

# Innovative technologies for hydrogen storage: safety and performance

TransH2 | Walter Tosto | Bora Aydin

WORKSHOP:

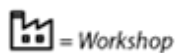
**“Challenges and Opportunities from Hydrogen  
for Cross-Border Maritime Mobility”**

Monfalcone, Via Garibaldi 64c - 20 June 2024

## Italy – Croatia



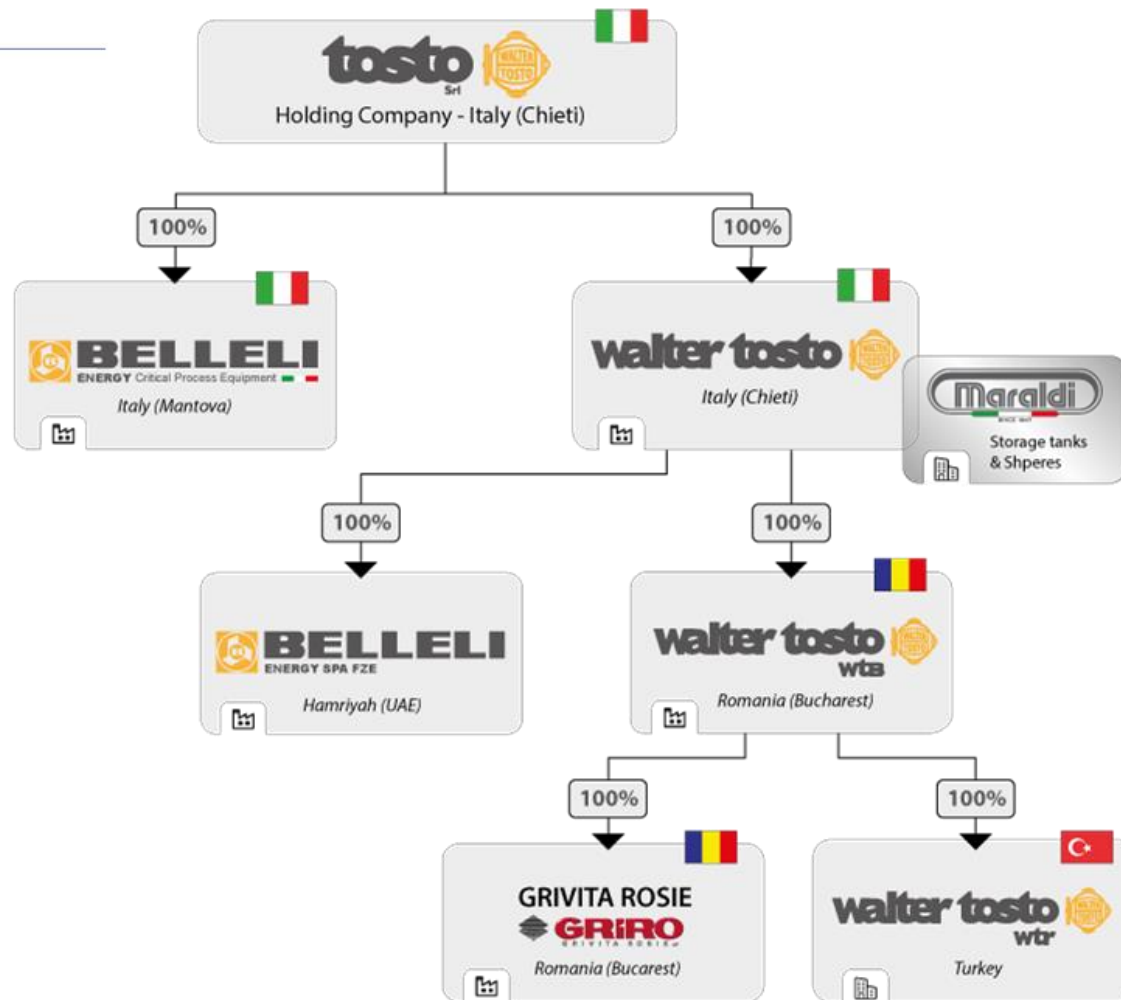
Total Employees 1300



= Workshop



= Office



## Storage products range

### SPHERES

- from 1,000 up to 7,000 m<sup>3</sup>
- diameters between 12 and 24 m
- wall thicknesses from 30 to 80 mm

### TANKS

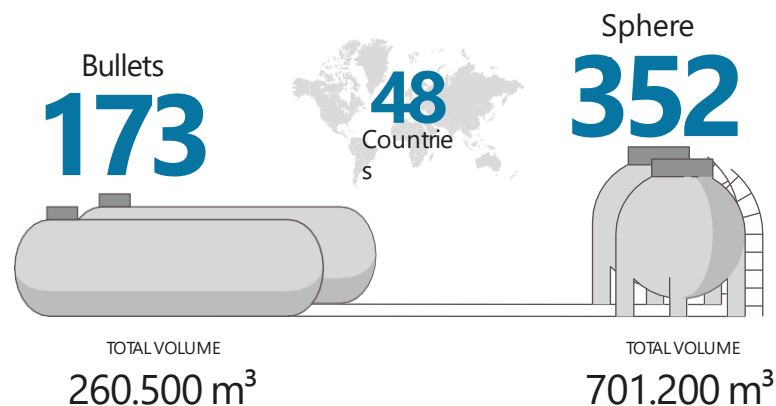
- low temperature and cryogenic storage
- experience up to a minimum design temperature of -196°C
- construction of single- or double-walled tanks
- from less than 100 m<sup>3</sup> up to 160.000 m<sup>3</sup> and even more



