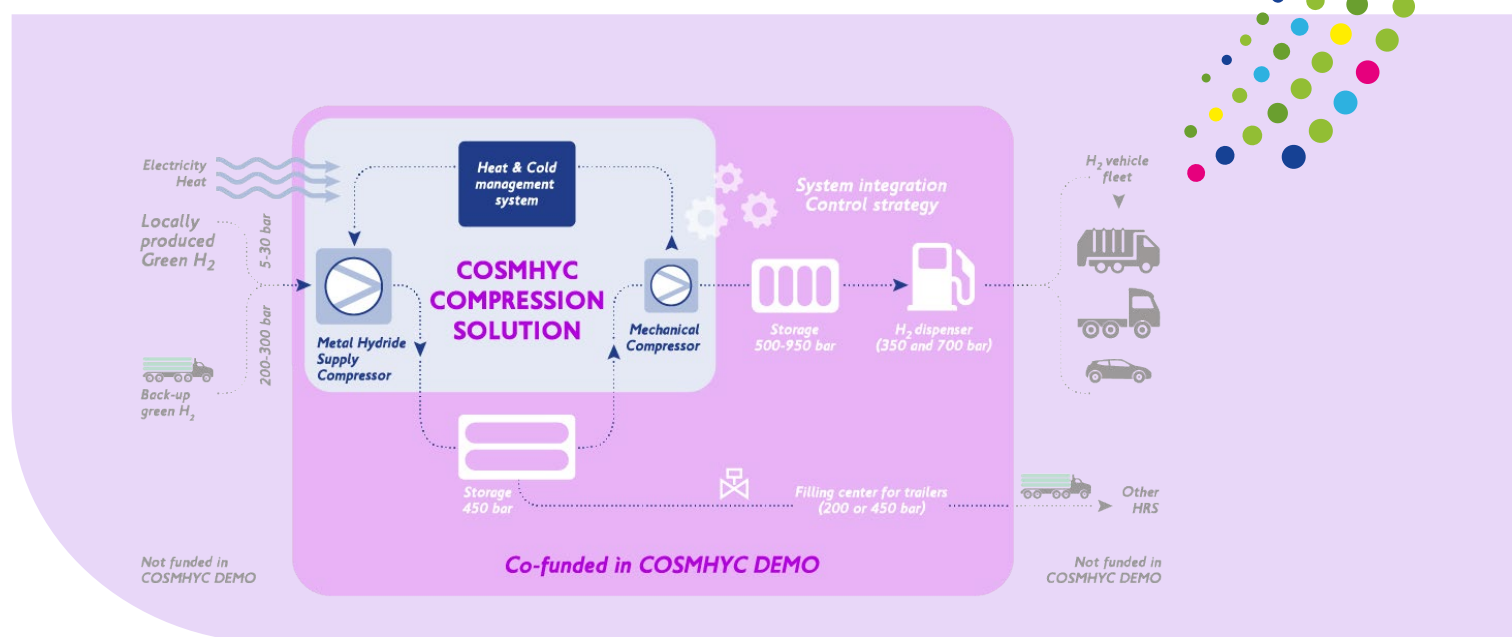


From concept to commercial readiness: the COSMHYC journey



Turning innovative research into commercially deployable hydrogen technologies requires sustained support. Through three successive projects - COSMHYC, COSMHYC XL and COSMHYC DEMO - the Clean Hydrogen Partnership transformed a promising laboratory concept into an operational hydrogen compression technology ready for commercial deployment.

Reinventing hydrogen compression

Hydrogen compression is one of the most critical and costly functions within hydrogen refuelling stations. Conventional mechanical compressors operate at very high pressures but can involve significant energy consumption, wear of moving parts and demanding maintenance.

