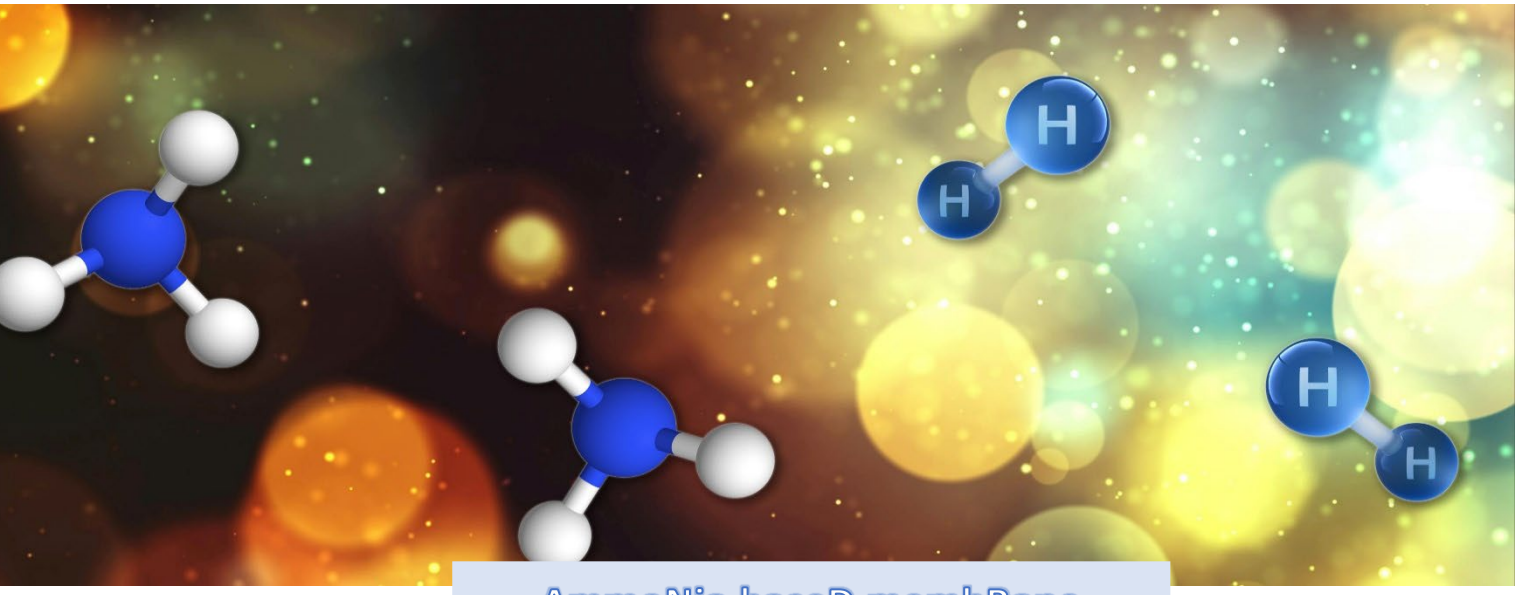


AmmoNia baseD membRane rEActor for green Hydrogen

Welcome to this **fifth ANDREAH newsletter**!

ANDREAH is a four-year European project, whose main objective is to provide a quantum leap in the development of advanced ammonia decomposition technologies to produce ultra-pure hydrogen (>99.998%) by developing an innovative system based on a Catalytic Membrane Reactor (CMR) for the cracking of Ammonia. In this way, optimised heat management, improved conversion per pass and purification/recycling for more cost-efficient and resource-effective ammonia decomposition at lower temperatures compared to conventional systems will be achieved.

The present newsletter is the fifth release of the biannual letter that will be published by AndreaH presenting the progress on the project and highlighting information related to the R&D fields addressed. Hope you will find the info in this newsletter interesting.

On our website www.andreahproject.eu you will find public presentations, all the public deliverables of the project and many other interesting news. Stay tuned!

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- **Interview to Antonio Vita (CNR-ITAE)**



Antonio Vita is the scientific lead and coordinator of the CNR-ITAE research unit in ANDREAH project.

*"Our team is responsible for the development of 3D-printed metallic structured catalysts, namely Periodic Open Cellular Structures (POCS) built on Triply Periodic Minimal Surface (TPMS) architectures, with geometries such as Gyroid, Diamond and I-WP cells, coated with a thin layer of Ru-based catalyst"*- said Antonio.

