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TransH2

Project TransH2

Transnational training and educational scheme

Output no. O 3.1

PP4 – Urbanex ltd

Responsible partner: URBANEX d.o.o. Involved partners: All			
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Project Acronym	TransH2
Project ID Number	ITHR0200413
Project Title	TRANSITION TO HYDROGEN FUELLED CROSS-BORDER SEA-MOBILITY
Priority Axis	3 - Sustainable maritime and multimodal transport Specific objective
Specific objective	SO 3.1 - Developing and enhancing sustainable, climate resilient, intelligent and intermodal national, regional and local mobility, including improved access to TEN-T and cross-border mobility
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Table of Contents

Table of Figures

Table of Tables

Executive Summary

The TransH2 project output O 3.1 is the project's capacity-building deliverable, designed to equip port authorities, transport operators, regional coordinators and industry representatives in both countries with the knowledge required to plan and implement hydrogen-based, zero-emission maritime solutions.

Four hybrid Transnational Training and Educational (TTE) sessions were held in May and June 2026 – two in Zagreb (22 May) and two in Trieste (16 June) – combining in-person and online participation. Sessions addressed the European and Croatian regulatory framework for maritime hydrogen, the state of hydrogen fuel cell technology, TransH2 project results including a systematic screening of Adriatic routes narrowed to three detailed case studies, digital twin applications, and the Hydrogen Hub Trieste.

Core findings highlight that hydrogen fuel cells offer approximately 240 times the gravimetric energy density of lithium-ion batteries, enabling faster refuelling and suitability for higher-frequency ferry routes, while key implementation barriers remain: absence of domestic production and distribution networks, lack of harmonised safety permitting, and higher per-kilometre energy costs compared to battery-electric alternatives.

The four events recorded 177 confirmed participations – 57 in Croatia and 120 in Italy – representing 354% of the programme output indicator target (RCO85_3.1) of 50 participations, with engagement from universities, port authorities, energy producers and public institutions across both countries.

1.Project and output context

1.1. Project Overview

The TransH2 project, Transition to Hydrogen Fuelled Crossborder Sea-Mobility (project code ITHR0200413), is co-funded by the Interreg VI-A Italy-Croatia 2021-2027 programme under Specific Objective 3.2, dedicated to sustainable maritime and multimodal transport. The project targets the decarbonisation of Adriatic maritime transport through the introduction of green hydrogen as a zero-emission fuel for sea-going vessels and the development of the associated port refuelling infrastructure. Its central objective is to enhance the sustainability of sea-mobility in the Adriatic region by developing low-carbon solutions for representative maritime routes, analysing zero-emission fuels with a focus on green hydrogen, demonstrating the feasibility and commercial viability of hydrogen-based propulsion and by promoting its adoption among port authorities, transport operators and other key stakeholders. The project pursues these objectives by establishing a complete hydrogen supply chain that encompasses vessel development, port refuelling infrastructure planning and investment facilitation, in alignment with the EU Sustainable and Smart Mobility Strategy target for market-ready zero-emission vessels by 2030. The TransH2 partnership brings together public institutions, research organisations and business support bodies from Croatia and Italy. The Croatian partner consortium includes Urbanex, the Croatian Chamber of Economy (CCE) and the Faculty of Maritime Studies of the University of Rijeka as Lead Partner, alongside Zadar County Development Agency ZADRA NOVA. On the Italian side, M.A.R.E. TC FVG leads the implementation in the Friuli Venezia Giulia region, supported by the relevant regional and sectoral actors. Other project partners on the Italian side, Navalprogetti Srl, Start Romagna S.p.A. and University of Trieste bring to this project academic and technical expertise.

The project is structured around three main work packages covering the technical feasibility and conceptual design of hydrogen vessels and port infrastructure, the development of business models and investment frameworks and the mobilisation of stakeholders through training, investment catalogues and cooperation agreements.

1.2. Output description

The PPs will jointly develop, organise and conduct a series of 4 transnational training and educational (TTE) events and joint educational scheme on zero-emission maritime transport for knowledge building. The PPs will give a minimum of 4 TTE targeting a minimum of 50 attendees in total on green H2 use-cases and open-source TransH2 solution for greening marine transport in the Adriatic. The target audience encompasses a wide range of stakeholders, including port authorities, transport operators, classification societies, industry representatives, and regional coordinators within the programme area.

The TransH2 Output 3.1 "Transnational training and educational scheme" is conceived as a structured, practice-oriented capacity building programme that equips key maritime and port stakeholders in Italy and Croatia with the knowledge and skills needed to plan, implement and scale hydrogen based, zero emission sea mobility solutions across the Adriatic. Objectives

The joint strategy aims to position the Adriatic region as a leader in the transition to sustainable maritime transport through the adoption of hydrogen as a clean energy source. It leverages the expertise of the H2 maritime transport collaboration network and external experts to establish a comprehensive framework for greening maritime transport routes. Rooted in environmental responsibility, cross-border cooperation, and economic innovation, the following objectives define the strategy's purpose:

- **Purpose and objectives**

The central purpose of the transnational training and educational scheme is to increase the institutional and technical capacities of port authorities, transport operators, regional coordinators and industry representatives to design and implement the green transition of maritime transport using hydrogen technologies. The scheme supports the project's overall objective of enabling sustainable cross border sea mobility by demonstrating feasible hydrogen solutions and preparing stakeholders to take them up through concrete investment and policy actions.

