



# APOLO NEWSLETTER ISSUE 1

ADVANCED POWER CONVERSION TECHNOLOGIES BASED ON ONBOARD AMMONIA CRACKING THROUGH NOVEL MEMBRANE REACTORS



Funded by the European Union



## APOLO



## WELCOME TO THE FIRST APOLO NEWSLETTER

APOLO Project Consortium is proud to present its first public newsletter! APOLO Project is 4 year European Project which is dedicated to advancing high performance, cost effective power conversion technologies using ammonia for maritime applications. Through this project, a team of researchers with industrial and academic background aim to develop innovative solutions involving catalytic membrane reactors, fuel cells and advanced ammonia engines to reduce emissions in maritime sector.

This newsletter marks the inaugural release of our biannual updates on APOLO project, where you can follow its progress and latest highlights on research and development. We sincerely hope you find the news and views provided in this newsletter informative and engaging. For more details, including public presentations, project deliverables and other dissemination articles, please visit our website [www.apoloproject.eu](http://www.apoloproject.eu). Stay tuned for more APOLO updates as we navigate towards a greener future for the maritime industry.



## MEET OUR COORDINATOR

APOLO project is coordinated by Dr. Angela Mary Thomas on behalf of Fundacion TECNALIA Research and Innovation. Angela is a recognized researcher with a PhD in Computation Chemistry from Indian Institute of Science, Bengaluru. Her field of interest varies from molecular level simulations on zeolites and porous structures to process level simulations on membrane based systems.

She is currently part of TECNALIA's Membrane Technology and Process Intensification Group, serving as a project manager. She has made significant contributions to various projects like ARENHA and AMBHER, under the mentorship of Jose Luis Viviente. APOLO project is her first solo endeavor as a project manager. Her vision is to follow her mentor's footsteps and lead the project to full fruition. She is committed to APOLO's vision of revolutionizing sustainability in the maritime sector.

# ABOUT THE PROJECT

APOLO Project is at the forefront of developing advanced power conversion technologies for maritime industry aiming to achieve significant reduction in emissions through novel ammonia cracking techniques. By leveraging Catalytic Membrane Reactors (CMRs) paired with hydrogen fuel cells or ammonia/hydrogen blend engines, APOLO targets a full decarbonization at TRL5 scale producing 125 kW of output power.

## STRATEGIC FOCUS AND OBJECTIVES

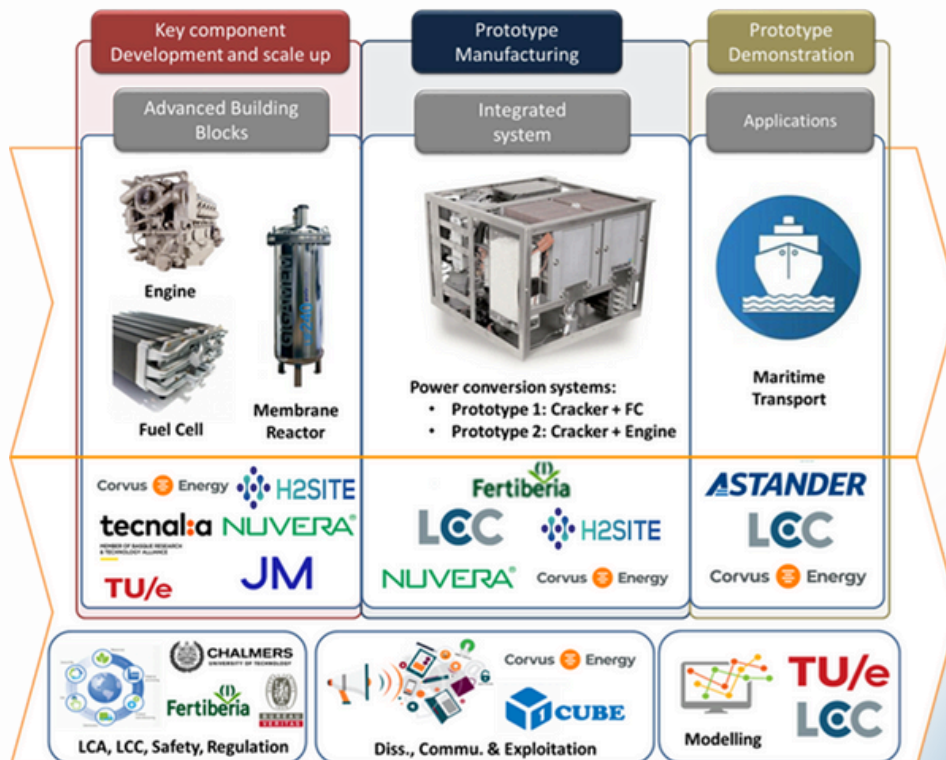
APOLO's strategic focus includes the development and comparison of two distinct power conversion solutions:

**1. High-Purity CMR with Fuel Cells:** The first prototype features a high-purity Catalytic Membrane Reactor (>99.998%, producing 150 kg of H<sub>2</sub> per day) integrated with two Proton Exchange Membrane (PEM) fuel cells, designed for both low and high-pressure applications.

