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RESEARCH DAYS
15-16 NOVEMBER

e-SHyIPS

Ecosystemic knowledge in Standards for Hydrogen Implementation on Passenger Ship

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ON THE WAVE OF HYDROGEN

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Project Overview

- Call year: 2020
- Call topic: FCH-04-2-2020: PNR on hydrogen-based fuels solutions for passenger ships
- Project dates: January 2021 – December 2024
- % stage of implementation: 75 %
- Total project budget: 2.500.000 €
- Clean Hydrogen Partnership max. contribution: 2.500.000 €
- Coordinator: Politecnico di Milano

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Partners

Research Units

- Politecnico di Milano
- Teknologian Tutkimuskeskus VTT OY
- CINECA Consorzio Interuniversitario
- IDF - Ingegneria del Fuoco srl

Industry

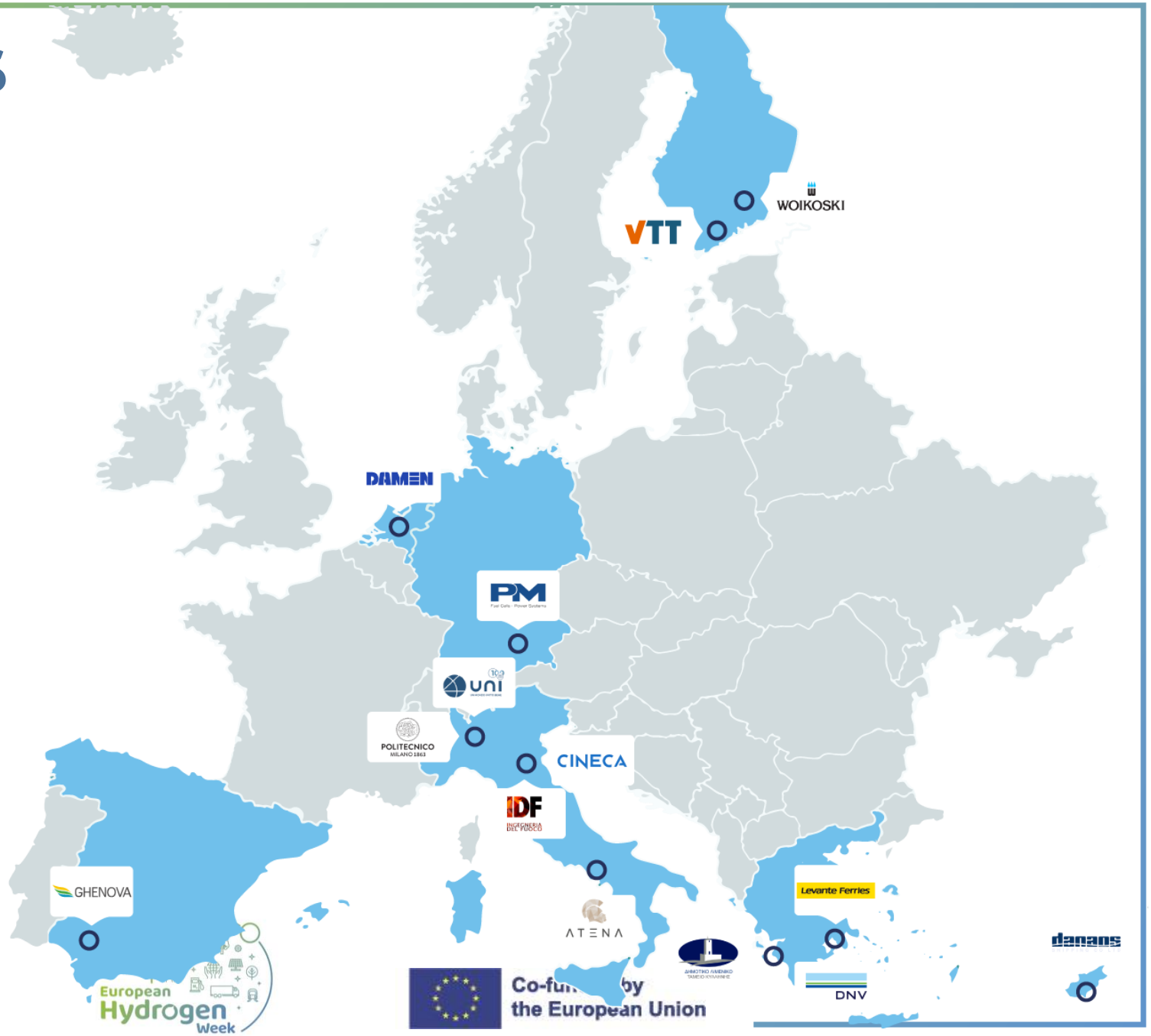
- ATENA Future Technology
- Proton Motor Fuel Cell
- Ghenova Ingenieria sl
- OY Woikoski AB
- Dimos Andravidas-kyllinis

Class Society

- UNI Ente Italiano Di Normazione
- DNV Hellas sa

Ship Owner

- Levante Ferries Naftiki Etaireia
- Danaos Shipping Company Limited
- Scheepswerf Damen Gorinchem Bv



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Project Summary

Through an ecosystem approach, e-SHyIPS integrates theoretical pre-normative research activities on standards with simulation and laboratory experiments

Sharing knowledge within International experts

- 14 partners from 7 EU countries
- 21 Advisory board members
- 28 connected projects

Real-time feedback from/to policymakers

- Certification bodies (DNV, RINA and Lloyd's)
- Standardization body UNI - CEN CENELEC - ISO
- IMO - IGF code Technical commission for H2 update
- EU working groups: SFEM Hydrogen and SGMF

Bottom-up approach

- Analysing the regulatory needs and gaps from a design perspective
- Leverage knowledge from experimentation

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Project Summary

To enable investments, financial institutions, shipbuilders, shipowners and charterers need comprehensive and predictable **certification framework**

The IGF Code covers primarily LNG. Since a regulatory framework applicable to hydrogen fuelled ships is not yet available, the only approach is given by **IMO generic 'Alternative Design' process** whereby safety, reliability and dependability of the systems is to be proven equivalent to that of traditional fuels and power generation systems.