**What has been the biggest challenge you have faced during the research?**

*"The biggest challenge has been the scale-up of the structured catalysts for the final demonstration. Moving from small lab samples to large POCS components means controlling the washcoat deposition, its uniformity and adhesion over much larger and more complex surfaces, while preserving the catalytic performance measured at lab scale. It was the first time our laboratories tackled a scale-up of this size, and we are genuinely proud of the result achieved by the whole team".*

**What is the next important step for your research within ANDREAH?**

*"Our next step is to support the partners during the final demonstration phase: delivering the structured catalysts, assisting with their integration into the reactor, and helping to interpret the performance data under real operating conditions, so that the knowledge gained at lab scale translates into a reliable technology."*

**What makes a catalyst suitable for ammonia-to-hydrogen conversion?**

*"A good ammonia-cracking catalyst must be highly active at the lowest possible temperature, since lower temperatures mean lower energy consumption and simpler reactor materials. It must also be stable over long operation, resisting sintering and deactivation, and it should use the active metal efficiently, which is particularly important for expensive metals such as ruthenium.*

*Finally, at reactor level, heat supply is crucial: ammonia decomposition is endothermic, so the catalyst must receive heat efficiently. This is exactly where structured catalysts like POCS make*

*the difference, as their conductive metallic lattice improves heat and mass transfer and reduces pressure drop compared with conventional pellets."*

**If you had to explain your research to someone outside the scientific community in one sentence, what would you say?**

*"We design 3D-printed structures coated with a catalyst that efficiently turn ammonia, an easy-to-transport hydrogen carrier, back into clean hydrogen exactly where it is needed."*

- **Interview to Luca Ricci (RINA)**




RINA Consulting leads WP5, which covers the environmental, social, economic and safety assessment of the ANDREAH technology.

**What is RINA's role in the ANDREAH project, and what are you focusing on in Phase 2?**

*"RINA Consulting leads WP5, which covers the environmental, social, economic and safety assessment of the ANDREAH technology. Within WP1, RINA also leads IPR management and exploitation strategy (T1.2) and regulatory and standardisation pathways (T1.4). RINA's role has grown in the second phase of the project, and it now covers both the exploitation side of the project and its sustainability and safety assessment. In Part 2, RINA delivered the Health and Safety Requirements for the prototype (D5.2). It is now completing the final LCA, LCC and S-LCA assessments and contributing to the business model and TRL9 roadmap. RINA is also turning each Key Exploitable Result into a concrete exploitation roadmap, consolidating the regulatory baseline, and assessing social acceptance and market readiness."*

**What are the main engineering or technical challenges you are addressing now?**

*"The main challenge for RINA is linking three levels of modelling so that they stay consistent. The first is component data for catalysts, POCS, membranes and sorbents. The second is process simulation for the 5 t/day and 100 t/day scenarios.*
*The third one is the design of the full integrated plant. To do this, RINA sent tailored questionnaires to the technical partners to collect environmental, cost and social data. These include how long each component lasts, which drives replacement and maintenance costs.*
*On safety, RINA used a HAZID-inspired method focused on major accidents such as releases, fires and explosions.*

*The main hazards it identified are hydrogen and ammonia handling, membrane and catalyst reliability, and the complexity of scaling up and integrating the system.*
*The risk of ammonia corroding materials and equipment is also receiving specific attention."*

**How does RINA contribute to bringing the different technologies developed within ANDREAH closer to an integrated solution?**

*RINA looks at the whole system across its life cycle. It follows each building block from WP3, through the process models in WP2, into the integrated plant in WP4, and uses this to compare configurations and identify where design choices matter most. The safety analysis also works as an integration tool.*

*The measures RINA proposed make the demonstration phase safer and give a reference for replicating the technology at other sites. RINA's work on exploitation and regulatory pathways connects this technical integration to a coherent market perspective. Building on the preliminary business model, which used a cost-benefit analysis of hydrogen produced and carried as ammonia, RINA contributes to testing additional scenarios, shaping the go-to-market strategy and supporting the spin-off pathway together with InnoEnergy.*

*Combined with the exploitation roadmap for each KER, this links technology, sustainability and business into one integrated value proposition.*