More specifically, Output 3.1 aims to:

- Provide structured training on technological, regulatory, safety and economic aspects of hydrogen propulsion and refuelling infrastructure in ports.
- Facilitate cross border learning and exchange of experience between Italian and Croatian stakeholders through joint workshops and peer interaction.
- Support the preparation and future implementation of investment plans and cooperation agreements for hydrogen fuelled maritime transport in the programme area.

➢ Methodology and transnational added value

The scheme follows an interactive, problem-based learning methodology that alternates targeted expert input with facilitated group work in mixed national teams. This approach ensures that participants do not only acquire up-to-date knowledge but also jointly develop solutions, compare regulatory and operational frameworks, and identify common challenges along the Croatian and Italian coasts.

Transnationality is embedded in several ways:

- Joint design and delivery of the training programme by Croatian and Italian partners with complementary expertise in maritime transport, hydrogen technologies, business support and regional development.
- Use of shared case studies and pilot actions so that participants work on the same routes and port systems from both sides of the border, fostering a common understanding of risks, opportunities and required standards.
- Establishment of a cross-border network of trained professionals who can later support implementation of hydrogen investments and act as multipliers within their institutions and professional communities.

Compared with conventional, single-country seminars, the TransH2 scheme therefore goes beyond information transfer and creates the foundations for sustained cross-border cooperation and coordinated investment decisions in hydrogen maritime transport.

2.TTE Events in Croatia

2.1. Event overview and organisation

Two Transnational Training and Educational sessions were held on 22 May 2026 at HUB 385, Petračićeva 6, Zagreb, jointly organised by Urbanex and the Croatian Chamber of Economy (CCE). The event was designed and delivered as a hybrid activity, combining in-person attendance at the Zagreb venue with remote participation via Zoom and simultaneous Croatian-to-English interpretation throughout both sessions. This format was chosen to maximise geographic and institutional reach, enabling participation from stakeholders across Croatia and internationally who could not attend in person.

The opening remarks were delivered on behalf of the Lead Partner, the Faculty of Maritime Studies of the University of Rijeka, by Borana Vlastelić, who welcomed participants and presented the objectives of the TransH2 project, highlighting the role of the TTE events within the broader project framework. The programme was organised into two complementary thematic sessions, separated by a lunch break, each addressing a key aspect of the maritime hydrogen transition. The first session explored the regulatory landscape and technological developments shaping the adoption of hydrogen in maritime transport, while the second focused on the outcomes of the TransH2 project and the challenges related to hydrogen-based mobility in Croatia and the wider region. Both sessions were moderated by Sonja Sočivica of Urbanex Ltd.

The event attracted participants from public institutions, academic organisations, industry, and project partner bodies. Attendance was recorded through a physical sign-in sheet for in-person participants and through the Zoom attendance log for remote participants, both of which form part of the supporting documentation for this output.

2.2. Programme

The full programme for both sessions is set out in the tables below.

Session 1: Regulatory framework and technological state of the art (09:30 to 11:45)

Table 1 – Zagreb Session 1 agenda

Time	Activity	Speaker / Organisation
09:30 to 10:00	Registration of participants	
10:00 to 10:10	Welcome speech on behalf of TransH2 project partners	Borana Vlastelić, Faculty of Maritime Studies, University of Rijeka (LP)
10:10 to 10:40	Regulatory Framework and Opportunities for the Application of Hydrogen and Alternative Fuels in Maritime Transport	Vesna Kučan Polak, Croatian Hydrocarbon Agency
10:40 to 10:50	Discussion	
10:50 to 11:20	Hydrogen in Maritime: State of the Art and Perspectives	Ankica Kovač, University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture
11:20 to 11:30	Discussion	
11:30 to 11:45	Final remarks and break	

Session 2: TransH2 project results and Croatian and regional mobility challenges (12:30 to 14:00)

Table 2 – Zagreb Session 2 agenda

Time	Activity	Speaker / Organisation
12:30 to 12:40	Welcome and introduction to the afternoon session	
12:40 to 13:10	Contribution of the Interreg Framework and the TransH2 Project to the Operational Use of Hydrogen in the Adriatic Maritime Transport Sector	Dražen Vrhovski, EERING
13:10 to 13:20	Discussion	
13:20 to 13:50	Analysis of the Applicability, Relevance and Challenges of Implementing Hydrogen as an Energy Source in Croatian and Regional Mobility	Dražen Vrhovski, EERING
13:50 to 14:00	Discussion and final remarks	

2.3. Session 1: Regulatory framework and technological readiness

2.3.1. European and Croatian regulatory framework for maritime hydrogen

The first presentation, delivered by Vesna Kučan Polak of the Croatian Hydrocarbon Agency (CHA), provided a structured overview of the European regulatory framework governing the decarbonisation of maritime transport and the role of alternative fuels including hydrogen. The presentation traced the evolution of EU hydrogen policy from the European Hydrogen Strategy adopted in July 2020, through the Fit-for-55 Package (2021) and the REPowerEU Plan, to the current suite of binding legislative instruments applicable to the maritime sector. Key instruments covered included FuelEU Maritime, the Alternative Fuels Infrastructure Regulation (AFIR), the Renewable Energy Directive (RED III) and the EU Emissions Trading System (EU ETS) as extended to the maritime sector. A central message of the presentation was that none of these instruments prescribes a single fuel or technology: they set GHG intensity targets and compliance obligations that can be met through a range of fuel pathways including green hydrogen, ammonia, methanol, biofuels and synthetic fuels, provided they meet the Renewable Fuels of Non-Biological Origin (RFNBO) definition under RED III.