The COSMHYC project series addressed these challenges through an innovative hybrid compression concept combining metal hydride compression with mechanical compression. Metal hydrides provide efficient baseload compression with very few moving parts, while a mechanical compressor delivers the flexibility and high flow rates needed for vehicle refuelling. Together, they improve efficiency, reliability and operational flexibility while reducing some of the limitations associated with conventional mechanical compression.

From laboratory innovation to real-world deployment

The COSMHYC initiative advanced through three complementary projects, each addressing a different stage of technological maturity. The original COSMHYC project established the foundations of the hybrid compression concept, demonstrating full-scale metal hydride compression while developing rare-earth-free metal hydrides and innovative reactor designs. COSMHYC XL then focused on scaling the technology for larger mobility applications, improving compression capacity, reactor performance and overall system integration. Finally, COSMHYC DEMO integrated the technology into a dual-pressure hydrogen refuelling station in Sornay, France, where the hybrid compression solution successfully operated under real-world conditions serving different vehicle types.

Together, the projects advanced the technology from TRL5 to TRL7, transforming a research demonstrator

into a CE-certified commercial product ready for industrial deployment.

"The COSMHYC project series demonstrates how sustained European research support can accompany an innovation from laboratory research to commercial readiness. Each successive project reduced technological risk while bringing the hybrid compression solution closer to deployment in hydrogen refuelling infrastructure."

Rami Chahrouri, Project Coordinator, COSMHYC DEMO

Supporting Europe's hydrogen economy

Hydrogen refuelling stations are critical to Europe's future hydrogen mobility ecosystem. By demonstrating hybrid hydrogen compression under real operating conditions, COSMHYC DEMO showed that the technology can become more efficient, reliable and commercially attractive while supporting wider deployment of hydrogen-powered transport.

Beyond the technology itself, the COSMHYC project family demonstrates the value of sustained Clean Hydrogen Partnership support. Successive projects reduced technological risk, strengthened industrial expertise and helped move an innovative compression concept from laboratory research to commercial deployment.

The goal? To develop and demonstrate an innovative hybrid hydrogen compression system that improves the efficiency, reliability and cost-effectiveness of hydrogen refuelling stations while supporting the wider deployment of hydrogen mobility.

Key results? Across three successive Clean Hydrogen Partnership projects, the COSMHYC initiative successfully developed, scaled up and demonstrated a hybrid hydrogen compression technology combining metal hydride and mechanical compression. The technology progressed from TRL5 to TRL7, achieved CE certification, and was successfully demonstrated in an operational hydrogen refuelling station, illustrating how sustained European research support can accelerate the journey from laboratory concept to commercial deployment.

KEY ACHIEVEMENTS

LARGE-SCALE MOBILITY APPLICATIONS

Scaled up to support hydrogen refuelling station capacities of up to 1400 kg/day.

LOWER TOTAL COST OF OWNERSHIP

Estimated reductions of 23-42% compared to a pure mechanical compressor in the same application.

HIGHER EFFICIENCY

Energy consumption below 4 kWh/kg with operating pressures up to 950 bar.

HIGH RELIABILITY

System availability above 98% with an expected operational lifetime of 10 years.

SIMPLIFIED SYSTEM DESIGN

Reduced the innovative compression architecture from three stages to two while maintaining a compression ratio of >20.

IMPACTS

THREE SUCCESSIVE EU-FUNDED PROJECTS

Progressive technology development from concept validation to real-world demonstration.

CE-CERTIFIED COMMERCIAL PRODUCT

Hybrid compression technology progressed towards commercial deployment.

SUPPORTING HYDROGEN MOBILITY

Compression capacity suitable for hydrogen refuelling stations serving passenger and heavy-duty vehicles.

EUROPEAN INDUSTRIAL CAPABILITY

Strengthening expertise in hydrogen materials, reactor design, compression systems and infrastructure integration.

RARE-EARTH-FREE METAL HYDRIDES

Reducing dependence on critical raw materials while maintaining performance.

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COSMHYC suite of projects
Clean Hydrogen Partnership project repository



Co-funded by
the European Union