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Clean Hydrogen Partnership


# AmmoNia baseD membRane rEActor for green Hydrogen production

Topic: HORIZON-JTI-CLEANH2-2022-02-04: Liquid hydrogen carriers: ammonia

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*"The project is supported by the Clean Hydrogen Partnership and its members Hydrogen Europe and Hydrogen Europe Research."*
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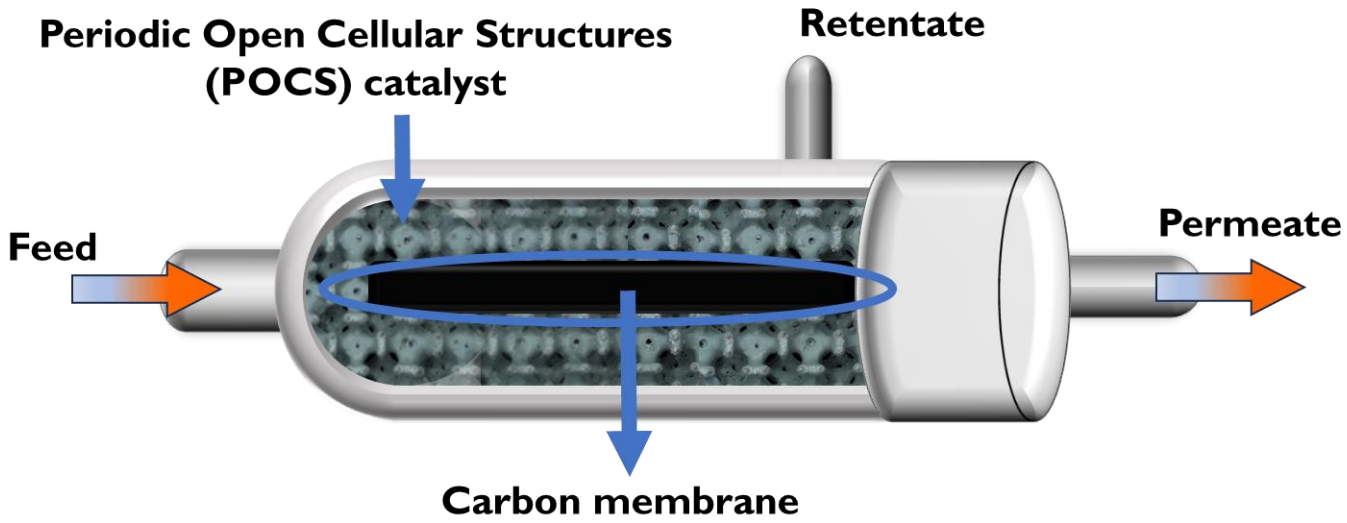
# 1. Main goal

The ANDREAH project aims at providing a quantum leap in the development 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.




ANDREAH will work through a holistic approach to tackle both the centralized and decentralized hydrogen generation from ammonia and develop a flexible and efficient ammonia cracking technology able to satisfy the decarbonization of hard to abate sectors.

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# 1. Main goal and S&T targets

- To develop and demonstrate at 10 $kgH_2$/day scale, a new Intensified ammonia cracking system based on Catalytic membrane Reactor Technology through advanced Carbon Molecular Sieve Membranes integrated with Novel Catalyst .
  - To develop an innovative, environmentally friendly and with less critical materials, structured catalyst that can be used at much lower temperatures compared to state-of-the-art process.
    - catalysts without or with low (<1wt%) Ru content (using not critical Ni) capable of operating at temperatures 400-450° C
    - To design and manufacture highly conductive 3D printed Periodic Open Cellular Structures (POCS) with optimised heat and mass transfer.
  - To develop innovative membranes for selective separation of $H_2$ during production process.
  - To develop novel sorbents for polishing the $H_2$ recovered by the membranes.

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# 1. Main goal and S&T targets

- To develop a full LCA, LCC and Health and Safety Analysis (HSE) of ANDREAH

- To pave the way for future exploitation of AMBHER Key Exploitable results .
  - To elaborate the business case of KER1. Advanced catalysts, sorbents and membranes integrated into a CMR for ammonia cracking.