At national level, the presentation highlighted that Croatia adopted the Hydrogen Strategy of the Republic of Croatia Until 2050 and that the Croatian Hydrocarbon Agency formally became the national coordinating body for hydrogen in 2023 (Official Gazette 83/23). A study for the Development and Implementation Plan of the Croatian Hydrogen Strategy until 2050 was completed in 2024. The study sets out projections for the expected use of renewable hydrogen in Croatian maritime transport, with anticipated CO_2-equivalent emission avoidance growing from 4,538 tonnes in 2030 to 8,233 tonnes in 2040 and 12,602 tonnes in 2050 under the baseline scenario. Croatia currently operates approximately 310 vessels larger than 100 GT in maritime traffic, of which approximately 85 percent are passenger

vessels, underlining the particular relevance of hydrogen and alternative fuels for the passenger and ferry segment.

The key EU regulatory instruments discussed and their relevance to maritime hydrogen are summarised below:

Table 3 - Regulatory instruments

Instrument	Relevance to maritime hydrogen
FuelEU Maritime	Sets progressive GHG intensity reduction targets for energy used on board vessels (2025 to 2050). Does not mandate a specific fuel. Non-compliance penalty of 2,400 EUR per tonne of conventional fuel above the GHG limit.
AFIR (Alternative Fuels Infrastructure Regulation)	Sets minimum infrastructure requirements for alternative fuels at ports. Creates a framework for onshore hydrogen bunkering development.
RED III	Defines RFNBO (renewable fuels of non-biological origin), which covers green hydrogen produced from renewable electricity. Maritime inclusion varies by member state transposition.
EU ETS (Maritime)	Extended to shipping from 2024. Covers 70% of verified emissions for vessels above 5,000 GT. Non-CO2 emissions to be included from the following year.
Croatian Hydrogen Strategy to 2050	National framework for hydrogen production and use. CHA as coordinating body. Baseline scenario projects significant CO_2 avoidance in maritime transport through 2050.

2.3.2. Hydrogen in maritime transport: state of the art and perspectives

The second presentation in Session 1, delivered by Professor Ankica Kovač of the University of Zagreb Faculty of Mechanical Engineering and Naval Architecture, provided a

comprehensive technical overview of the state of hydrogen development in the maritime sector and the perspectives for its wider application.

The presentation contextualised the current state of technology by noting that while hydrogen and fuel cell technology are not new concepts, having roots in the 19th century, their practical application in maritime transport is only now reaching commercial maturity. Key milestones highlighted included the world's first commercial fuel cell buses deployed through the EU CUTE project in the early 2000s and the delivery in 2021 of the MF Hydra by Norwegian operator Norled, the world's first ferry powered by liquid hydrogen fuel cells.

A central finding of the presentation was the comparison between battery-electric (BEV) and hydrogen fuel cell (H2) propulsion for maritime applications. While BEV technology offers higher round-trip energy efficiency and lower infrastructure complexity, hydrogen has approximately 240 times higher gravimetric energy density than lithium-ion batteries (40,000 Wh/kg versus 167 Wh/kg) and allows for significantly faster refuelling of approximately 10 minutes compared to several hours for battery charging. This energy density advantage makes hydrogen particularly suited to longer-range routes, heavier vessels and high-frequency ferry operations where battery weight and recharge time would be prohibitive.

The presentation also stressed that maritime transport remains a significant source of greenhouse gas emissions and that rapid action is required given that vessels remain in operation for more than 30 years, meaning investment decisions made today will determine the emission profile of the fleet well into the second half of the century. The role of ports as future hydrogen hubs covering production, storage, distribution and bunkering was emphasised as a critical enabling condition for the deployment of hydrogen vessels across Adriatic routes.

Key technical characteristics of hydrogen compared to battery-electric propulsion for maritime applications:

Table 4 - Key technical characteristics of hydrogen

Parameter	Battery-electric (BEV)	Hydrogen fuel cell (H2FC)

Energy density (gravimetric)	167 Wh/kg (Li-ion battery)	40,000 Wh/kg (H2 at 700 bar)
Refuelling / recharging time	Several hours	Approximately 10 minutes
Range suitability	Short-range, low-frequency routes	Medium to long-range, high-frequency routes
Round-trip efficiency	Higher (direct conversion)	Lower (electrolysis + fuel cell losses)
Infrastructure complexity	Lower (grid connection)	Higher (H2 production, storage, bunkering)
Port as energy hub	Not required	Central to deployment model

2.4. Session 2: TransH2 project results and challenges for Croatian mobility

2.4.1. TransH2 methodology and Interreg framework

The first presentation in Session 2 was delivered by Dražen Vrhovski of EERING and covered the contribution of the Interreg VI-A Italy-Croatia framework and the TransH2 project to the operational use of hydrogen in the Adriatic maritime sector. The presentation provided participants with a structured understanding of how Interreg functions as a cross-border cooperation and co-financing instrument within the EU cohesion policy framework, noting that the 2021-2027 programme cycle encompasses a total EU budget of 10.6 billion euros across 86 programmes and that the Italy-Croatia programme specifically commands a total budget of 222.7 million euros with 99 projects funded across eight Croatian and 25 Italian regions.