## Storage products range

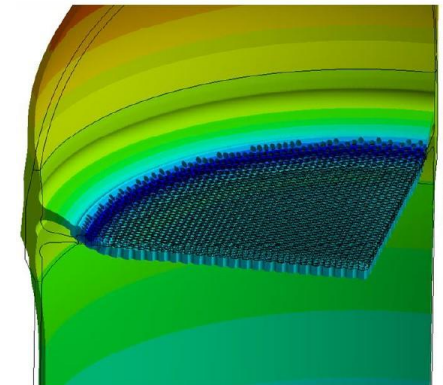
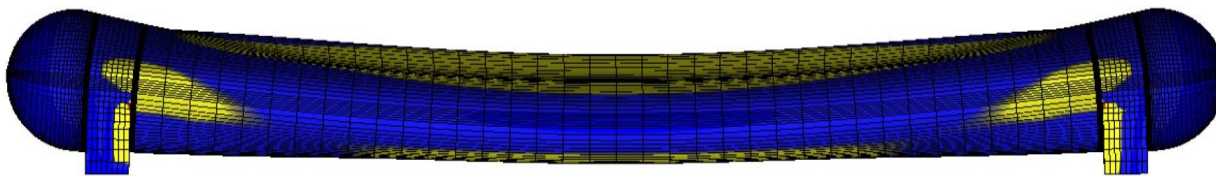
### BULLETS

- no limitations in terms of capacity
- biggest LPG bullets ever designed and fabricated in Italy with a capacity of 5000 m<sup>3</sup>
- LPG bullets supplied abroad with a capacity exceeding 9000 m<sup>3</sup>



## Design capability

- Design activities: 3D simulations, stress analysis by FEM, fracture mechanics analysis, static analysis in steady and unsteady conditions, fatigue analysis, creep fatigue damage evaluation, thermo-hydraulic design of heat transfer systems
- Thermal calculations
- Experienced manufacturer of complex pressure equipment (TEMA, EN 13445, ASME VIII Div. 1, 2 & 3)



## Standardisation

There are some standards for traditional storage (such as cylinders) available. However some segments such as **welded pressure vessels** require the development of new standards.

Standards are required to include the issues related to safety aspects (material compability, qualification of metallic materials, leakage etc.) for high- and very-high pressure tanks for long-term and high-capacity hydrogen storage which require the necessity of using the metallic materials with the welded components.

*Support of the standardisation process through*



## Material

One of the major critical issues in the storage of gaseous hydrogen is the potential **embrittlement effect** that reduces the ductility of a metal due to absorbed hydrogen. The cracks will be initiated and propagated due to decrease in stress.

Identification and application of the mechanical tests according to codes and standards helps to understand:

- susceptibility of metals to embrittlement
- fracture toughness
- fatigue crack growth rate
- parameters used in the design-by-analysis



*Cooperation with steel mills and laboratories to activate mechanical test campaigns*

## Useful life prediction

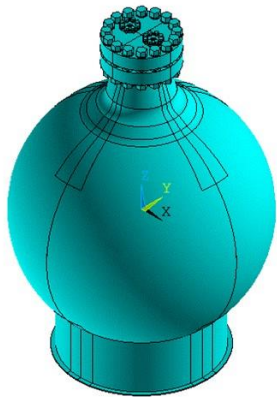
**ASME BPVC Section VIII Division 3:** standard that regulates the design and construction of pressure vessels; compared to ASME BPVC Section VIII Division 2 it has much more stringent requirements in the design, manufacturing and control phases of the product by being a **design-by-analysis**.