- To promote the dissemination and communication of ANDREAH's results and expand its impact

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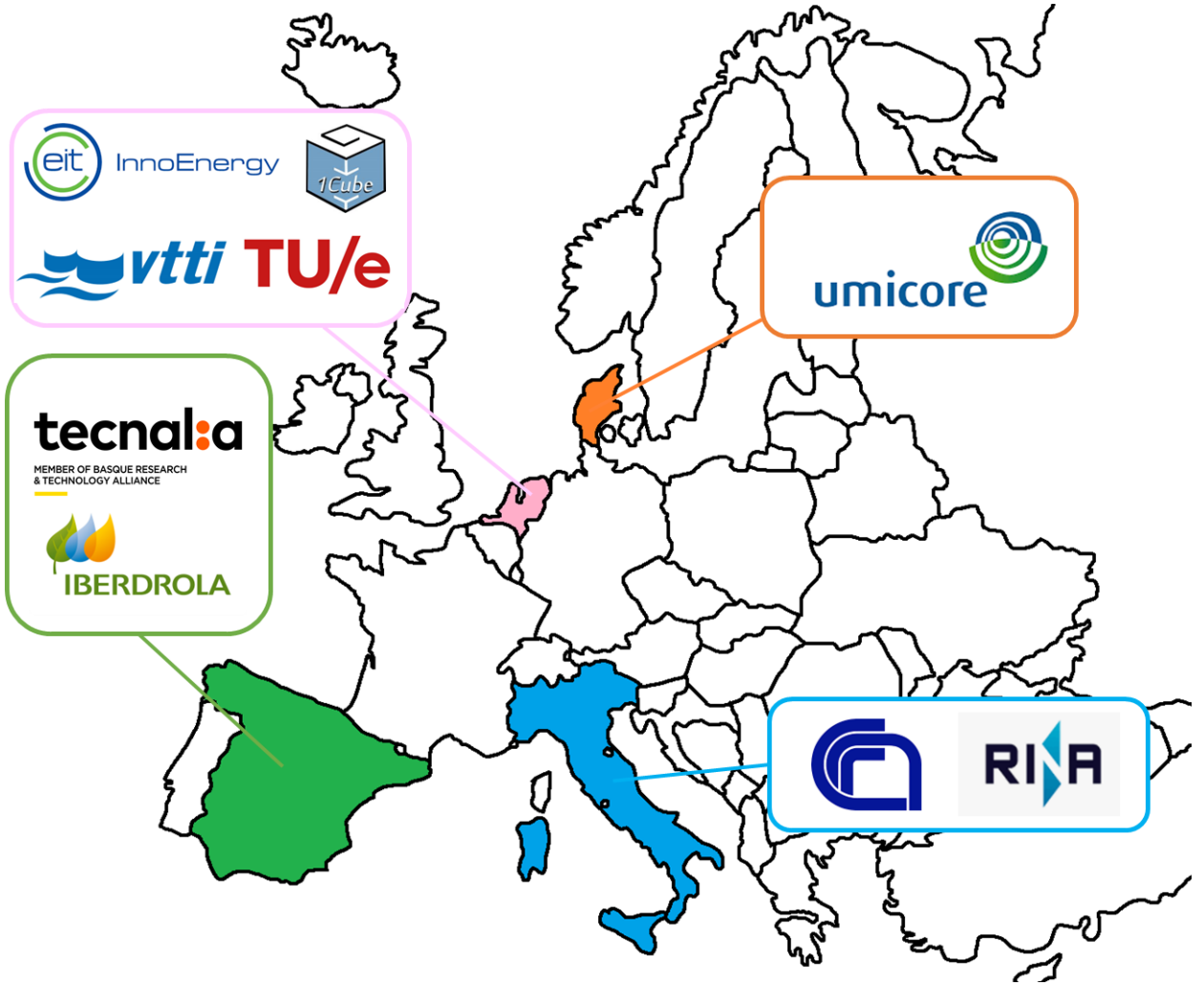
# 2. Participants & Consortium synergies

- 9 partners from 4 countries .
- 6 SME/IND + 3 RTD partners (66% SME/IND; 22% SME)
- AMBHER has an interdisciplinary approach including chemistry, material design, engineering, modelling, manufacturing, safety, business and economics.
  - companies specialised in materials development (UMI), energy multinational companies (IBER) and energy storage provider (VTTI).
  - top-level European Research Public/private Institutes and Universities will collaborate (TUE, CNR and TEC) to turn AMBHER objectives into results that can later be scaled-up and exploited
  - LCA, LCC and HSA will be performed by RINA-C and tailored dissemination and communication strategies led by 1CUBE.