The TransH2 project's main objective was presented as enhancing the sustainability of sea mobility in the Adriatic by developing low-carbon solutions for representative maritime routes, demonstrating the feasibility and benefits of hydrogen-based propulsion and promoting adoption among port authorities, transport operators and key stakeholders. The project establishes a complete hydrogen supply chain covering vessel development and port refuelling infrastructure.

2.4.2. Route analysis and selection methodology

A key output of the TransH2 project presented during this session was the systematic methodology for identifying and prioritising Adriatic maritime routes for hydrogen conversion. The process involved an initial screening of 54 Adriatic maritime routes, which was progressively narrowed to 17 pre-selected routes based on technical criteria including route distance, service frequency, vessel type, passenger flow and travel time. From these 17, three representative routes were selected for detailed technical and environmental assessment.

The 17 pre-selected routes are listed below:

Table 5 - Pre-selected routes

Route	Type	Vessel type	Freq./week	Passengers/year	Distance (NM)	Travel time (h)
Tronchetto to Lido	ITA-ITA	RO-RO	161	n/a	3.5	0.67
Punta Sabbioni to Lido	ITA-ITA	RO-RO	252	n/a	1	0.16
Pellestrina to Lido	ITA-ITA	RO-RO	252	n/a	1.5	0.41
Valbiska to Merag	CRO-CRO	RO-RO	83-91	1,142,556	6	0.41
Misnjak to Stinica	CRO-CRO	RO-RO	91-161	954,711	2	0.33
Prizna to Zigljen	CRO-CRO	RO-RO	84-147	943,260	4	0.25
Korcula to Orebic	CRO-CRO	RO-RO	98-154	735,503	2	0.25
Porozina to Brestova	CRO-CRO	RO-RO	84-91	553,627	3	0.33
Tkon to Biograd	CRO-CRO	RO-RO	68-133	455,791	2	0.25

Split to Supetar	CRO-CRO	RO-RO	61-98	367,709	10	0.83
Sucuraj to Drevenik	CRO-CRO	RO-RO	42-77	366,714	4	0.58
Ploce to Trpanj	CRO-CRO	RO-RO	21-28	238,768	9	1.00
Zadar to Preko	CRO-CRO	RO-RO	157-196	230,799	3	0.33
Sobra to Praprtano	CRO-CRO	RO-RO	42/28	146,126	6	0.75
Ancona to Split	ITA-CRO	RO-RO	2-3	184,184	129	8 to 11.5
Bari to Dubrovnik	ITA-CRO	RO-RO	2-4	69,049	107	6.3 to 8
Ancona to Zadar	ITA-CRO	RO-RO	1-2	35,941	80	7 to 9

Source: TransH2 project technical analysis (D.2.3.2). From these 17 routes, three were selected for detailed feasibility assessment: Tronchetto to Lido (Venice lagoon, Italy), Split to Supetar (island ferry, Croatia) and Ancona to Split (cross-border Adriatic route).

2.4.3.Technical analysis: the Split to Supetar case study

The Split to Supetar route on the island of Brac was presented as the primary Croatian use case for hydrogen-powered ferry operation. This route is operated by Jadrolinija with a frequency of 61 to 98 trips per week depending on season, covering a distance of 10 nautical miles at a service speed of 11.5 knots and a trip duration of approximately 50 minutes. Annual passenger volume is approximately 367,709 passengers.
The technical assessment carried out within the TransH2 project analysed the current vessel (Hrvat) and its energy requirements, yielding the following key parameters:

Table 6 - Key assesment parameters

Technical parameter	Value
Installed engine power	2.14 MW
Required power at 11.5 knots	1.487 MW
Engine thermal efficiency	38%
Energy demand per trip	1,239 kWh
Diesel fuel consumption per trip (conventional)	275 kg
H2 fuel cell efficiency assumed	50%
H2 required per trip (calculated)	Approximately 75 kg
Daily H2 demand (estimated, peak season)	Approximately 600 to 750 kg/day

Source: TransH2 project technical assessment (D.2.3.2). H2 calculated on the basis of: required energy input 1,239.16 kWh / fuel cell efficiency 0.5 / H2 lower heating value 33.3 kWh/kg = approximately 75 kg H2 per trip

2.4.4.Challenges for hydrogen implementation in Croatian mobility

The second presentation in Session 2 addressed the applicability, relevance and challenges of implementing hydrogen as an energy source in Croatian and regional mobility. The presentation situated the discussion within the broader context of the BEV versus H2 debate, acknowledging that while fuel cell technology has been under development for over a century, the practical deployment of H2 in transport remains at an early stage with significant challenges remaining.

Key challenges identified for Croatia and the wider Adriatic region included the absence of domestic green hydrogen production infrastructure and distribution networks, a lack of harmonised safety standards and permitting frameworks for hydrogen maritime applications, the significantly higher total cost of energy per kilometre for H2 propulsion compared to battery-electric alternatives and the limited number of trained personnel with the skills needed to operate and maintain hydrogen systems on board vessels and in ports.