**Safety** also depends on the useful life prediction for cyclic fatigue and fracture.

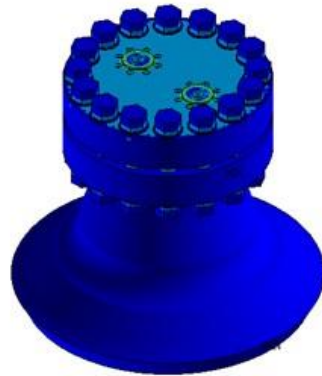




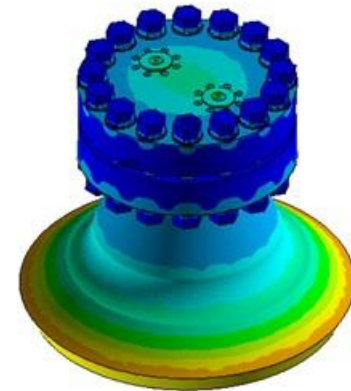
## Finite Element Analysis



Coarse



sub-model pre-tensioning



sub-model tensioning and pressure

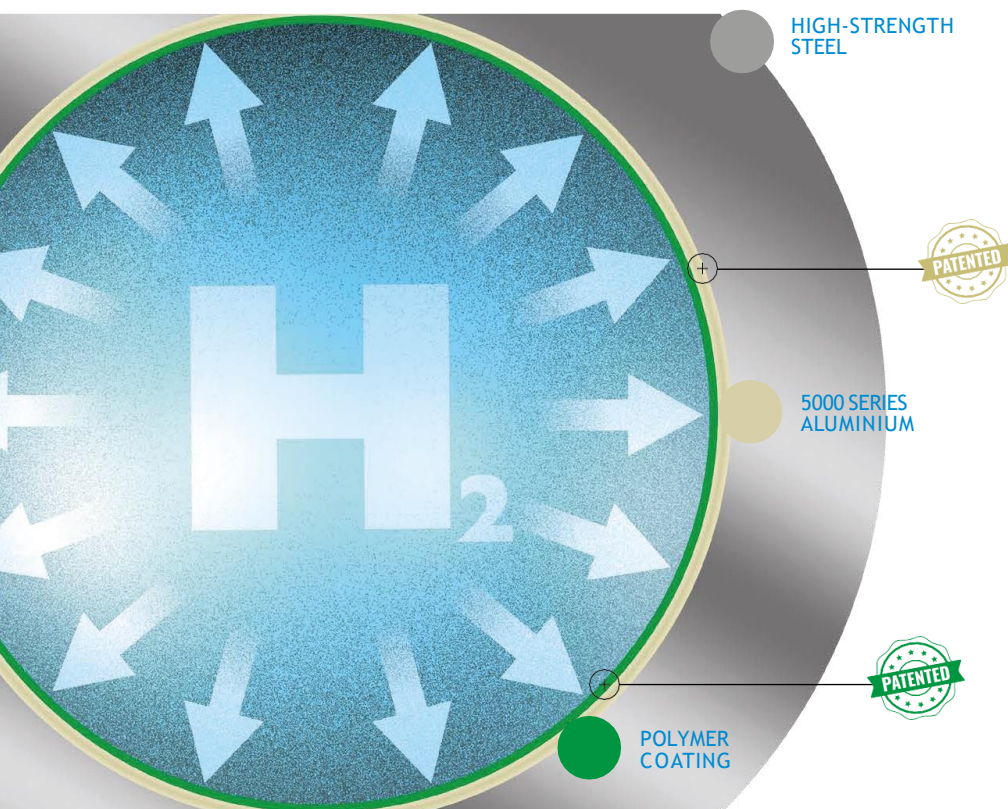
Each component of the storage has been analysed rigorously to understand the structural behaviour under **stress**, the effect of **hydrogen pressure** and the consequence of **mechanical loads** on the critical zones of each component.

# Interreg



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Italy – Croatia



**sphero**  
HIGH SAFETY HYDROGEN STORAGE



Walter Tosto uses **geometric perfection** to revolutionize the storage market with **Sphero®**, an innovative spherical tank for **high-pressure hydrogen gas storage**.

In addition to the **shape**, the **materials** and **safety systems** bring Sphero® to a perfect approach:

**higher performance, more resistance**  
**enhanced safety, lifetime extension**

to make the processes of large industrial plants and hard-to-abate sectors **protected, sustainable** and ready for profitable use in a **circular economy**.

A **continuous monitoring system** addresses the problem of **unexpected structural ruptures**. However, the primary objective achieved by Walter Tosto's R&D department is to **ensure the storage time according to the desired life cycles**, further optimizing the efficiency and reliability of Sphero as a response to industry demands.

Interreg



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 TransH2



Increase in the **safety level**  
through the introduction of a  
detection system between the  
steel and aluminium layer



# HydraSea - project proposal

Call: HORIZON-JTI-CLEANH2-2024

## OBJECTIVES:

The general objective of the project is to advance the adoption of hydrogen propulsion in maritime transportation by **designing, testing, and integrating innovative hydrogen storage and bunkering systems**, ensuring safety, efficiency, and regulatory compliance across the entire hydrogen supply chain.

**REQUESTED GRANT AMOUNT: 4 987 907 €**

**EXPECTED PROJECT DURATION: 48 months**

**PROJECT STATUS: Submitted to EU (17/04/2024)**



**Interreg**



Co-funded by  
the European Union

**Italy – Croatia**

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## PROJECT PARTNERS:

The consortium is composed of 10 EU innovative entities with relevant expertise in various sectors, including academia, industry, end users and research institution.



Sveučilište u Rijeci  
**POMORSKI FAKULTET**



**NTNU**

Norwegian University of  
Science and Technology



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