

## Increasing understanding of the environmental implications of utilising treated wastewater effluent in hydrogen production

### Section 1: Project Overview

#### Introduction

The Centre of Expertise for Waters (CREW) intends to commission a **capacity building project** aligned with CREW's **Water Quality and Health theme**. The project aims to increase understanding of the environmental implications of utilising treated wastewater effluent in hydrogen production.

#### Background & policy relevance

Policy levers and industrial strategy to increase hydrogen production have the potential to place additional pressure on potable, surface and ground water resources at a time of increased water stress. During a parliamentary debate on Scotland's hydrogen future on 1st May 2025, the then Acting Cabinet Secretary for Net Zero, Gillian Martin, highlighted that "hydrogen stands as a critical pillar of Scotland's route to net zero by 2045, but also, alongside the development of our offshore wind capacity, as one of Scotland's greatest industrial opportunities since the discovery of oil and gas in the North Sea."

The hydrogen economy in Scotland requires large volumes of water to support the electrolysis process as well as other types of hydrogen production technologies. Electrolysis is currently the most common proposed method of hydrogen production in Scotland. This typically requires 9-15 litres of ultra-pure water<sup>1</sup> per kilogram of hydrogen produced, with additional cooling requirements in many electrolysis systems increasing overall water demand to approximately 30-40 litres per kilogram. The ultra-pure water production stage requires a source water that is treated through multi-stage membrane processes. Given pressures on potable water resources for hydrogen production, alternative sources are increasingly being considered, including raw water abstraction from the environment, seawater, and the use of treated final effluent from coastal wastewater treatment plants (WWTPs).

#### Knowledge gap

Although the treatment processes required to produce ultra-pure water for hydrogen production from electrolysis are well established, there is limited clarity regarding the use of final WWTP effluent for this purpose, including the associated total water demand and the specific effluent streams that would supply ultra-pure water production. The overall volume of water required when WWTP effluent is used as the source remains unclear in practice, particularly when treatment and cooling requirements are considered, limiting understanding of its resource implications.

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<sup>1</sup> Also referred to as demineralised water.

Furthermore, while the composition of discharge effluent and reject streams arising from ultra-pure water production using “clean”<sup>2</sup> source waters is relatively well characterised, the reject streams generated when WWTP effluent is used as the input are less well understood. Reject streams generated during the pre-hydrogen production treatment process contain impurities and contaminants removed from the source water. When WWTP effluent is used, these may include a wider and more complex range of substances. This has implications for the management and disposal of such streams.

These uncertainties extend to the broader environmental implications of using WWTP effluent as source water, including: i) the potential impact of its contaminant profile on reject stream composition and downstream risk and ii) the potential consequences of diverting treated WWTP effluent from established discharge pathways.

To enable SEPA to assess environmental risks and determine appropriate licencing requirements, a better understanding of the end-to-end ultra-pure water treatment process and its associated discharges, is required.

## **Aim**

The overall aim of this project is to better understand the technical and environmental considerations associated with using final WWTP effluent as a source water for electrolytic hydrogen production, drawing on existing evidence. This includes treatment requirements, waste streams, and lifecycle environmental impacts, with reference to alternative water sources where relevant<sup>3</sup>.

The key questions to be addressed are:

1. What further treatment is required for the final wastewater effluent before it can be used to produce hydrogen, and which pollutants are removed from the wastewater and therefore contained in the treatment effluent and solid waste?
2. What are the management requirements, regulatory considerations, and environmental impacts for effluent arising from this further treatment when compared with the pre-treatment of “clean”<sup>4</sup> water?
3. What are the broader lifecycle environmental impacts of using final WWTP effluent as source water, including:
  - a. further treatment and associated energy use;
  - b. disposal of effluent or discharge from the further treatment (including emerging chemicals such as PFAS and pharmaceuticals);
  - c. emissions outputs (gas, air and water) from the production process and combustion of the hydrogen produced from wastewater, and
  - d. waste streams from hydrogen production using wastewater as an input?