At the same time, the presentation emphasised that hydrogen is not primarily a technological challenge but an economic, organisational and infrastructural one. Successful implementation requires reliable sources of green hydrogen, a developed distribution infrastructure, regulatory harmonisation and highly skilled operational teams. The TransH2 TTE events were presented as a direct response to this capacity gap, serving not only to transfer project results but to strengthen the ability of institutions, operators and technical experts to assess where hydrogen can have real impact and where additional preparation, partnerships and investment are needed. With its advanced infrastructure, renewable energy capacity, and commitment to sustainability, Friuli-Venezia Giulia is poised to play a pivotal role in implementing hydrogen-powered maritime solutions. These initiatives not only support environmental protection but also drive long-term economic growth and innovation, solidifying the region's position as a leader in green maritime transport.

2.5. Participants

The Croatian TTE event attracted participants from a wide range of institutional, academic and industry backgrounds. Attendance was recorded through signed attendance sheets and the Zoom platform log.

Table 7- Croatian TTE participants by category

Participation category	Count
In-person (signed attendance sheets)	22
Online via Zoom (unique)	35
Total unique participations (HR)	57

Participating organisations at the Croatian TTE event included among others:

- Croatian Hydrocarbon Agency (CHA)
- University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture
- Faculty of Maritime Studies, University of Rijeka (Lead Partner TransH2)
- Croatian Chamber of Economy (CCE)
- Urbanex d.o.o.
- EERING d.o.o.
- Green Sustainable Solutions
- Port Authority from Valona/Vlora
- Solarwatt d.o.o.
- Korkyra / Niksa
- Notitia d.o.o.
- SOL Croatia d.o.o.
- Leonitus

- Representatives of the FVG Region, Italy
- Individual professionals and consultants from Croatian energy and maritime sector

3. TTE Event in Italy

3.1. Event overview and organisation

The Italian TTE events were held on 16 June 2026 in Trieste as part of the Next Innovation Road conference, organised by M.A.R.E. TC FVG as the responsible Italian TransH2 partner in collaboration with the University of Trieste. The event was conducted in hybrid form and integrated the TransH2 TTE sessions within a broader innovation and technology conference framework, enabling the project to reach a wider audience of technology actors, research institutions, industry representatives and institutional stakeholders active in the Friuli Venezia Giulia region and the northern Adriatic area.

The Next Innovation Road format provided an established and well-attended platform for the dissemination of TransH2 results, ensuring that the TTE sessions reached participants beyond the usual project stakeholder network. Attendance was recorded through a formal signed attendance list following standard Interreg documentation requirements, covering name, surname, organisation and participant consent for audio-visual recording and personal data processing.

3.2. Programme and presentations

The TransH2 TTE sessions at the Trieste event comprised seven expert presentations delivered by researchers, industry specialists and institutional representatives, covering the full range of topics relevant to the deployment of hydrogen in maritime transport. The first TTE session included three presentations, while the second TTE session expanded the discussion with four additional expert contributions, collectively covering the technological, regulatory, industrial, and operational dimensions of hydrogen adoption in the maritime sector.

Table 8 - List of speakers

#	Title	Speaker	Organisation
1	Onboard utilisation of liquid hydrogen: an overview	Rodolfo Taccani	University of Trieste (UNITS)
2	sHYpS, an hydrogen system in a cruise ship	Stefano Quattrini	Viking Cruise
3	Unlocking hydrogen in the maritime industry	Marco Molica Colella	Hydrogen Europe
4	Designing Digital Twins for energy transitions: the H2 Smart Lab approach	Alberto Soraci	Area Science Park
5	Digitalization and alternative fuels for zero emission maritime systems	Fabrizio Cadenaro	Lloyd's Register EMEA
6	Digital Twin applications for the Port of Trieste	Giacomo Morassutti	Port Network Authority of the Eastern Adriatic Sea
7	Hydrogen Hub Trieste	Massimo Giacomini	AcegasApsAmga

3.3. Session 1: Current state / future to zero emission maritime transport

3.3.1. Onboard liquid hydrogen: technology and engineering

The opening presentation by Rodolfo Taccani of the University of Trieste provided a technical foundation for the session by addressing the fundamental physics and engineering

challenges of storing and utilising liquid hydrogen (LH2) on board marine vessels. Hydrogen in liquid form must be stored at cryogenic temperatures of approximately 20 Kelvin, requiring specialised tank architectures to manage boil-off losses and maintain thermal insulation over extended operational periods. The presentation highlighted that hydrogen offers approximately three times the gravimetric energy density of conventional jet fuel, making it an attractive option for maritime applications where vessel weight is a determining factor in range and payload capacity.

The sHYpS project, presented by Stefano Quattrini, demonstrated a concrete application of LH2 technology through the development of an intermodal ISO 45 LH2 container and evaporator unit designed as a swappable storage solution compatible with multiple vessel types. The project, co-funded by the EU, has designed, built and is currently testing a prototype in collaboration with Viking cruise ships, with the objective of integrating and testing the LH2 storage system, fuel handling system and electric connection to the ship backbone on board a Viking newbuild cruise vessel. This approach offers the advantage of infrastructure flexibility, allowing refuelling through container exchange rather than fixed bunkering infrastructure.

3.3.2.EU framework and market design for maritime hydrogen

The presentation by Marco Molica Colella of Hydrogen Europe addressed the structural market and regulatory conditions required to unlock hydrogen deployment in the maritime sector. The presentation opened with a stark market reality: 76 percent of EU external trade moves by sea, yet approximately 65 percent of global electrolyser manufacturing capacity is concentrated in China, creating a strategic vulnerability in the European hydrogen supply chain.