**From an engineering perspective, what are the main requirements for making ammonia-to-hydrogen technologies viable for real-world applications?**

*According to the ANDREAH work, the first requirement is hydrogen quality. The project targets ultra-pure hydrogen above 99.998%, and mobility applications must meet ISO 14687 limits on residual ammonia and nitrogen.*

*Efficiency and resource use matter just as much. ANDREAH aims to run the reactor at lower temperatures, between 400 and 450 °C, with better conversion per pass, and to use 80–90% fewer critical raw materials than conventional packed-bed systems. The techno-economic analysis also shows that membrane performance is decisive. Improving hydrogen/nitrogen selectivity together with permeance allows smaller reactors and cuts purification costs.*

*Finally, real-world deployment requires designs that comply with Seveso III, ATEX, REACH and PED, supported by transparent risk management.*

**Looking beyond ANDREAH, where do you see the greatest potential for ammonia-based hydrogen technologies in the European energy landscape?**

*RINA sees the strongest potential in large-scale hydrogen imports. REPowerEU targets 10 million tonnes of renewable hydrogen imports by 2030 and supports hydrogen corridors, and ANDREAH's demonstration at the Port of Rotterdam fits directly into that picture. The project's business analysis*

*follows this import value chain: renewable hydrogen is produced where renewables are abundant, shipped as ammonia, and cracked close to the end users.*

*Regulation such as Fit for 55 and FuelEU Maritime also favours hard-to-abate sectors like shipping, steel and heavy-duty transport.*

*The project studies two business cases. The centralised case uses 100 t/day of ammonia to supply the hydrogen backbone, and the decentralised case uses 5 t/day to supply truck refuelling stations. For these markets to develop, RINA sees harmonised certification, faster permitting, safe demonstrations and public trust as the main enablers.*

Ammonia is more than a chemical used to produce fertilisers. It can also play an important role in the energy transition, acting both as a carrier for hydrogen and as a potential low-carbon fuel for maritime transport.




Three European projects — AMBHER, ANDREAH and APOLO — are exploring complementary technologies that could help unlock this potential.

The recently completed AMBHER project, which concluded in May 2026, investigated innovative solutions for hydrogen storage. Its research addressed two complementary approaches: long-term, large-scale hydrogen storage using green ammonia and shorter-term storage using metal-organic frameworks (MOFs). These technologies offer different possibilities for storing hydrogen to meet future energy demands.

For a deeper insight into the research conducted by AMBHER partners, explore the scientific publications resulting from the project: https://www.ambherproject.eu/article-papers/

But how can hydrogen stored in ammonia be made available for use? This is where ANDREAH comes in. The project is developing an innovative catalytic membrane reactor that combines ammonia cracking with hydrogen separation to produce ultra-pure hydrogen. By integrating these processes, ANDREAH aims to contribute to more efficient hydrogen recovery and support the development of future hydrogen technologies.

Ammonia also offers opportunities beyond hydrogen storage. APOLO focuses on innovative solutions for maritime power conversion, investigating the use of ammonia in technologies such as onboard cracking and fuel cells or ammonia-powered engines. These approaches could help reduce the maritime sector's reliance on conventional fossil fuels.

Although the three projects address different challenges, they share a common ambition: advancing technologies that can support Europe's energy transition.

From storing hydrogen for future use to recovering it from ammonia and exploring cleaner maritime power systems, AMBHER, ANDREAH and APOLO demonstrate how complementary European research can contribute to a more sustainable energy future.




Fausto Gallucci form 1CUBE presented ANDREAH project talking about "Membrane reactors with Carbon Membranes" at the 18th Edition of the International Conference on Inorganic Membranes (ICIM- 29 June to 3 July) held in Montpellier

Valentina Cechetto participated in ICSET2026 (31 Aug – 4 Sept) within ADREAH project, presenting her work on "Performance evaluation of structured POCS catalysts for $H_2$ production via $NH_3$ decomposition"




Thanks to our partner RINA, ANDREAH project joined the POR H2 Final Event, entitled "Research and Innovation: Opportunities and Perspectives for the National Hydrogen Value Chain", that took place at the Auditorium Porta del Parco in Bagnoli, Naples (Italy) on 22–23 September.





