Innovation Launchpad Network+

CASE STUDY

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The Challenge

With the ambitious target of 10GW of low carbon hydrogen production capacity by 2030, it is expected that at least 40% will come from low-carbon hydrogen using methane reforming integrated with carbon capture and storage (CCS) technologies, known as 'blue' hydrogen. Whilst recent regulator's guidance has established a design carbon capture rate of at least 95%. For hydrogen produced via the electrolytic route, renewable energy supply, such as wind, is essential for the so-called 'green' hydrogen, however, their intermittency is a challenge to keep up the electrolytic hydrogen production combined with its storage. A key challenge is the selection of technologies and the speed of their deployment that considers their effects on emissions, costs and performance and enable achieving the net zero target. Thus, modelling tools that support the assessment of multiple technological solutions to decarbonise the UK energy system are needed.

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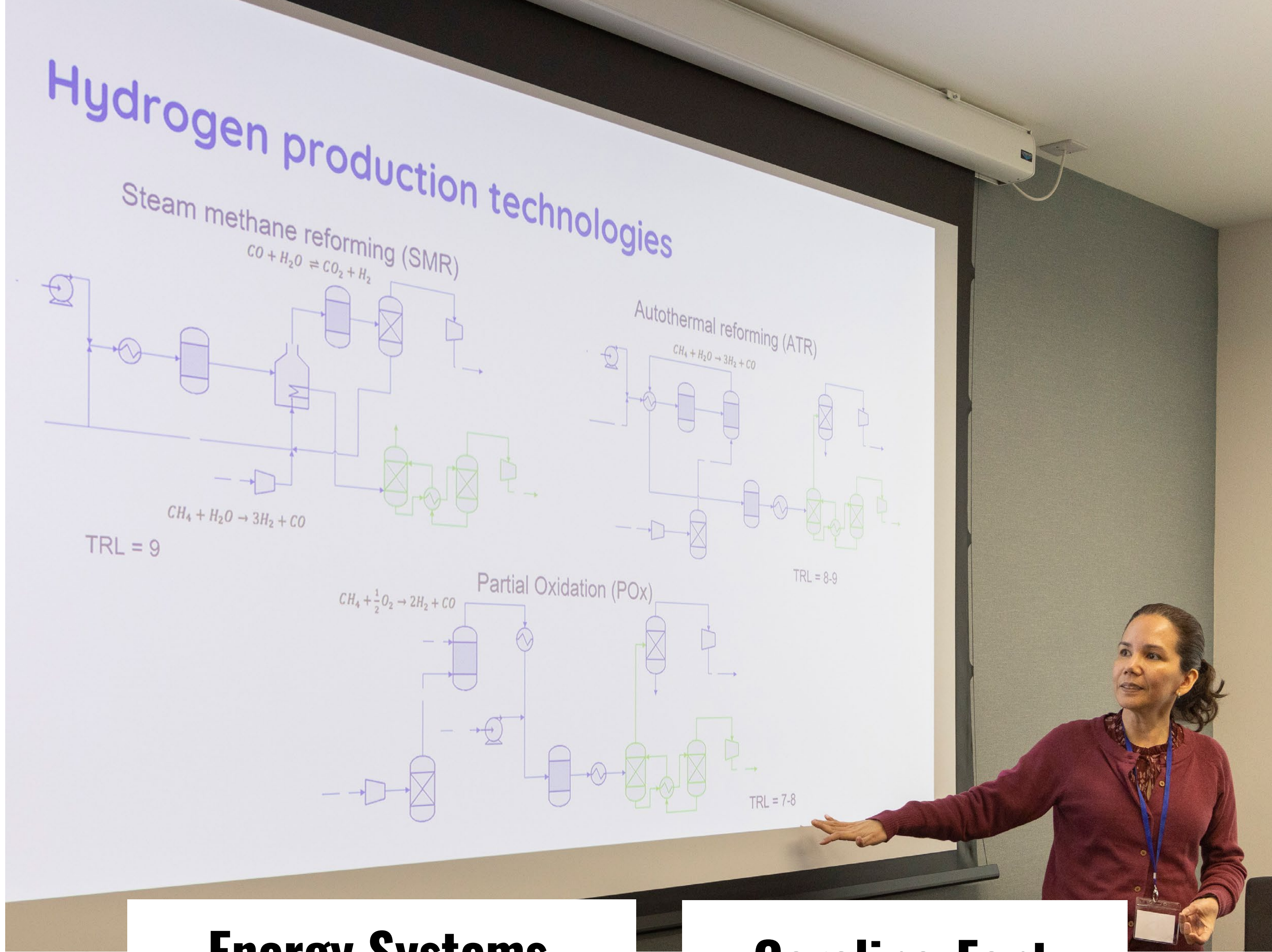
Working in partnership with the Energy Systems Catapult, the project included a combination of techno-economic assessment studies and the application of a whole system model, ESME (Energy System Modelling Environment), owned and operated by the Catapult. This enabled assessing case studies involving three selected blue hydrogen technologies: steam methane reformation (SMR), autothermal reforming (ATR) and partial oxidation (POx). We assessed preferred low-carbon hydrogen production methods considering the role of biomass, nuclear and electrolysis for net zero pathways. A key deliverable was updating ESME tool with the three blue hydrogen technologies assessed with varying carbon capture rates. The findings aim to support the expansion of hydrogen projects and the development of the hydrogen economy.