On the regulatory side, the presentation analysed FuelEU Maritime and the EU ETS as the two primary instruments affecting maritime decarbonisation incentives. The FuelEU Maritime non-compliance penalty of 2,400 EUR per tonne of conventional fuel consumed above the GHG intensity limit was identified as a potentially powerful market signal, though its near-term impact is limited by the absence of binding RFNBO targets within the regulation

and the fact that LNG compliance pathways reduce the financial pressure on operators before 2030. The EU ETS maritime extension was projected to generate approximately 8 billion euros in shipping revenues in 2026, rising to approximately 11 billion euros by 2030, representing a substantial potential source of reinvestment in maritime decarbonisation infrastructure.

A key theme of the presentation was the market design challenge underlying the hydrogen scaling problem: hydrogen producers require long-term revenue certainty to reach Final Investment Decision (FID), while buyers in immature markets prefer shorter-term contracts with green premiums, and public budgets face constraints that limit catalytic intervention. The Sustainable Transport Investment Plan (STIP), announced in December 2025, was assessed as a step in the right direction with total mobilisation of 2.9 billion euros until end-2027, against estimated total investment needs in the range of 34.7 to 46.7 billion euros. The double-sided auction mechanism for clean shipping fuels, modelled on the e-SAF Early Movers Coalition approach, was presented as a promising instrument to bridge the structural gap between production costs and market prices.

3.4. Session 2: How digital technologies can be used to achieve zero emission maritime transport in the Adriatic Sea

3.4.1. Digital twins for hydrogen and port management

Two presentations addressed the role of digital technologies in advancing the hydrogen maritime transition. The presentation by Alberto Soraci introduced the H2 Smart Lab Digital Twin approach, designed for monitoring, coordinating and predicting the behaviour of decentralised hydrogen energy systems. This approach is grounded in the European Green Deal's concept of a Twin Transition, where digital innovation and sustainability objectives are pursued together. The Digital Twin for hydrogen systems enables simulation of high-risk operational scenarios, optimisation of energy flows between production, storage and consumption and generation of the operational data required to support certification and safety validation processes.

The presentation by Giacomo Morassutti of the Port Network Authority of the Eastern Adriatic Sea presented Digital Twin applications being developed for the Port of Trieste within a transnational consortium of seven port authorities: Venice, Trieste, Ravenna, Rijeka, Ploče, Zadar and Split. The project has a duration of 30 months (April 2024 to September 2026) and a total budget of 2,384,226 euros. The Digital Twin tools being developed provide data-driven planning capacities and operational sustainability monitoring, creating a direct enabling synergy with the TransH2 port hydrogen infrastructure investments identified in the TransH2 investment catalogue.

3.4.2. Classification society perspective on zero-emission propulsion

The presentation by Fabrizio Cadenaro, Lead Specialist Alternative Fuels at Lloyd's Register EMEA, provided the classification society perspective on zero-emission maritime propulsion. Lloyd's Register plays a central role in the certification and safety approval of alternative fuel systems on board vessels, and the presentation addressed the current state of hydrogen fuel rules, onboard safety frameworks and the digitalization of risk assessment processes. The involvement of Lloyd's Register in the Italian TTE session reflects the strategic engagement of major classification bodies in the TransH2 stakeholder network, which is essential for advancing the Alternative Design Approval pathway for hydrogen-powered vessels in the Adriatic region.

3.4.3. Hydrogen Hub Trieste: supply-side anchor for the Adriatic corridor

The final presentation, delivered by Massimo Giacomini of AcegasApsAmga, presented the Hydrogen Hub Trieste project, which represents one of the most significant supply-side developments directly relevant to the TransH2 investment catalogue. AcegasApsAmga is constructing a 5 MW electrolysis plant powered by a 5 MWp photovoltaic installation with 2 MWh of battery storage, designed to produce approximately 370 tonnes of green hydrogen per year. The total investment amounts to more than 22 million euros, co-funded by PNRR and Horizon EU. The facility is designed around the principle of industrial symbiosis with the Trieste Waste-to-Energy plant, using waste heat and renewable electricity to maximise the efficiency of the electrolysis process.

Table 9 - Development overview

Parameter	Value
Electrolysis capacity	5 MW
Photovoltaic power	5 MWp
Battery storage	2 MWh
Annual H2 production	Approximately 370 tonnes per year
Total investment	More than 22 million euros
Funding	PNRR (Italian National Recovery Plan) and Horizon EU
Industrial symbiosis	Trieste Waste-to-Energy plant (heat and power)
Strategic relevance to TransH2	Primary supply-side anchor for port HRS investments at Trieste (H2-PORT-TRI-01 in TransH2 investment catalogue)

3.5. Participants

The Italian TTE event recorded a total of 120 confirmed participations: 63 in-person (51 from the main signed attendance list and 12 from the separate speaker's attendance list) and 57 online participants confirmed from the Zoom CSV attendance log. Participants represented a diverse cross-section of organisations active in maritime technology, hydrogen development, research, port operations, industry and financial services in the Trieste and FVG region and internationally.