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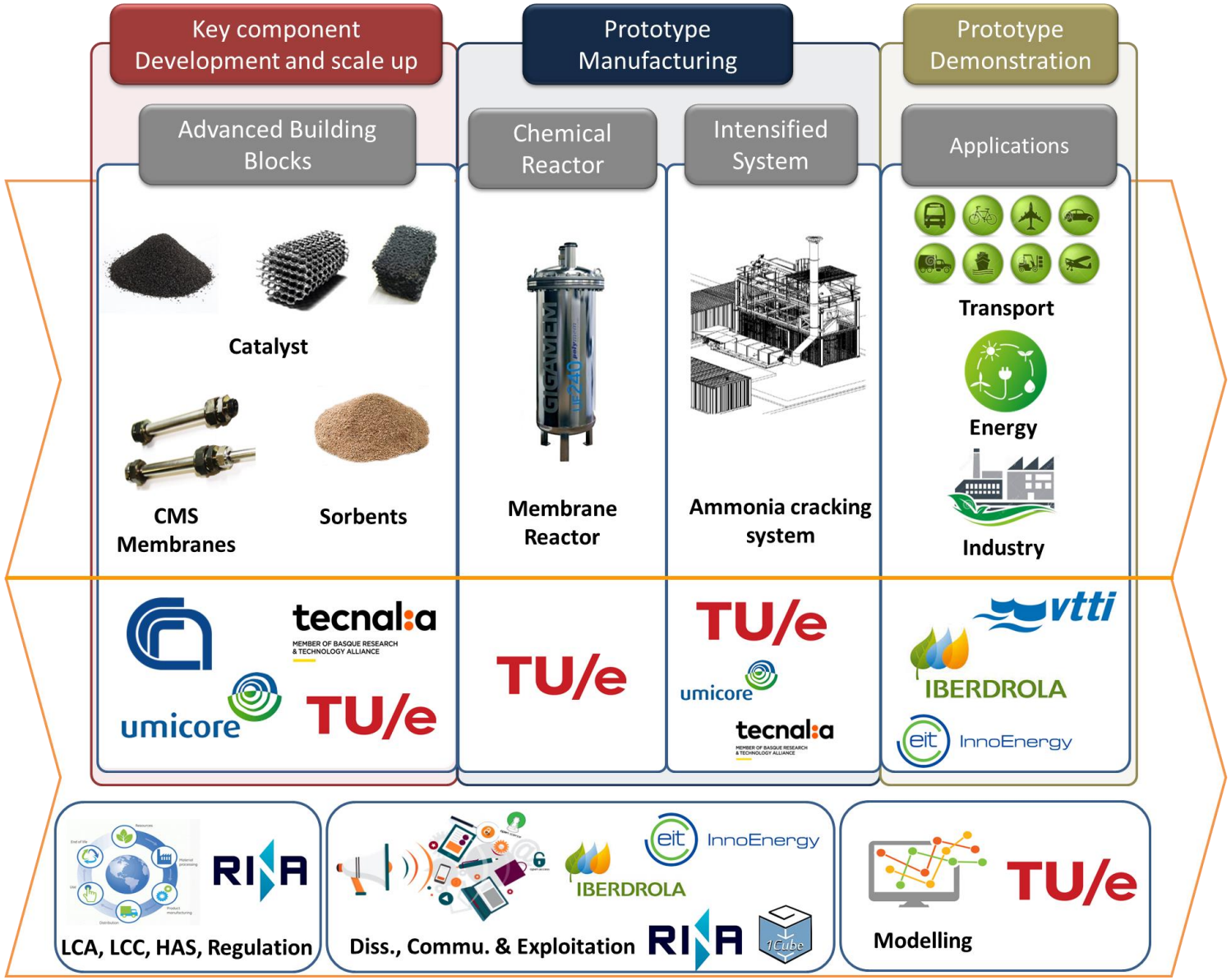
# 3. Overall approach and methodology



