at the impact of scaling up hydrogen production to meet this increasing demand affects the power, network and gas supply chain.

There will be a stage gate between phase 2 and phase 3 to determine the most suitable option for progressing with regional replication based on outputs from phases 1 and 2. However, a proposed scope is set out below

Phase 3 will investigate hydrogen production from biogas, to potentially provide an alternative to fossil fuel reformation. The overall concept of production of hydrogen from biogas results in biogenic CO2 emissions associated with the process but these could be captured to potentially result in "negative" carbon emission. The application of carbon capture technology to biogas-based hydrogen production will be studied to benchmark efficiencies and overall carbon emission reduction potential. Following this, the project will investigate high-level options for developing hydrogen hubs in the region centred on anaerobic digestion plant at wastewater treatment facilities which could potentially alleviate local power constrain by using hydrogen as an energy store.

The technologies identified in phase 1 and the economic assessment will be looked at from a national and regional roll out perspective.

A final report collating the findings from the three phases will be produced and published An academic review will be undertaken for each project phase report and final report.

Objective(s)

The objectives of the project are to determine

- the feasibility of carbon negative anaerobic digestion of waste, by producing hydrogen from biogas and capturing the CO2 for sequestration, or utilisation.
- Feasibility of recovering wastewater effluent for electrolyser feedstock as an alternative to the potable water currently required
- the hydrogen supply requirements to fuel the wastewater treatment works and sludge drying process
- feasibility of the oxygen produced from electrolysis to supply the wastewater treatment process
- the impacts of large-scale hydrogen production on water and power sectors

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

This is a desktop-based study focussing on industrial customers and therefor does not impact consumers in vulnerable situations

Success Criteria

Success criteria for the project will be as follows:

- Delivery of phase 1 and phase 2 reports highlighting key findings, conclusions and recommendations
- Delivery of phase 3 reports subject to meeting the project requirements at the stage gate
- Delivery of a final project report outlining the key findings, conclusions and recommendations for all phases of the project
- Academic peer review of the phased reports and final report

Project Partners and External Funding

DNV, Scottish Water, S P Energy Networks

Potential for New Learning

The learnings in this project will provide knowledge on the applicability of hydrogen solutions for the water industry and the impact of large-scale hydrogen demand in industrial processing on power, gas and water resources

Scale of Project

Phase 1 and 2 is a small-scale study in Levenmouth, Fife with Phase 3 applying these learnings for national and regional replication

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

East Nuek region of Fife

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£230,000

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 LWwTW project helps inform the knowledge base in support of the aims of the Government's Ten Point Plant for a 'Hydrogen Town'. The project will enable feasible technologies to support the water sector in decarbonising their energy intensive waste water treatment processes.

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

N/A

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

Phase 3 of the project aims to determine the replicability of the project to different wastewater treatment facilities nationally and regionally

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

The outputs of Phase 3 will provide an economic assessment for national and regional replication

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 learnings in this project will provide knowledge on the applicability of hydrogen solutions for the water industry and the impact of large scale hydrogen demand in industrial processing on power, gas and water resources which can be used by network licensees for further pilot projects of hydrogen for industry

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.

A review of the Smarter Networks Portal has indicated that no previous work has published in this specific scope

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 recyclable decarbonisation solution that utilises hydrogen and oxygen from an electrolyser whilst simultaneously supplying the electrolyser with wastewater as feedstock is not a proven decarbonisation solution

Relevant Foreground IPR

A detailed report outlining the project's objectives

Data Access Details

Can be shared upon request

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

The project aims to research novel hydrogen solutions which currently sit outside SGN’s business as usual activities

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 NIA offers a robust, open framework to support this work and ensures the results are disseminated to all licenses. This work inputs into the evidence base in support of the UK Government's net-zero ambitions.

This project has been approved by a senior member of staff

☑ Yes