The role of hydrogen for a resilient and low-emissions UK water sector

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WATER INFRASTRUCTURE AND RESILIENCE WIRe
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Background

- The UK water industry is an energy intensive sector consuming around 3% of the UK's total energy demand.
- The sector is committed to becoming carbon neutral by 2030, or 2040 in the case of Scottish Water (this target includes both operations and supply chain).
- Hydrogen (H_2) can play a role in the transition to achieving a carbon neutral UK water sector. The implementation of H_2 production technologies will enable the recovery of H_2 which can then be used to decarbonise key processes.

Project Aim

To develop an evidence-based strategy for the UK water industry to switch towards a hydrogen economy aligned to achieving carbon neutrality.

Objectives

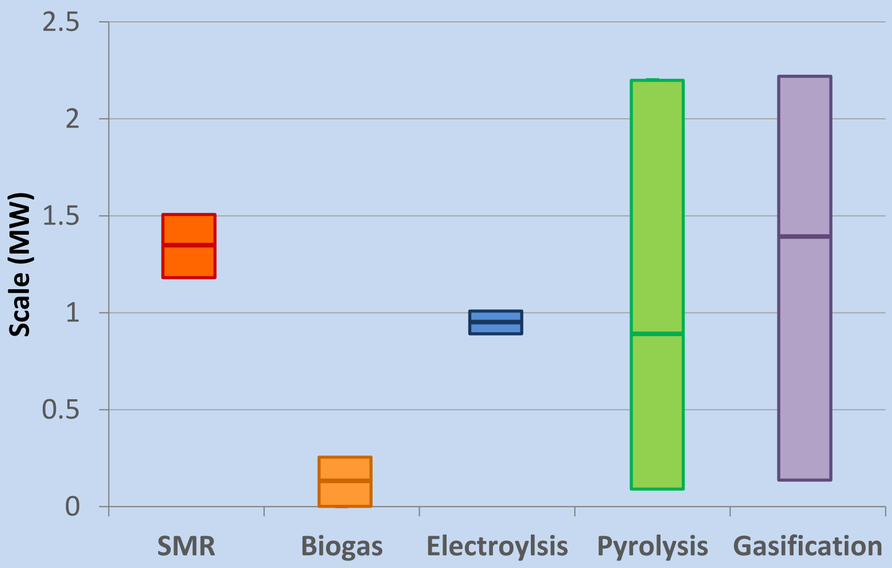
- Understand the current limitations on the implementation of carbon-neutral (green) H_2 production processes.
- Define the applicability of solutions to the water sector.
- Define the contribution to carbon emissions reduction and energy resilience.

Established or emerging technologies?

Hydrogen production technologies are evaluated to determine their applicability to the UK water sector. Steam methane reforming (SMR) and electrolysis have examples of industry scale applications (Figure 1) and low water requirements (Figure 2), which demonstrates potential for application to the UK water sector.

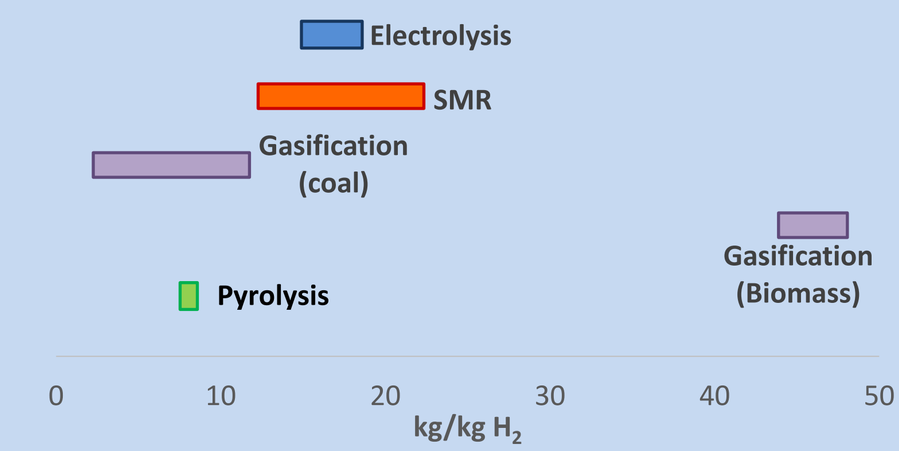
Table 1. Characteristics of high TRL (>7) H_2 production technologies.