Table 10 – Italian TTE participants by category

Participation category	Count	Notes

In-person — main attendance list (signed)	51	Two-section alphabetical list (A to L and M to Z)
In-person — speakers attendance list (signed)	12	Separate list for presenters and moderators
In-person total	63	51 + 12
Online via Zoom (unique)	57	CSV attendance log, unique participants confirmed
Total confirmed participation (IT)	120	63 in-person + 57 online

Participating organisations included:

Table 11 - Participating organisations

Sector	Organisations represented
Universities and research institutions	University of Trieste (UNITS), University of Udine, University of Toulon, SISSA (Scuola Internazionale Superiore di Studi Avanzati), Area Science Park Trieste
Classification societies	RINA Services, Lloyd's Register EMEA
Shipbuilding and marine technology	Fincantieri, Navalprogetti, Goriziane E&C, CETMAR (Centro Tecnológico del Mar), Groupe Beneteau Italia
Energy and hydrogen	AcegasApsAmga (Hydrogen Hub Trieste), Wärtsilä
Port and maritime authorities	Port Network Authority of the Eastern Adriatic Sea (Porto di Trieste Servizi), eFrame

Industry associations and networks	Confindustria Udine, Confindustria Alto Adriatico
Technology SMEs	StarTech Trieste, Origami Technology, BK Srl, infoFactory, FAST Computing, Mipot, StartUp Marathon, StartingFinance Club Trieste, muleML, E-Phors, Glance Vision Technologies, Info.era (Circle Group), SMA-RTY ITALIA
Business and financial services	Maverick Consulting, Fondazione REI, META Circularity, ARTI
CrossBorder (Croatia)	LP PFRI (Faculty of Maritime Studies, University of Rijeka), Ecubes (Kvarner region), Urbanex, CCE (Croatian Chamber of Economy), PRIGODA (Regional Development Agency of the Primorje-Gorski Kotar County)
General public and private citizens	Individual attendees registered

4.Achievement of Output Indicator RCO85_3.1

4.1. Indicator framework

Output 3.1 is linked to the Programme Output Indicator RCO85_3.1, defined as "Participations in joint training schemes" with a measurement unit of participations and a target value of 50 for the project duration. The indicator is tracked in Period 5 (project months 25 to 30). The TransH2 application committed to a minimum of 4 TTE events with a total of at least 50 attendees, delivering educational content on zero-emission maritime transport solutions and green hydrogen technologies to representatives of port authorities, transport operators, public institutions and industry across the programme area.

The events reported in this document represent 4 confirmed TTE events conducted under Output 3.1: two sessions in Zagreb on 22 May 2026 (Session 1: regulatory and technological framework; Session 2: TransH2 project results and Croatian mobility) and two events in Trieste on 16 June 2026 (Session 1: Current state / future to zero emission maritime transport in the Adriatic area and Session 2: How digital technologies can be used to achieve zero emission maritime transport in the Adriatic sea). Events were delivered in two participation modes (in-person and online via Zoom), each with separate attendance documentation. This meets the Application Form commitment of a minimum of 4 TTE events.

4.2. Confirmed participation figures

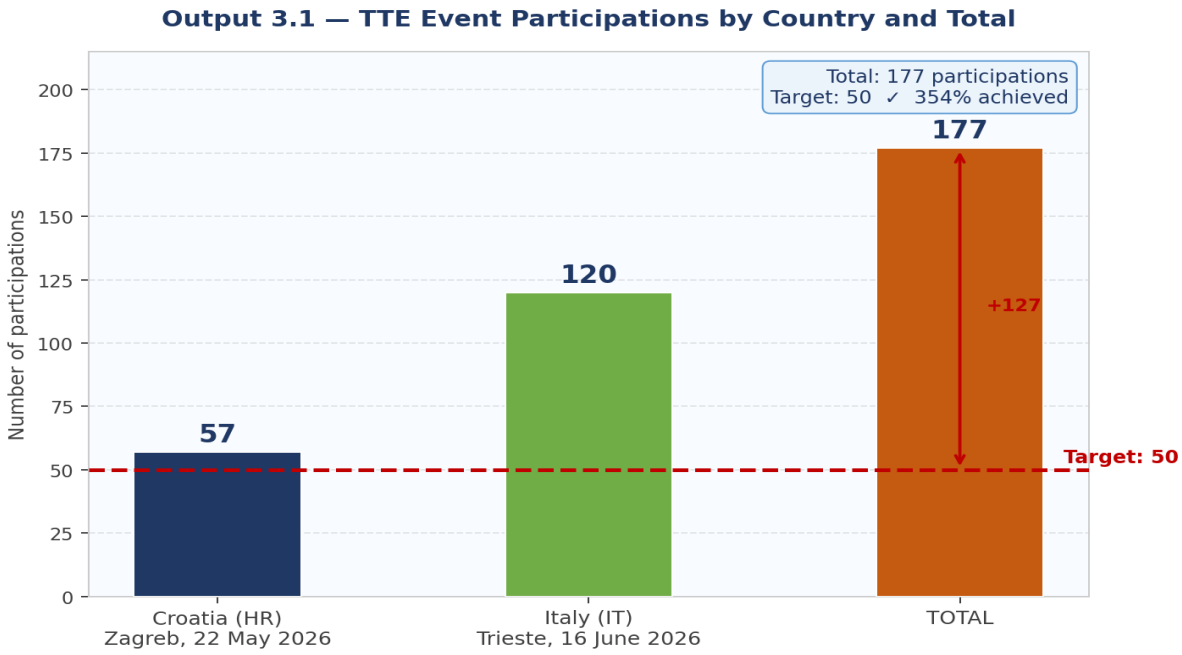
Table 12 - Confirmed participation figures