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<sup>2</sup> In this context ‘clean’ water refers to treated potable water or other conventionally treated waters with relatively well-characterised contaminant profiles compared to WWTP effluent.

<sup>3</sup> This project focuses on final WWP effluent. Other potential sources (e.g. surface water, groundwater, seawater) are considered at a high level for contextual comparison where relevant.

<sup>4</sup> See footnote 2 for clarification of ‘clean’.

**Deliverables**

- **Final report** of 20-30 pages, excluding annexes and the bibliography, and including:
  - A critical review of the use of WWTP in electrolysis-based hydrogen production, including relevant policy and regulatory context.
  - A technical summary of treatment processes, reject stream composition, and associated environmental considerations including energy use.
  - A concise set of recommendations, including whether a reject stream could be discharged at site of hydrogen production (i.e. to a watercourse).
  - Cover image(s) with associated photo credits
- **Spreadsheet database (e.g. excel format)** containing collated and structured data found throughout the project (e.g. scientific data, costs, treatment specifications).
- **Policy brief** (of c.2-4 pages)
- **Plain English summary** of aims and results (up to 1 page)
- **Website summary** (approximately 200 words)
- **Communications and impact plan**, supported by CREW at the project start and during delivery

**Events/meetings**

- 3 Project Steering Group meetings (throughout the project lifecycle<sup>5</sup>)

**Intended impacts**

There are multiple pathways for a project to achieve impact, and multiple factors that can impact the project’s ability to achieve what it intends to do; both along the project lifecycle (A.IMPACT) and beyond project completion (B.IMPACT) (Figure 1).

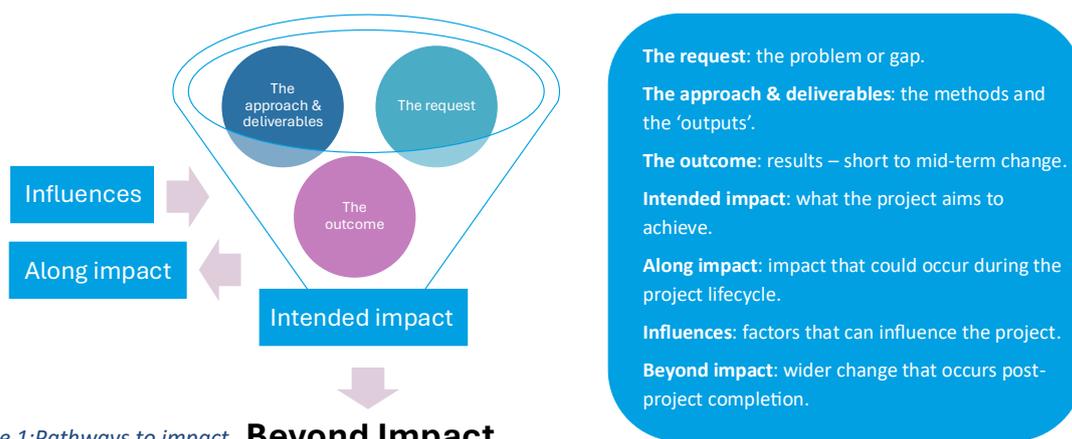


Figure 1: Pathways to impact **Beyond Impact**

**Along Impact (A.Impact):**

These stakeholders are anticipated to be a key influence on this project: SEPA, Scottish Water, and the Scottish Government Hydrogen Policy Team.

<sup>5</sup> Please note, CREW requests a brief written update c. two weeks prior to project steering group meetings.

### Beyond Impact (B.Impact)

The project is intended to provide evidence to inform policy and regulatory decisions, and to identify barriers and opportunities for both the wastewater treatment sector and the hydrogen production sector to produce hydrogen in ways that avoid or mitigate additional environmental impacts associated with using final effluent wastewater as an input. It will also consider the implications of diverting final effluent from existing uses, recognising the need to situate hydrogen production within the broader context of competing demands on treated wastewater.