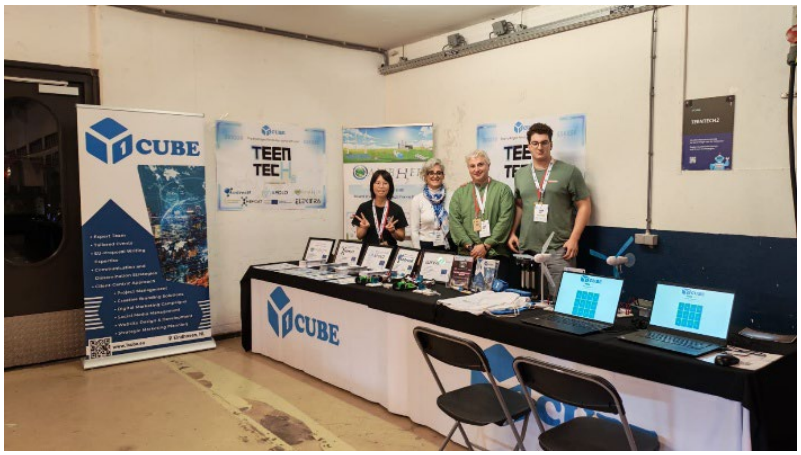

On 12–13 September, ANDREAH joined Maker Days Eindhoven through the TEENTECH2 programme, coordinated by 1CUBE, alongside four other EU-funded projects. Through interactive activities, games and conversations, visitors of all ages discovered how ammonia can help store and transport hydrogen, and how innovative technologies can convert it back into hydrogen.

The event welcomed more than 10,000 visitors, offering an opportunity to connect European research with the public and inspire curiosity about future energy technologies.

Read the full article





The European Hydrogen Innovation Cluster (EUH2cluster) now brings together nine EU-funded projects working on complementary technologies across the hydrogen and ammonia value chains, with COUPLE recently joining the Cluster.

The Cluster connects projects addressing different challenges, from hydrogen production and purification to storage, conversion and end-use applications. By sharing knowledge, coordinating activities and creating opportunities for collaboration, the initiative aims to strengthen connections between research, industry and other stakeholders and increase the impact of European hydrogen innovation.




Another important milestone is the publication of the Cluster's first joint brochure, presenting the nine participating projects: AMBHER, ANDREAH, APOLO, CARMA-H2, COUPLE, HERMES, HYIELD, MEASURED and PYRAH2.

The brochure provides an overview of each project, highlighting its objectives, technologies, expected impacts and demonstration activities. Together, these profiles offer a snapshot of the diverse solutions being developed across Europe to advance hydrogen innovation.

Discover the nine projects and explore the first EUH2cluster brochure [here].

The Cluster's activities will continue with the upcoming **"Ammonia as an Energy Carrier" webinar**, bringing together EU-funded projects to explore the potential of ammonia in the energy transition.

The webinar will feature short pitches introducing the EUH2cluster projects, followed by more in-depth presentations from APOLO, ANDREAH and COUPLE, highlighting their approaches and contributions to advancing ammonia technologies.

On behalf of ANDREAH project Antonio Vita from CNR-ITAE will talk on "Scaling up 3D-Printed POCS Catalysts for Ammonia Cracking in a Membrane Reactor: The ANDREAH Journey from Lab Microscale to Demonstrator"




**Join us on 9 December 2026, from 10:00 to 12:00 CET**, to discover the projects, exchange insights and learn more about the role of ammonia in the future energy system by following this link:

Registration teams link

- **A.A.A. Cluster activity:** ANDREAH & APOLO projects at [Congreso Net-Zero MAR 2026 - Islas Canarias - 11-13 Noviembre - Alianza Net-Zero MAR] with TECNALIA partner