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# 5. Expected results and KER

- **ER1: Advanced Ammonia decomposition system** based on Membrane Reactor technology for hydrogen production
- **ER2: Innovative environmentally friendly catalyst materials** that can be used at much lower temperatures compared to conventional ammonia decomposition.
- **ER4: Innovative carbon membranes** for selective separation of hydrogen during the gas phase production process.
- **ER4: Recipes for the activation of OCFs and 3D-printed POCSs** with the catalyst.
- **ER5: Novel sorbents for polishing** the $H_2$ recovered by the membranes

**KER2: Advanced $NH_3$ cracking system based on Membrane Reactor technology for $H_2$ production.**

**Main partner:** TUE/TEC/CNR (Participates: IBER, UMI,VTTI, KIC )

**Value proposition**: Ammonia decomposition system based on advance catalysts and membranes integrated into catalytic membrane reactor coupled with sorbent-based polishing technology.

# 6. Impact

- Contribute to Europe technology leadership developing innovative reactors and catalysts for the dehydrogenation of ammonia as well as new integrated solution for heat management and hydrogen separation and purification;
- Reducing the use of critical raw materials in ammonia dehydrogenation reaction;
- Improving the economics of the ammonia dehydrogenation process;
- Develop new business models related to the use of hydrogen from ammonia for various applications, such as centralised and distributed power generation, shipping, heavy mobility, etc;
- Contributing to the understanding of Europe need in terms of infrastructure and regulation for the management of liquid hydrogen carriers;
- Foster the demonstration of the solutions developed in the project throughout Europe.

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# 7. Expected objectives of the Clean Hydrogen JU SRIA

Develop a range of $H_2$ carriers that will be used commercially to transport and store $H_2$ while improving their roundtrip efficiency and lowering their cost.

1. The performances of the innovative $NH_3$ cracking technology developed and validated in ANDREAH will be used to feed an economic and environmental analysis with ambition to provide a clear perspective on the potential of $NH_3$ as carrier for $H_2$ long distance transportation and dispatch
2. ANDREAH's consortium will perform a comparative analysis in order to provide a holistic view on the potential of these hydrogen carriers for hydrogen long distance supply and specifically on the competitive advantages provided by ANDREAH's membrane reactor technology for the use of $NH_3$ as a carrier.

Contribute to the SRIA KPIs on $H_2$ carrier delivery cost, for 3000km ship transfer.

1. ANDREAH will perform a complete Well-to-Tank techno-economic and LCA for a typical transport route as mentioned in RePower EU (i.e Morrocco- Rotterdam. 3115 km ship route) the cost of producing, transport and cracking green $NH_3$ into pure hydrogen.

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# 7. Expected objectives of the Clean Hydrogen JU SRIA

Contribute to the SRIA KPIs on hydrogen carrier specific energy consumption (Targets: 2024 = 17kWh input/kg$H_2$ recovered, 2030 = 12 kWh input/kg$H_2$ recovered). This figure encompasses the energy consumption for the production of ammonia from hydrogen, for which the project shall retrieve the value from the SoA.

1. The technology developed in ANDREAH allows for lower temperature ammonia cracking compared to conventional technology (400-450°C vs 900°C respectively). ANDREAH's consortium will model and simulate the entire power-to-ammonia-to-hydrogen value chain and define the overall well-to-tank energy efficiency of the proposed solution. The overall energy consumption and efficiency of ANDREAH's membrane reactor solution will be compared to the one achieved by conventional ammonia cracking technologies (fired-heated furnace type).

Foster the demonstration of the solutions across Europe.

1. ANDREAH pretends to attract key players in the $H_2$ economy that can ensure the proper dissemination of the results (ER1-ER5), and thus, fostering the demonstration of the cutting-edge technologies developed. In this sense, ANDREAH counts with UMI, VTTI, RINA and IBER, companies with a strong position towards $H_2$ in Europe .

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# *Thank you for your attention*

https://www.andreahproject.eu/