By supporting evidence-based decision-making, the project outputs could contribute to climate mitigation, reduce pressure on water resources, advance net-zero outcomes, and add value to waste streams, while enabling sustainable hydrogen production.

## Section 2: Further information for applicants

### Eligibility

CREW Capacity Building funding is open to applications from **all relevant Scottish HEIs and Research Institutes (approved subcontractors)**. One eligible organisation must lead the bid, however an eligible organisation can sub-contract work in accordance with the Grant Terms which would include putting in place an appropriate agreement with the relevant sub-contractor(s) (updated December 2022). Any UK based HEI, RI or SME can be sub-contracted. Where successful, CREW funding would be subject to agreement to the CREW Grant Offer Letter and T&Cs (“Grant Terms”). CREW encourages applications from experienced to early career researchers (ECRs) under the supervision and mentorship of experienced researchers.

### Expectations and award criteria

A copy of expectations and the award criteria are provided on page 5 and 6 respectively.

### Project management

Day-to-day communication will be between the research/review team (the contractor) and a CREW Project Manager and is likely to involve short catchups as agreed.

### Communications and impact

CREW’s impact officer will engage with the research team and project steering group on any agreed upon comms and impact activities throughout the project and for post project evaluation.

### Project steering group

A CREW representative, and representatives of Scottish Government and its delivery partners, will form part of the project steering group. They will meet with the preferred bidder(s) for a pre-contract meeting. A pre-contract meeting between will take place approximately **wb.1<sup>st</sup> June**.

**Anticipated timescale (c. 7.5 months)**

- The project will commence on **15<sup>th</sup> June 2026**, depending on contract processing and signage.
- The 1st PSG meeting should be held in **late July–early August 2026**. *Project progress should be presented, with an opportunity for the Project Steering Group to review any initial work in progress.*
- A first draft of the report and spreadsheet database should be submitted by **2<sup>nd</sup> October 2026**. *Please allow 2 weeks for the project steering group to review the drafts.*
- The 2nd PSG meeting should be held in **mid-October 2026**, following the project steering group review period.
- A second draft of the report and spreadsheet database, and a first draft of the policy brief should be submitted by **27<sup>th</sup> November 2026**. *Please allow 2 weeks for the project steering group to review the drafts.*
- The 3rd PSG meeting should be held **wb.14<sup>th</sup> December 2026**, following the project steering group review period.
- A final copy of all draft outputs (report, database, policy brief, and plain English summary) should be submitted by **8<sup>th</sup> January 2027**. *Please allow 2 weeks for the project steering group to review the drafts.*
- All final outputs should be submitted by **29<sup>th</sup> January 2027** for sign off by the CREW Director and formatting.

**Funding**

The maximum amount of funding available **exclusive of VAT** (where applicable) is **£77,000**.

**Submitting a proposal**

Please complete a **CREW Capacity Building Application form** outlining your proposal.

Proposals need to be submitted to [Procurement@crew.ac.uk](mailto:Procurement@crew.ac.uk) for evaluation **by 15:00 on Thursday 23<sup>rd</sup> April**. We aim to notify the preferred bidder by **20<sup>th</sup> May**.

Please contact [Procurement@crew.ac.uk](mailto:Procurement@crew.ac.uk) by **16<sup>th</sup> April** if you would like any clarification on any of the above. You should highlight any potential conflicts of interest in your proposal. For queries about what may constitute a potential conflict of interest please contact the CREW Manager ([Nikki.Dodd@hutton.ac.uk](mailto:Nikki.Dodd@hutton.ac.uk)).

**Expectations**

No.	Criteria	Descriptor
1	Duration	The proposed duration will align closely to the details provided in the anticipated timescales section of the specification.
2	Staff time and effort	The proposed allocation of staff time and effort is appropriate and includes all deliverables. The proposal provides a commitment that named staff members will be available to work on the contract if the bid is successful. For any unnamed staff, appropriate risk identification and mitigation measures are provided.
3	Project costs	The estimated breakdown of project costs is realistic and inclusive of all deliverables.

