PECATHS: A SUSTAINABLE WAY TO STORE HYDROGEN

FRANCISCO FABREGAT-SANTIAGO,[1] JOSE MATA,[1] CARMEN MEJUTO,[1] ROSARIO VIDAL,[1] ELENA MAS-MARZÁ,[1] CRISTIAN BACHMANN, [1] DAVID TILLEY,[2] THOMAS MOEHL,[2] JORDI ARBIOL,[3] MAX GARCIA-MELCHOR,[4] & CONOR BRENNAN-POLLAK,[5] NURIA MAÑÉS-BELTRÁN.[6]

[1] Universitat Jaume I, Institute of Advanced Materials, Castelló de la Plana, Spain, fabresan@uji.es
[2] University of Zurich, Deptartment of Chemistry, Zurich, Switzerland.
[3] Catalan Institute of Nanoscience and Nanotechnology, Bellaterra, Barcelona, Spain
[4] CIC EnergiGune, Victoria, Spain
[5] Trinity College Dublin, Dublin Ireland.
[6] Comet Global Innovation, Barcelona, Spain

Abstract.

Present technology to obtain green hydrogen is based on water splitting through electrolysis using green energy sources or photo-electrocatalysis. However, the cost of producing green H_2 from water electrolysis is high compared to traditional methods, mainly due to the cost of electricity and catalysts. This is why, over 90% of Europe's H_2 production is derived from natural gas, with a cost of 1-2 €/kg compared to 2.7-8.8 €/kg for green H_2.(World Energy Council, 2021)

When using catalysts based on earth-abundant materials, the oxygen evolution reaction (OER) poses significant challenges, with high overpotentials and sluggish kinetics and currently constitutes the bottleneck limiting global H_2 production from water splitting.(Suen, et al. 2016;) Furthermore, OER generates low-price oxygen (O_2) as a by-product, which hinders

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competitiveness. This makes the forecast for the price of green H_2 very slow in reaching similar prices to present conventional technologies, which is estimated to occur by 2050 according to PWC. (PWC, 2022) That is too late for the urgent need of transforming the energy system to stop climate change.

To ease the transition to a CO_2-free society through green H_2, it is crucial to create cost-effective and highly efficient catalytic (photo)electrodes, to explore alternatives to OER and develop efficient ways for H_2 storage. Our approach in PeCATHS aims to develop an integrated long-term energy storage system utilizing hydrogen in the form of liquid organic hydrogen carriers (LOHCs), coupled with innovative biomass conversion.

This approach enables the direct transfer of hydrogen from biomass to LOHCs in the cathode without the need of hydrogen gas production, while simultaneously generating high-value chemicals at the anode. By integrating chemical and energy sectors, the project aims to synthesize platform chemicals and achieve long-term energy storage in liquid form, enhancing both the sustainability and efficiency of energy systems. (Solera-Rojas, et al. 2025;

The direct storage into a stable liquid energy carrier significantly facilitates the storage, transport and distribution, while the combined use of renewable power and biomass as simultaneous source of hydrogen and platform chemicals provides the opportunity to successfully solve the economic and sustainability challenges associated with green H_2 production and storage and eases the transition to CO_2-free chemical industry.

In this work we will present some of the latest results of PeCATHS consortium in the implementation of this cost-effective strategy.

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