# FICHE PROJET

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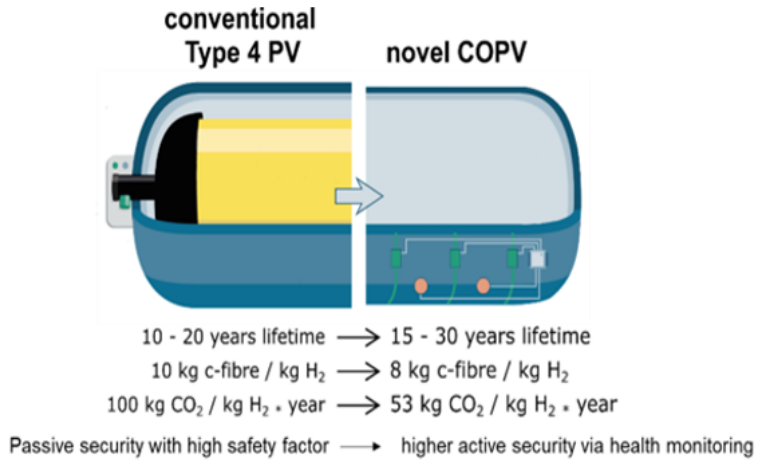
# HYMOCA

Today, the most efficient and mature means of storing hydrogen is type-IV high pressure composite vessels for on-board applications. The HYMOCA project studies new perspectives to design high-performance composite tanks with a self-sensing capacity and provide optimized, safe, and cost-effective solutions for the next generation of high-pressure vessels.




## Inspiration

Hydrogen is a carbon-free energy carrier, and this clean, abundant resource presents a promising solution for the 21st century. A hydrogen-based economy could serve as a strong alternative to the EU's fossil fuel-driven economy, with hydrogen storage emerging as a key enabling technology. Currently, the most efficient and mature method for onboard hydrogen storage is high-pressure composite overwrapped vessels (COPVs) type-VI. However, this technology requires extensive research and development to reduce costs, enhance performance, and improve durability for commercial deployment.

The HYMOCA project is driven by the industrial and technological need to develop a new class of high-pressure hydrogen storage vessels with enhanced properties, such as greater durability and integrated sensing capabilities. As a strategic building block for hydrogen use in transport applications, HYMOCA introduces innovative approaches to designing high-performance composite tanks with self-sensing functionality, ensuring optimized, safe, and cost-effective solutions for the next generation of high-pressure vessels. This project will significantly contribute to energy security through advanced smart vessel technology.

Additionally, HYMOCA aims to understand and characterize the relationship between microscopic failure mechanisms and the initial failure of reinforced composites, focusing on the behavior and damage processes of COPVs. A key aspect of the project involves developing a sensing strategy to monitor these processes effectively. To achieve this, carbon fiber-reinforced polymers (CFRP) will be enhanced with nanoparticles, specifically graphene nanoplatelets and nano silica, which will improve the mechanical properties of the polymer while enabling self-sufficient sensing capabilities. The integration of multi-materials with functional additives will provide both sensor functionality and enhanced physical and mechanical properties. Robust simulation models, combined with experimental validation, will be used to accurately predict burst pressure and continuously monitor the damage state and fatigue lifetime of composite pressure vessels.

HYMOCA extends beyond technological advancements, as it also opens new market opportunities for suppliers and manufacturers within the hydrogen fuel value chain for automotive applications. Additionally, the project will enhance resource and energy efficiency through optimized materials, less conservative designs (lower safety factors), and increased durability. Understanding the adverse effects of in-service applications is also a key priority, particularly in contexts where maintaining structural health throughout an operational lifecycle is crucial.

Ultimately, HYMOCA aims to optimize the tank's life cycle cost, ensuring the development of eco-friendly and sustainable onboard hydrogen storage solutions. The project aligns with European strategic policy targets and United Nations Sustainable Development Goals (SDGs) by contributing to greenhouse gas emission reduction. HYMOCA will begin at TRL3 and aims to reach TRL5 by the project's end, with technology validation in relevant environments through the integration of smart COPVs into industrial settings. The work is structured across five technical work packages, complemented by an additional work package dedicated to project management and the dissemination and exploitation of results.

## Innovation

The driving forces behind this project are the political agenda, and industrial and technological needs to develop a new class of high-pressure vessels for hydrogen storage with enhanced properties (durability, sensing capacity).

The innovation potential of HYMOCA is to develop research at TRL3 correlating the COPV performances to process and raw material characteristics, combined with existing blocs at TRL4 such as the manufacturing process.

LIST will be the coordinator of HYMOCA and will implement the project through two research units within the Materials Research and Technology department (MRT). The main contributions are foreseen in WP1 (Improvement of matrix properties by nanofillers), WP3 (Modelling and Simulation), and WP4 (Development and integration of functional sensor).

Furthermore, LIST will participate in all other technical WPs and will contribute to the organization of the project work, the harmonization of the different activities of the research groups, project management & financial and technical monitoring, and the supporting of the technological transfer and valorization of project outcomes.

## Impact

- Decarbonization of global economy (mobility, power generation, industry)
- Improved competitiveness and strengthened European industrial leadership
- Strengthened innovation excellence of the European companies
- Scientific and economic impacts

## Partenaires

Luxembourg Institute of Science and Technology (LIST) , Izmir Institute of Technology , Fraunhofer Institute for Machine Tools and Forming Technology , Lightweight Structures Engineering GmbH and İZOREEL Composites

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