Parameter	Detail
Output indicator	RCO85_3.1 Participations in joint training schemes
Target value (total project)	50 participations

Delivery period	Period 5 (months 25 to 30)
TTE events conducted (this report)	4 (Zagreb Session 1, Zagreb Session 2, Trieste Session 1, Trieste Session 2)
Croatia: in-person participations (signed sheets, unique)	22
Croatia: online participations (Zoom log, unique)	35
Croatia: total confirmed participations	56
Italy: in-person participations (main + speakers lists, signed)	63
Italy: online participations (Zoom CSV, unique)	57
Italy: total confirmed participations	120
TOTAL confirmed participations	177 (57 HR + 120 IT)
Indicator target achieved?	YES ✓ - 177 participations = 354% of target achieved.

The distinct value of the organized TTE is reflected in the project's cross-border reach. The indicator regarding the involvement of stakeholders from other countries in Adriatic Sea outside the programme area was successfully achieved through the active participation of relevant regional actors. Notably, the Port Authority of Valona took part in the Croatian TTE, thereby confirming interest in the project results even beyond the official borders of the programme area.

Figure 1 - Output 3.1 TTE event participations by country and total



Red dashed line: indicator target (50, per Application Form). Total confirmed: 177 participations = 354% of target. Source: TransH2 project TTE attendance records (May–June 2026). HR: 22 in-person + 35 online = 57. IT: 63 in-person (51 main list + 12 speakers) + 57 online = 120.

4.3. Assessment

The combined participation across the Croatian and Italian TTE events substantially exceeds the indicator target of 50 participations. Total confirmed participations are 177: 57 in Croatia (22 in-person and 35 online) and 120 in Italy (63 in-person and 57 online). The diversity of participants, covering public institutions, universities, port authorities, energy producers,

technology SMEs and industry associations in both Croatia and Italy, confirms that the events reached the target stakeholder groups defined in the project application.

Through the TTE workshops, representatives of these groups are brought together in mixed Italian Croatian cohorts, ensuring that technical content is systematically linked with policy, planning and investment perspectives. This transnational composition is essential for aligning future hydrogen investments and operational solutions on both sides of the Adriatic. Participants have enhanced their understanding of hydrogen technologies for maritime transport, their confidence in evaluating and promoting hydrogen-based solutions, and their readiness to integrate such solutions into local and regional development strategies, port masterplans and transport policies.

The indicator is measured as participation rather than unique individuals, which means that participants attending multiple events or multiple sessions within the same event contribute to the count proportionally. The confirmed indicator value reported for this otuput is 177 participations, representing 354% of the target of 50, confirming full and substantial achievement of the output indicator.

Additional events are planned within the remaining project period to further expand the knowledge transfer and capacity building activities described in this report, which will contribute overall visibility of the project and to the dissemination of the results.

5.Conclusion

The Transnational Training and Educational events conducted under Output 3.1 of the TransH2 project have successfully delivered structured and substantive knowledge transfer activities in both the Croatian and Italian parts of the programme area. The TTE events, held in Zagreb on 22 May 2026 and in Trieste on 16 June 2026, addressed the full spectrum of topics relevant to the green hydrogen maritime transition, from the European and national regulatory framework and technological state of the art to project-specific technical results, investment frameworks, digital twin applications and the classification society perspective on hydrogen vessel certification.

The hybrid format adopted for the Croatian and Italian events maximised geographic reach by combining in-person and online participation channels, while the integration of the Italian TTE sessions within the Next Innovation Road conference in Trieste ensured exposure to a broad innovation ecosystem beyond the established project stakeholder network. Together, the four TTE events attracted 177 confirmed participations (57 in Croatia and 120 in Italy), highly exceeding the indicator target of 50 participations for Output 3.1.

The content delivered across the TTE sessions reflects the depth and transnational ambition of the TransH2 project. Participants were exposed to concrete technical evidence from the project's own feasibility work, including the 17-route screening methodology and the Split to Supetar hydrogen propulsion case study, alongside broader European market intelligence from Hydrogen Europe, regulatory analysis from the Croatian Hydrocarbon Agency and the University of Zagreb, cutting-edge research from the University of Trieste on liquid hydrogen systems and live project examples including the sHYpS initiative and the Hydrogen Hub Trieste.

The participation of Lloyd's Register, RINA, Fincantieri, AcegasApsAmga, the Port Network Authority of the Eastern Adriatic Sea and Area Science Park alongside academic institutions, innovation clusters and SMEs from both countries confirms that the TTE events have activated the key stakeholder groups required for the next phase of TransH2

implementation: investment decision-making, infrastructure development, vessel procurement and cross-border cooperation agreement signing.

The stakeholder networks and institutional relationships consolidated through these TTE events will be essential for the successful delivery of the remaining TransH2 outputs, including the finalised investment catalogue (D.3.3.3), the cooperation agreements (D.3.3.5) and the follow-up engagement with green hydrogen production initiatives (D.3.3.6). The TTE events have made a direct and measurable contribution to building the shared knowledge base and institutional capacity that the Adriatic maritime hydrogen corridor will require to move from the current pilot and planning phase to operational deployment.

6. Annexes to the report

Annex 1 – Presentation Materials from the Croatian Transnational Training and Educational Event

Annex 2 – Presentation Materials from the Italian Transnational Training and Educational Event