**2. Lower-Purity CMR with Engine:** The second prototype employs a lower-purity Catalytic Membrane Reactor (>98%, producing 50 kg of H<sub>2</sub> per day) combined with an advanced 4-stroke engine and a Selective Catalytic Reduction (SCR) system to minimize NOx emissions.

Along with the technical objectives, APOLO also aims to:

- Develop a full LCA, LCC, sLCA and Health and Safety Analysis (HSE) of APOLO.
- Pave the way for future exploitation of APOLO Key Exploitable results.
- Promote the dissemination and communication of APOLO's results and expand its impact.



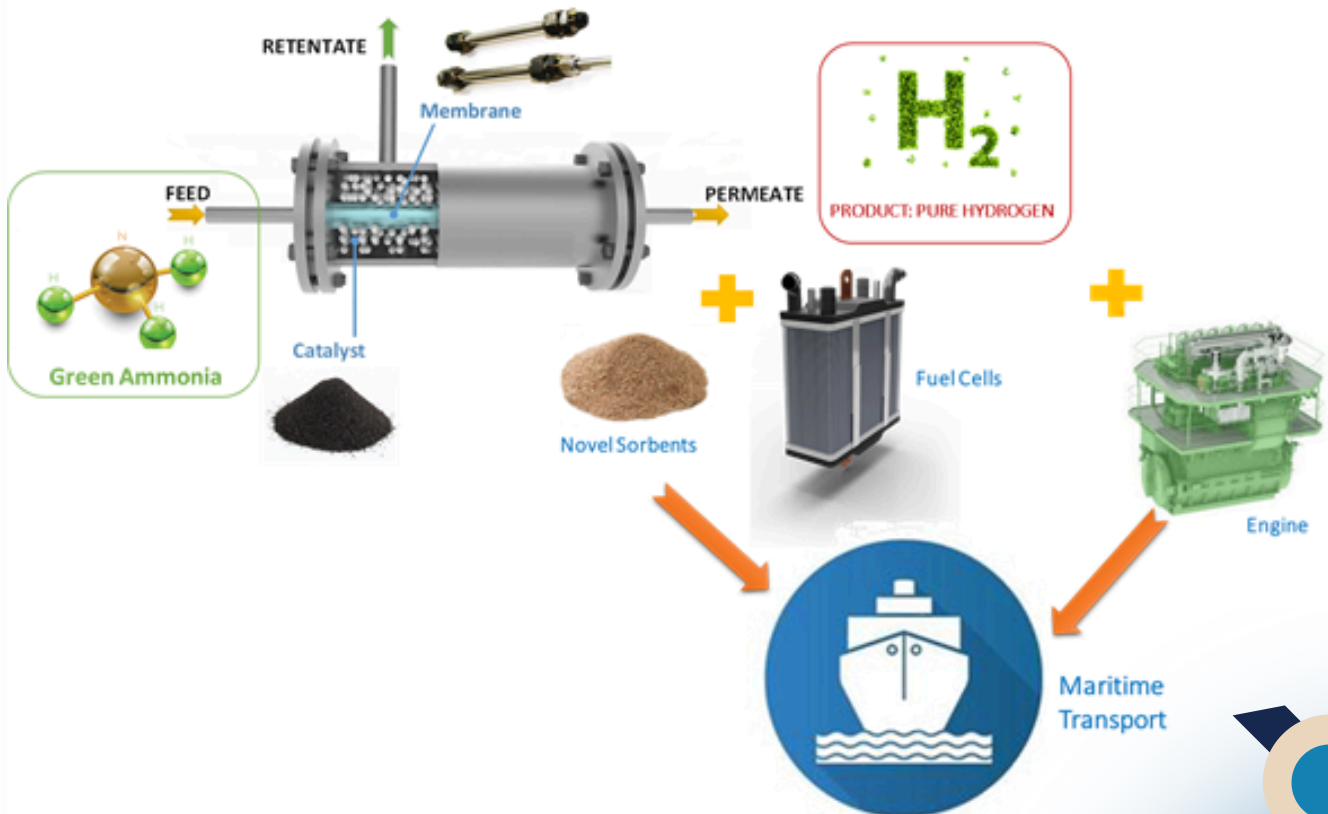
# ECONOMIC AND ENVIRONMENTAL IMPACT

Aligned with the EU's 'Fit for 55' and Ship Emission Trading System, APOLO aims to deliver significant environmental and economic benefits, including:

- **CO<sub>2</sub> Savings:** An estimated reduction of 13.45 million tons of CO<sub>2</sub> equivalents from 2032-2037.
- **Energy Efficiency:** Demonstration units are expected to achieve 45-51% energy efficiency, surpassing current fossil fuel-based solutions.
- **Job Creation:** Projected creation of 23,000 new jobs globally within the same timeframe.
- **Zero-Emission Transport:** Facilitating the development of carbon-free energy storage solutions and innovative port infrastructure for zero-emission waterborne transport.

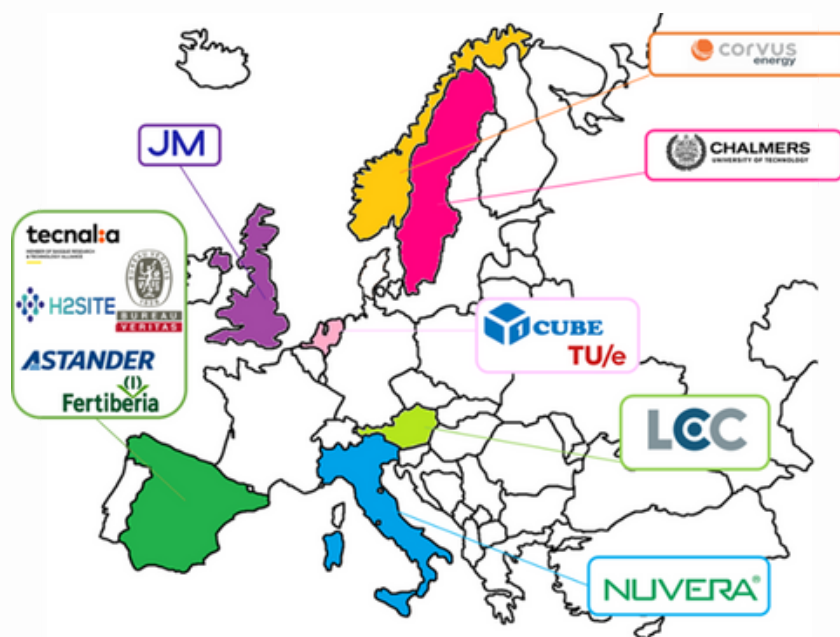
## LONG TERM VISION

APOLO's long-term vision is to revolutionize maritime decarbonization by ensuring the resilience of power systems to fuel impurities and varying power demands. The project also emphasizes the importance of safety and regulatory compliance, supported by international collaboration among partners like CHALMERS and TECNALIA.



# CONSORTIUM MEMBERS

APOLO is driven by a diverse consortium of 12 partners from 7 countries, each selected for their expertise and market replication potential. The consortium includes industries and SMEs such as Fertiberia, Astander, Corvus, Nuvera (Hyster Yale SPA), Johnson Matthey, Bureau Veritas, 1CUBE, and H2Site, as well as renowned research centers and universities like TECNALIA, TU/e, CHALMERS, and LEC. This collaboration ensures a robust industrial participation rate of 67%, fostering a comprehensive approach to economic feasibility and technological innovation.



## tecnalia

MEMBER OF BASQUE RESEARCH  
& TECHNOLOGY ALLIANCE

## TECNALIA

Fundación TECNALIA Research & Innovation (<https://www.tecnalia.com>) is the largest private, nonprofit applied research centre in Spain, a benchmark in Europe, and member of the Basque Research and Technology Alliance (BRTA).