Technology	Input	Pre-treatment	Output	Post-treatment
Electrolysis	H_2O, Electricity	High purity H_2O	H_2, O_2	None
SMR/Biogas Reforming	Biogas, Steam, Heat	Desulfurization Gas compression	H_2, CO_2	WGS, PSA
Gasification	Sludge, Steam, O_2/Air	Sludge drying	Syngas Ash / Char	Syngas cleaning WGS, PSA
Pyrolysis	Sludge, Steam	Drying, grinding	Syngas, Bio-oil, Char	Steam reforming, WGS, PSA



- Biogas reforming is currently used for research purposes / smaller projects.
- Gasification has been implemented into larger water industry projects.
- Electrolysis projects are no longer research only but also include commercial applications

Figure 1. Scales for H_2 production schemes developed in the water sector.

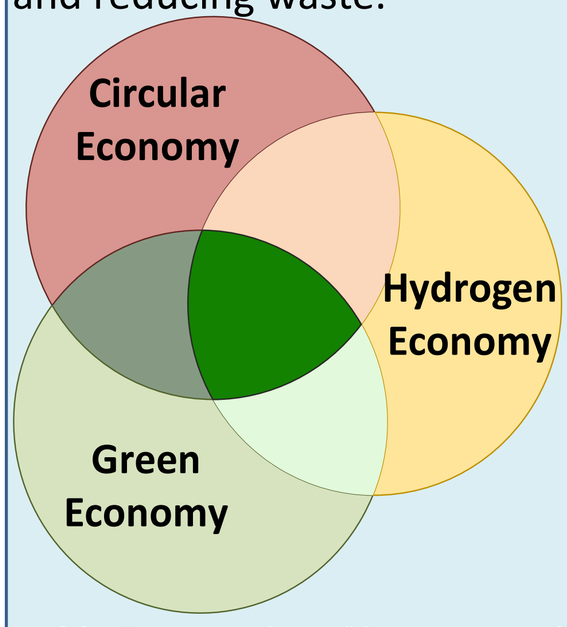


- Biomass gasification has the highest water demand.
- Electrolysis and steam reforming have considerably lower water requirements.

Figure 2. Water demand for high TRL H_2 production technologies.

Synergic or competing economies?

Hydrogen economy = relies on H_2 as energy vector.
Green economy = ensuring substantiality and ecosystem regeneration as well as decarbonisation of society.
Circular economy = focus on regenerating materials for use and reducing waste.



Key questions:

- How do these economies apply to the UK water sector?
- What are the synergies and constraints between the three economies?
- How can a H_2 economy be successfully implemented?

Table 2. Examples of how H_2 production technologies can sustain (green) or limit (red) the achievement of the three economies.

	Economies		
Technology	**Circular**	**Green**	**Hydrogen**
Electrolysis	O_2 as co-product Fresh water	Renewable energy Fossil fuels Rare elements	High purity H_2 Established and scalable tech Cost
SMR/Biogas Reforming	Use of black carbon Catalyst deactivation	Renewable methane SMR produces CO_2	SMR produces high purity H_2 Technology downscaling
Gasification	Use of tar-char Non reusable by-products	Sludge disposal High water demand	Demonstration project Tech development Syngas purification
Pyrolysis	Use of bio-oils No use for aqueous fraction	Sludge disposal Inefficient process	Low energy input Tech development Syngas purification

Future work

- Evaluation of the impact of H_2 production and usage on the carbon emissions of Anglian Water and Scottish Water.
- Investigation of the requirements (such as pre-treatment) associated with the implementation of these technologies.
- Develop experimental activities to fill the gaps for the most promising technologies with a view of future implementation.

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