PRESS RELEASE | 23rd April 2025

High performance materials for green hydrogen production without critical raw materials

Brussels, 23rd April 2025 – Achieving Europe's ambitious climate goals requires a significant shift from fossil fuels to renewable energy sources. With the EU aiming to cut greenhouse gas emissions by 40% by 2030—and up to 95% by 2050—there is an urgent need for scalable, sustainable energy solutions. Green hydrogen offers a versatile and clean alternative to decarbonise energy-intensive sectors. However, its widespread adoption depends on overcoming cost, durability, efficiency and resource challenges.

HYScale is addressing this challenge by upscaling innovative high-performance materials that reduce dependency on scarce resources, without compromising on performance or efficiency. By replacing CRMs and PFAS, traditionally used in Anion Exchange Membrane-water electrolyser (AEMEL), the project is advancing the first single stack 100 kW AEM electrolyser prototype, more cost-effective and environmentally friendly for hydrogen production.

Building on a series of tests, the HYScale team has successfully demonstrated that its newly developed materials can be scaled up without compromising performance. Large-scale applications are now delivering results that align with those achieved in small-scale single-cell laboratory tests, a crucial milestone on the path to real-world implementation. With this progress, HYScale is now one step closer to integrating the stack into a fully functional electrolyser system, targeting a CAPEX of 400 €/kW and advancing towards validation in an industrially relevant environment, reaching Technology Readiness Level 5.

Refining materials for scalable hydrogen production

To achieve this goal, optimising individual cell components of a stack is a crucial step. Before scaling up to a full electrolyser system, researchers focused on refining catalysts, membranes, and porous transport layers in small-area cells. This process ensures that each component is fine-tuned for efficiency, durability, and long-term operation.

The Italian Centro Nazionale delle Ricerche (CNR) have investigated the influence of the substrate used for the electrode as well as the type of porous transport layer, which was designed and manufactured by Bekaert, employed for the transport of produced gas. CENmat provided catalyst coated substrates using high- performance CRM-free catalysts. CNR and DLR have performed extensive tests to assess both performance and stability of the HYScale components.

A direct comparison with a commercial polymer, Piperion™, has demonstrated the performance advantage of CENmat PFAS-free AionFLX™ membrane and ionomer. Moreover, durability tests have shown the stability of the HYScale components, meeting the objectives of the project.

As stated by Julien Fage, polymer chemist and engineer at CENmat: “Scaling up material innovations from lab-scale to industrial electrolysers requires overcoming challenges in durability, manufacturability, and cost-efficiency. HYScale tackles these by integrating advanced materials with scalable processing techniques, ensuring performance and stability at a competitive cost.”

Scaling up: large area cell assessment
Building on small-cell optimisation, the HYScale team has developed a large-area cell, vital for meeting the project’s scalability targets. Drawing on CNR’s expertise, the architecture was adjusted to improve cost-effectiveness and manufacturing efficiency.

The large cell was meticulously designed with two primary objectives in mind: cost efficiency and high performance. To achieve these goals, the design incorporates specialised solutions for the frames, sealing, and transport layers. By optimising the design and carefully selecting materials, the number of machining steps was minimised, lowering the cost while maintaining the high performance required for the application.

A key innovation in this phase was the decision to adopt a flow-field-free design—an approach that brings multiple advantages for both production and performance. As Nicola Briguglio, senior researcher from CNR explains: “The decision to adopt a flow-field-free design was driven by the need to simplify the architecture of the AEM short stack and reduce manufacturing complexity. Additionally, eliminating the flow field reduces the overall thickness of the stack and facilitates a more compact and lightweight design, which is beneficial for system integration and scale-up.”

Efforts have focused on optimising the cell structure by reducing frame thickness and validating the materials previously tested in small single cells. With testing now underway as part of the short-stack phase, HYScale is advancing towards integrating these improvements into a fully functional electrolyser system.