TECNALIA is a key agent in the European Research Area. TECNALIA actively participates in the governing bodies of several European Technology Platforms, PPPs and JTI (EEB, FOF, SPIRE, ARTEMIS...) and associations. TECNALIA has participated in 252 H2020 projects, coordinating 73 of them, and on 35 HORIZON EUROPE projects under negotiation by April 2022 coordinating 6 of them. The Membrane Technology and Process Intensification group of the Material and Processes Dept. in the Energy, Climate and Urban Transition Unit will be involved in the projects both coordinator and technical partner for innovative membrane synthesis and safety analysis. The group develops advanced membranes and membrane reactors for Industrial Gas and liquid Separation demands. Aiming at increasing the efficiency, reducing the operating and capital costs as well as physical and environmental footprint in different applications. Some examples, H<sub>2</sub> purification and production, CO<sub>2</sub> Capture and conversion, natural gas processing, biogas upgrading and olefin/paraffin separation among others. We have extensive testing and membrane manufacturing capabilities, and we have experience on working from proof-of-concept to relevant industrial scale.



## FERTIBERIA

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Fertiberia is a leading European company in the fertilizer industry and a significant player in the chemical sector. With a strong focus on sustainability Fertiberia is committed to developing environmentally friendly products and processes. The company's extensive experience in ammonia production and its derivatives is crucial to the APOLO project's goal of advancing ammonia cracking technologies. Fertiberia's expertise will help optimize the integration of ammonia engines and catalytic membrane reactors, ensuring efficient and sustainable maritime operations.

## ASTANDER

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Astander is a renowned shipyard specializing in ship repair, conversion, and maintenance. Located in Spain, Astander brings decades of maritime engineering expertise to the APOLO project. The shipyard's capabilities in retrofitting and adapting maritime vessels will be instrumental in implementing the advanced power conversion technologies developed by the project. Astander's involvement ensures practical and effective application of the innovative solutions in real-world maritime settings.



## CORVUS ENERGY

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Corvus Energy is a global leader in energy storage solutions for the maritime industry. Known for their high-performance lithium-ion battery systems, Corvus Energy is dedicated to enhancing energy efficiency and reducing emissions in maritime applications. In the APOLO project, Corvus Energy will contribute their expertise in energy storage to complement the fuel cells and ammonia engines, facilitating a seamless and efficient power conversion system.



## NUVERA FUEL CELLS

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Nuvera Fuel Cells, a subsidiary of Hyster-Yale Group, specializes in the development and commercialization of fuel cell systems. Their innovative solutions focus on providing clean, reliable, and efficient power sources for various applications, including industrial vehicles and maritime vessels. Nuvera's experience in fuel cell technology will be pivotal in integrating hydrogen fuel cells with the catalytic membrane reactors developed in the APOLO project, driving forward the goal of maritime decarbonization.

Johnson Matthey is a global leader in sustainable technologies, with a strong emphasis on chemical processes and material sciences. Their expertise in catalyst development and environmental technologies aligns perfectly with the goals of the APOLO project. Johnson Matthey will contribute advanced catalytic solutions to enhance the efficiency and performance of the ammonia cracking and hydrogen production processes, ensuring the project achieves its emission reduction targets.



H2Site is dedicated to developing on-site hydrogen generation and purification technologies. Their advanced membrane reactors for hydrogen production are at the forefront of the industry. In the APOLO project, H2Site will leverage their cutting-edge technologies to support the production of high-purity hydrogen from ammonia, a critical component for the efficient operation of fuel cells and engines in maritime applications.



## BUREAU VERITAS

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Bureau Veritas is a world leader in testing, inspection, and certification services. Their role in the APOLO project is crucial for ensuring that the developed technologies meet stringent safety, quality, and regulatory standards. Bureau Veritas' extensive experience in the maritime sector will help guide the project through compliance with international regulations, ensuring the safe and effective deployment of the new power conversion systems.



## 1CUBE

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1CUBE specializes in organizing, writing, submitting, and managing research and development projects. In addition to these core services, 1CUBE is adept at organizing events, conferences, workshops, and various activities to foster collaboration and knowledge sharing. As a partner in EU projects, 1CUBE focuses on business planning, exploitation, dissemination, and management, ensuring that projects achieve their full potential and make a significant impact.



**LEC** (LARGE ENGINES COMPETENCE CENTER)

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LEC is a leading research institution specializing in large engine technologies. Their expertise is crucial for developing and optimizing the ammonia/hydrogen blend engines used in the APOLO project. LEC's involvement ensures that the power conversion systems are efficient, reliable, and capable of meeting the rigorous demands of maritime applications. Their research will play a significant role in reducing emissions and enhancing the performance of maritime engines.



**TU/e** (EINDHOVEN UNIVERSITY OF TECHNOLOGY)

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Eindhoven University of Technology (TU/e) is a research university specializing in engineering science & technology.

