Project PEPPER

Press Release No.1

The project is supported by the Clean Hydrogen Partnership and its members.

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Press Release #1

PEPPER Project Launched to Advance Innovative Hydrogen Technology

• The German Aerospace Center (DLR) is coordinating a consortium of eight European project participants to develop an innovative hydrogen electrolysis reactor under the Horizon Europe PEPPER project.
• PEPPER focuses on advancing planar Proton-conducting Ceramic Cells for electrolysis application (PCCEL) operating at intermediate temperatures (400 - 600°C), offering significant efficiency and sustainability advantages.
• The project aims to develop two scalable cell technologies — cermet-supported and metal-supported — with a target cell size of 100 cm², integrating them into compact short-stacks validated under ambient conditions, while individual cells will also be tested under pressurized conditions.
• Key innovations include ultra-thin electrolytes, >90% reduction in critical raw material use, improved tolerance to acidic contaminants, hence minimized environmental impact and a commercialization roadmap by 2035.

The **PEPPER project** (*Performant and Efficient Planar Proton-conducting Electrolysis Reactor*) was officially launched in January 2025, funded by the EU's Horizon Europe programme under the Clean Hydrogen Joint Undertaking. **Its mission: to develop a new generation of high-performance, scalable electrolysers** that will accelerate the production of **more affordable and sustainable green hydrogen**.

Led by the **German Aerospace Center (DLR)**, PEPPER brings together **eight project participants from six EU Member States**, combining expertise in advanced materials, energy systems, electrochemistry and industrial-scale electrolysis. Over its duration, the project will deliver a breakthrough in **planar Proton-conducting Ceramic Cells for electrolysis application** - flat, stackable devices that efficiently convert steam into hydrogen using both heat and electricity.

The Urgent Need for Innovation & PEPPER's Answer

As Europe transitions to a climate-neutral energy system, green hydrogen is set to play a vital role - especially in hard-to-abate sectors like the steel industry, chemistry and transport. However, current green hydrogen production struggles to meet the future projected demand. To make hydrogen more widely available, it is necessary to address important production challenges, such as **high energy consumption**, **dependency on scarce materials** or **limited scalability for industrial integration**.

Unlike conventional low- or high-temperature electrolysis systems, PEPPER targets the **intermediate temperature range (400-600°C),** in which the PCCEL operates. This middle temperature range allows for the reuse of waste heat from industrial processes, reducing

electricity demand while maintaining high efficiency. It also supports smoother integration with existing infrastructure and reduces the dependency on costly and critical raw materials.

PEPPER will **develop and demonstrate large-area planar PCCELs (100 cm²)** integrated into **compact short-stacks**, a form optimized for real-world industrial integration. Two complementary cell designs are under development: **cermet-supported** and **metal-supported technologies**, the latter enabling up to 90% reduction in rare earth and cobalt usage with enhanced resistance to acidic impurities such as chromium and silicon.

PEPPER's technical targets involve:

- **≥ 90% faradaic efficiency**
  Meaning nearly all the electricity used goes directly into producing hydrogen.
- **≥ 0.75 A/cm² current density at nominal capacity**
  Indicates a high hydrogen production rate under balanced energy conditions, improving efficiency.
- **Thin-film, multilayer electrolyte architectures (electrolytes <5 µm)**
  Very thin layers that help the device run more efficiently while keeping it strong and compact.
- **Validated electrolysis performance under realistic operating conditions**
  Proving the cells work safely and reliably under pressure while demonstrating stack operation at atmospheric pressure.
- **Integrated 3D transient modelling to optimize stack thermal and electrochemical behaviour**
  Using advanced computer simulations to ensure the system runs smoothly, evenly, and efficiently.

The project includes the development of full **techno-economic** and **life cycle assessments**, comparing the new planar PCCEL systems to today's solid oxide electrolysis (SOEL) benchmarks. These results will shape PEPPER's commercialization roadmap aiming for **market readiness by 2035**.

"With PEPPER, we're advancing a promising hydrogen technology by transitioning it from research and moving it further towards its industrial deployment," said **Dr. Rémi Costa**, Project Coordinator at DLR. "By focusing on the often overlooked intermediate temperature range and advancing both cell materials and stack designs, we're developing a clean, compact, and resource-efficient solution that is going to **help Europe to close the future hydrogen supply gap**."

About PEPPER

PEPPER has received nearly €3 million in funding from the European Union's Clean Hydrogen Partnership under the Horizon Europe research and innovation programme (Grant Agreement No. 101192341). The project began in January 2025 and is scheduled to conclude in December 2027. PEPPER starts at Technology Readiness Level (TRL) 2 and aims to reach TRL 4 by the end of the project.

PEPPER Consortium

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- AVL LIST GMBH (AVL), Austria

- COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES (CEA), France
- CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS), France

  CNRS-affiliated entities: Institut des Matériaux de Nantes Jean Rouxel, Université de Montpellier, Université de technologie de Belfort-Montbéliard
- TECHNICAL UNIVERSITY OF DENMARK (DTU), Denmark
- EIFER EUROPAISCHES INSTITUT FUR ENERGIEFORSCHUNG (EIFER), Germany
- AKTSIASELTS ELCOGEN (ELCOGEN), Estonia
- GRANT GARANT S.R.O. (GG), Czech Republic

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