As shown, HYScale continues to make advancements in cost-effective and scalable hydrogen production. By optimising materials and refining cell design, the project is laying the groundwork for more efficient electrolyser systems. While testing moves forward in the short-stack phase, HYScale remains focused on demonstrating the viability of its innovations in real-world applications, bringing Europe closer to its clean energy goals.

A detailed report on HYScale’s latest developments, including technical findings and next steps, is available for [download on the project website](#).

About HYScale

HYScale is a multinational, industry-focused, interdisciplinary EU-funded project with a primary goal of enhancing its electrolyser technology to produce the green hydrogen.

Co-funded by the European Union

Clean Hydrogen Partnership

The project is supported by the Clean Hydrogen Partnership and its members.
Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Clean Hydrogen Partnership. Neither the European Union nor the granting authority can be held responsible for them.

The project will focus on refining materials synthesis and components production, particularly membranes, ionomers, electrodes, and porous transport layers, looking for optimisation and upscaling.

The project's final goal is to integrate the stack into a functional electrolyser system and to get to its validation in an industrial relevant environment (TRL5).

About the Consortium

Led by Cutting-Edge Nanomaterials (CENmat), the consortium includes eight additional partners from seven EU countries. Among these are four renowned EU research centres specialising in hydrogen technology: the German Aerospace Center (DLR), the Italian National Research Council (CNR), the French Alternative Energies and Atomic Energy Commission (CEA), and the University of Ljubljana. Additionally, there are five industrial partners: CENmat itself, the Public Power Corporation of Greece (PPC), which is the greatest energy producer in the south-east Europe, HyGear, Meta Group, and Bekaert. The diverse expertise of these project partners ensures an efficient and targeted pursuit of the project's objectives.

Glossary

- **Green Hydrogen**: A sustainable form of hydrogen gas produced using renewable energy sources, such as wind or solar power, to power the electrolysis of water. This process splits water into hydrogen and oxygen, and since it uses renewable energy, it results in zero greenhouse gas emissions, making it an environmentally friendly energy source.

- **Water Electrolyser Technology**: A technology used to produce hydrogen by electrolysis of water. An electric current is passed through water, splitting it into hydrogen and oxygen gases. This technology is key in producing hydrogen for various applications, including energy storage and as a fuel source.

- **AEMWE (Anion Exchange Membrane Water Electrolysis)**: A type of water electrolysis technology that uses an anion exchange membrane. This membrane allows the passage of negatively charged ions (anions) and is used to efficiently produce hydrogen and oxygen from water without the need for expensive and rare catalysts.

- **CRM (Critical Raw Materials)**: Materials that are crucial for the economy and have a high risk associated with their supply. CRMs are typically used in the manufacture of high-tech devices, green technologies, and other important industrial applications. Their scarcity or geopolitical constraints on supply can pose risks to economic security and technological progress.

- **PFAS (Per- and Polyfluoroalkyl Substances)**: A large group of man-made chemicals that include PFOA, PFOS, GenX, and many other substances. PFAS are used in a wide range of consumer products for their water- and oil-resistant properties. They are

Co-funded by the European Union
Clean Hydrogen Partnership

The project is supported by the Clean Hydrogen Partnership and its members.
Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Clean Hydrogen Partnership. Neither the European Union nor the granting authority can be held responsible for them.

known for being environmentally persistent, meaning they do not break down easily, leading to concerns about environmental and human health impacts.

Join the HYScale community

- Website: https://www.hyscale.eu/
- LinkedIn: HYScale
- Bluesky: @hyscale-eu.bsky.social

Media contact

Project coordinator
Dr. Schwan Hosseiny, Cutting-Edge Nanomaterials UG (CENmat)
shosseiny@cen-mat.com

Press officer
Lucía Cortés, META Group
l.diez@meta-group.com

Co-funded by the European Union

Clean Hydrogen Partnership

The project is supported by the Clean Hydrogen Partnership and its members.
Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Clean Hydrogen Partnership. Neither the European Union nor the granting authority can be held responsible for them.