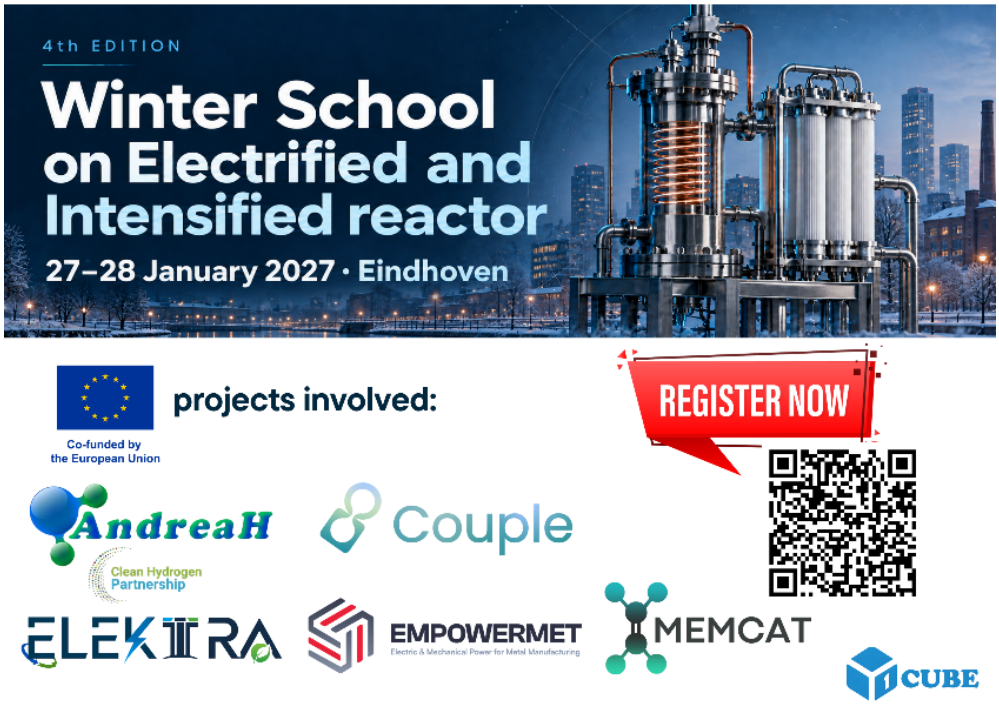
- **EUH2 Cluster activity:** Webinar "Ammonia as Energy Carrier" Part III

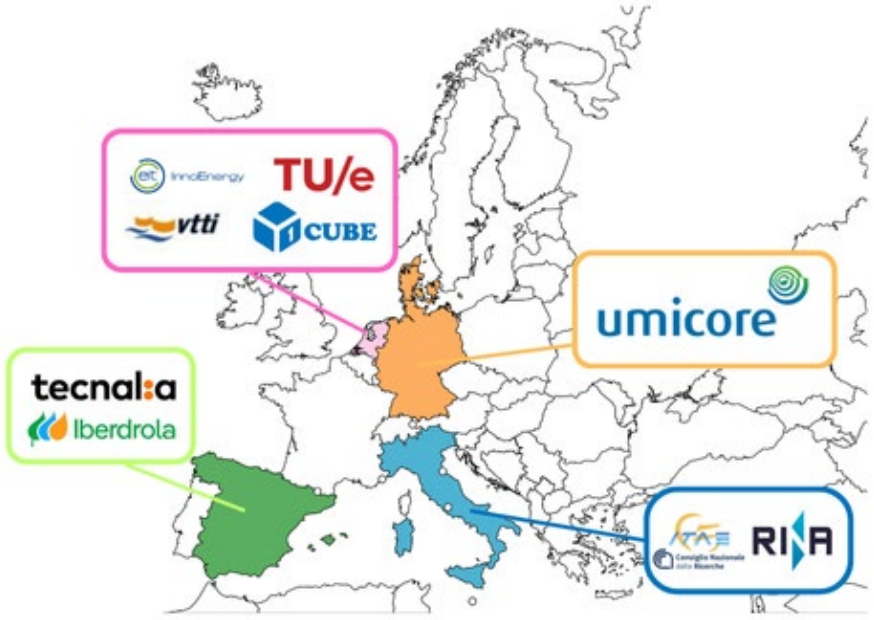





➢ **4th Edition of Winter School on "Electrified and Intensified reactor"**

Registration LINK






**Project details:**

**Project Number: 101112118**
**Title: AmmoNia baseD membRane rEActor for green Hydrogen production**
**Project Acronym: ANDREAH**
**Call: HORIZON-JTI-CLEANH2-2022-2**
**Starting date: July 1st 2023**
**Duration: 48 months**
**UE funding: 2,980,361 Euro**
**Coordinator: Fundación Tecnalia Research & Innovation**
**Project Coordinator: José-Luis Viviente, Jaione Ollo Loinaz**

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Clean Hydrogen Partnership