The research group Sustainable Process Engineering, is part of the faculty of Chemical Engineering and Chemistry at the Eindhoven University of Technology. The main objective of the research group is the development of novel integrated reactor concepts (such as Membrane Reactors, micro reactors, structured catalysts and reactors) based on improved fundamental knowledge using validated advanced (multi-phase) reactor models. This is achieved by employing a combination of state-of-the-art numerical models (at different levels of detail using the multi-level modelling approach), advanced (noninvasive) experimental techniques and experimental demonstration of novel reactor concepts (proof of concept).



## **CHALMERS UNIVERSITY OF TECHNOLOGY**

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Chalmers University of Technology in Sweden is renowned for its research in engineering and natural sciences. Their participation in the APOLO project brings advanced knowledge in sustainable technologies and systems engineering. Chalmers University will focus on the optimization and integration of ammonia cracking technologies, contributing to the overall success of the project in achieving its sustainability goals.

# HIGHLIGHTS AND UPDATES

## PROJECT FOLLOWUP



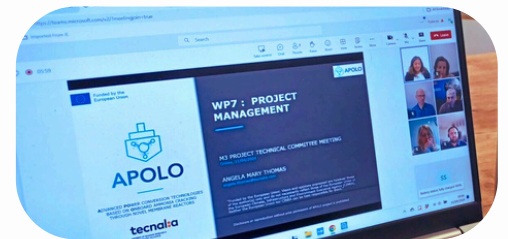
## KICK – OFF MEETING

APOLO Project kicked off on 15th of January 2024, where the project partners gathered at TU/e Eindhoven. The consortium was joined by Project Officer Agnieszka Zaplatka from CINEA – the European Climate, Infrastructure and Environment Executive Agency. During the meeting, the coordinator Angela Mary Thomas, introduced the overall project to the consortium and the project officer. Afterwards, each project partner presented themselves and the work package leaders introduced their allotted work packages in the project.

Following the one day meeting, a visit to the TU/e lab facilities was conducted. The day was then wrapped with a social dinner at Fling Restaurant at Eindhoven, Netherlands.

## M3 PROJECT TECHNICAL COMMITTEE MEETING

On April 11, 2024, the Project Technical Committee (PTC) of the APOLO project convened for the M3 PTC meeting, a regular check-in to discuss the project's ongoing progress. The committee expressed satisfaction with the current status of the project and is looking forward to further technical advancements in the coming months.



## M6 CONSORTIUM MEETING

The APOLO consortium held their M6 Consortium Meeting at Hamburg Port Authority in Germany on 20th and 21st of July 2024. During the meeting, the progress and highlights of the project were evaluated and a plan for the coming months were formulated. The consortium dinner was held at Schönes Leben Speicherstadt at Hamburg to conclude the meeting.





# HIGHLIGHTS AND UPDATES

## DISSEMINATION ACTIVITIES

### PARTICIPATION IN LSSTF

APOLO Project was part of the 5th LEC Sustainable Shipping Technologies Forum (LSSTF) headed by one of our partners LEC in collaboration with Hamburg Port Authority which was held on 19th and 20th of June 2024. The forum aims to bring key stakeholders to discuss and promote decarbonisation in maritime transport, aligning perfectly with APOLO's mission to develop ammonia as a sustainable maritime fuel. The forum witnessed insightful talks from APOLO partners: Nicole Wermuth from LEC, Svenn K. Haveland from CORVUS as well as Eduardo Briales from H2SITE. Our coordinator, Angela Mary Thomas from TECNALIA was also in attendance for the event following keenly on the advancement of alternate fuel use in maritime. Other partners also participated actively both offline and online.




### PARTICIPATION IN HYCELTEC 2024

Our coordinator, Angela Mary Thomas participated on behalf of APOLO in the IX Symposium on Hydrogen, Fuel Cells and Advanced Batteries (HYCELTEC) 2024 which was held from 30th of June till 3rd of July 2024 in Milazzo Italy. The conference provided a platform for discussing innovations in the field of fuel cells and batteries. The introduction of APOLO project by Angela sparked new conversation among the participants about the possible use of ammonia especially in maritime sector.



## FOLLOW APOLO PROJECT

Stay updated with the latest news on the APOLO project by following us on LinkedIn and visiting our website. Get insights into our progress, events, and key developments as we work towards advancing sustainable maritime fuel solutions.

 [www.linkedin.com/company/apolo-project/](https://www.linkedin.com/company/apolo-project/)



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Project number: 101138466  
Call: HORIZON-CL5-2023-D5-01  
Topic: HORIZON-CL5-2023-D5-01-11  
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Duration: 48 months