**Award criteria**

No.	Criteria	Descriptor
1	Understanding the project ask and policy background	The proposal should include an introduction which demonstrates a clear understanding of the project requirements. This should include an understanding of the policy background and the supporting role of this project; the need for this research; the project aim; and how the proposal will address this aim.
2	Proposed methodology	The proposal should demonstrate a high quality and workable methodology, including: how the evidence will be identified, reviewed and assessed; consulting relevant stakeholders and/or experts where appropriate to address the key questions and produce the deliverables in the timescales required. It should explain the suitability, robustness and limitations of the proposed methodology.
3	Milestones	The project milestones are logical, practical and include all deliverables.
4	Project Management	The staff, resources and expertise are appropriate for conducting the proposed project. The proposal should name the project lead and outline their project management experience.
5	General and specific topic expertise and experience	The proposal should provide details of individual staff members who will work on this project and demonstrate how they will meet the project requirements, both in terms of general research experience and expertise, and specifically: <ul style="list-style-type: none"> <li>- experience and expertise on the topic of water treatment and water quality assessment;</li> <li>- environmental and lifecycle impact assessment; and</li> <li>- electrolytic hydrogen production systems</li> </ul>
6	General communication and deliverables	The proposal should describe the approach to producing the deliverables, which will be published on the CREW website. It should detail who will take lead responsibility for report-writing and overall report quality. It should provide examples of previously published reports, reviews, or similar assessments in which they have been involved.
7	Quality assurance	The proposal should provide details of quality assurance procedures to demonstrate how the contract will be continuously delivered to a high standard. It should specifically address issues of quality control at different stages of the project, including evidence gathering, analysis and report writing. It should include a timetable for delivery of tasks, project milestones and allocation of staff and staff time against each task, covering the duration of the contract.
8	Risk	The proposal should provide a risk assessment matrix detailing any risks identified in relation to the delivery of this contract, and proposed mitigation measures to minimise their probability and impact, focused particularly on risk to completion on time.

## **Annex A. Relevant reports, studies and policies**

References and further reading:

- SEPA Hydrogen Webpage – [Hydrogen | Beta | SEPA | Scottish Environment Protection Agency](#)
- Scottish Government – [Hydrogen Action Plan](#) (December 2022)
- Scottish Government – [Hydrogen Policy Statement](#) (December 2020)
- Scottish Government – [Scottish hydrogen: assessment report](#) (December 2020)
- CXC – [Scotland’s capabilities in producing hydrogen products and derivatives](#) (April 2025)
- Department for Energy Security and Net Zero – [UK Hydrogen Strategy](#) (August 2021)
- Department for Energy Security and Net Zero – [UK Low Carbon Hydrogen Standard](#) (April 2022)
- Scottish Water Horizons – [Shaping our hydrogen future with sustainable water solutions](#)
- Hydrogen Scotland – [H2 from wastewater for shore power](#)
- SGN/ Ramboll – [FEASIBILITY STUDY INTO WATER REQUIREMENT FOR HYDROGEN PRODUCTION](#) (November 2022)<sup>6</sup>
- CS NOW – [Water demand for hydrogen production](#) (March 2024)
- Scottish Government – [Water, wastewater and drainage policy consultation](#) (February 2024)
- Scottish Government – [Assessment of electrolyzers: report](#) (October 2022)
- Scottish Enterprise Hydrogen assets map – [Scotland's green energy opportunity](#)
- Scottish Enterprise Hydrogen factsheets – [Insights | Scottish Enterprise](#)
- Scottish Development International – [THINK HYDROGEN THINK SCOTLAND](#)

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<sup>6</sup> N.b. some messaging in this document is not consistent with SEPA advice