Result

The project delivered models for the three selected technologies, SMR, ATR and POx integrated with carbon capture using Aspen Plus® software for the material and energy balances and the equipment costing. Those results were introduced into ESME tool. All technologies were assessed under two scenarios: a) Standard scenario, where ESME looked for the combination of technologies that provide the lowest cost system that meets net zero targets; and b) Scenario restricting installation rate of biomass-based hydrogen plants (BECCS, bioenergy with CCS).
Key findings and recommendations
In the standard scenario, blue hydrogen production appears from the mid-2040s. Most of the hydrogen supply in the 2030s and early 2040s comes from BECCS with a small proportion from electrolysis and nuclear cogeneration (from 2040).
In the scenario restricting installation rate of BECCS, blue hydrogen production starts earlier from 2030.
Hydrogen production could reach approximately 200 TWh by 2050 in both scenarios with approximately 35-50% of this coming from POx with 99% capture rate.
Assumptions made play a significant role in the results, thus findings reflect those decisions made early on.

Impact

The UK target of 10GW of low-carbon hydrogen production capacity by 2030 has set that at least 60% will come from 'green hydrogen' (electrolysis combined with renewables). Though, this project has shown that hydrogen produced from biomass could play a significant role provided biomass is sourced sustainably and that the high costs of electrolysis suggest a much modest role than the current UK government target. The project also confirmed the key early role of 'blue' hydrogen as a transition technology to reach the ambitious net zero target. Thus, these findings could provide government bodies, industry, and research institutions with insights to accelerate the hydrogen economy.



Energy Systems Catapult

"Catapults operates in the space between Government, industry and academia. The Researcher in Residence scheme is a really effective way of bringing expertise from academics into the Catapult. Together we can explore novel technology areas that benefit both the Catapult and academic institutions. Findings and insights can then be disseminated across the Catapult's network including within Government. Through this project in particular we have learnt more about blue hydrogen production methods and obtained useful data to characterise these technologies in our energy systems model. This has then allowed us to see which innovations offer the most value to the energy system both in terms of hydrogen production and decarbonisation. I look forward to seeing how we can build on this."

Carolina-Font Palma

"I encourage academic colleagues at any career stage to look for opportunities that allow collaboration with the Catapults. This is a unique opportunity to gain insights from a technology and innovation centre, plus the added benefit of strengthening links and extending your network. I'm glad I took part of this project with the Energy Systems Catapult's team through the Researcher in Residence scheme at current exciting times for low-carbon hydrogen in the UK".

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