The project aims to contribute to the development of a goal-based regulatory framework on the use of hydrogen and hydrogen-based alternative fuels for waterborne transport. **Primary target IMO - IGF update**

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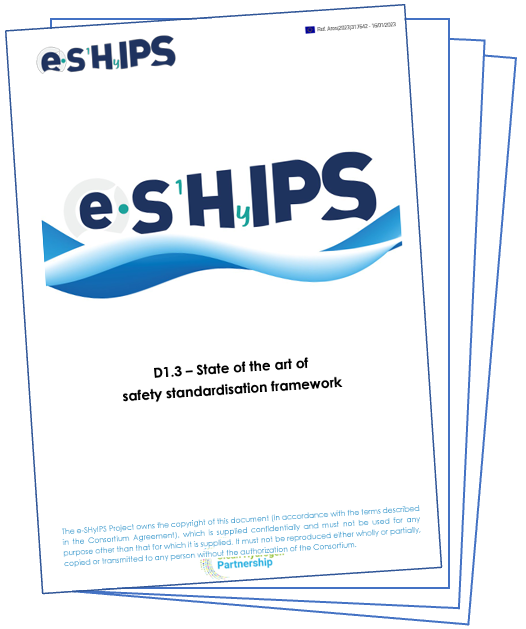
IGF Code review: GAPS indentified

All chapters covered:

- ➢ 98 GAPS IDENTIFIED
- ➢ 35 MATCHED WITH CURRENT STANDARDS

- •ARRANGEMENTS AND LOCATION
- •EQUIPMENT & COMPONENTS FCH VESSEL SYSTEM
- •SAFETY SYSTEM DESIGN
- •MATERIALS AND MANUFACTURE
- •EQUIPMENT & COMPONENTS FCH VESSEL SYSTEM
- •EQUIPMENT & COMPONENTS FOR BUNKERING
- •FUEL
- •MATERIALS AND MANUFACTURE
- •SAFETY SYSTEM DESIGN
- •SAFETY SYSTEM: OPERATING PROCEDURES



https://e-shyips.com/publications/#public-deliverables

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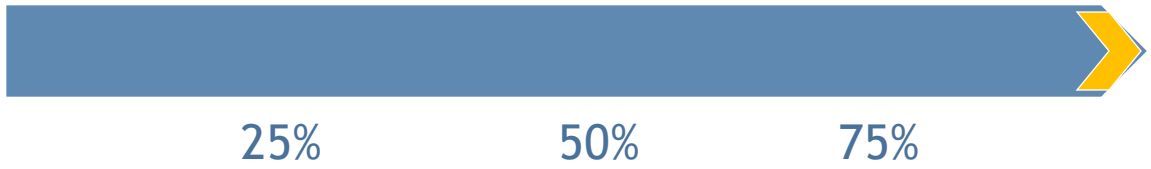
Project Actions

Achievement to-date

H2 STANDARD MAPPING AND NORMATIVE GAP ANALYSIS SPECIFIC FOCUS ON IGF CODE



ALL CHAPTERS COVERED
98 GAPS IDENTIFIED
35 MATCHED WITH CURRENT STANDARDS

- Standards for H2 in non-maritime, LNG and cryogenic vessels that could be relevant in Maritime : #65 standards mapped (current and WIP)
- Technical bodies at EU and International level: #127 developing standards relevant for the project scenarios
- Connection with CEN / CENELEC JTC 6 through UNI CT 056 → mutual exchange of information. Presentation June 2022 plenary meeting, invited to 2023 plenary meeting
- Initiated connection with UNI/CT 030 – Ships, to reach ISO TC 8 and CEN TC 305 [liaison with IMO]
- Inclusion in the AB of CEN/CENELEC, RINA, NMA (member of the subcommittee IMO CCC7) [liaison with IMO]

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Project Actions

Achievement to-date

EXPERIMENTATION SETTING TO FILL THE KNOWLEDGE GAP

15% 25% 50% 70% 75%

3 SCENARIOS
3 VESSEL DESIGNS and GENERAL ARRANGEMENT
4 PILLAR EXPERIMENTAL SETTING: IN PROGRESS
PRELIMINARY RESULTS

To reach the widest impact, the project approach is vessel independent.

SCENARIO S
FAST WATERBUS

DAMEN WATERBUS 2407

SCENARIO M
RO-PAX

LEVANTE FIOR DI LEVANTE FERRY

SCENARIO L
SMALL LUXURY CRUISE

CELEBRITY CRUISE FLORA SHIP

Ship Design | Safety System Experiments | Material and Components Experiments | Port and Bunkering Experiments

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Design case studies

	Waterbus (CGH2)	RoPax (LH2)	Cruise (LH2)
Routing NM	inland navigation 22NM roundtrip	Costal navigation 40 NM roundtrip	Offshore Up to 120 NM per day
Energy Demand	780 kWh/roundtrip	39.300 kWh daily (6 trips)	65.000 kWh daily
Fuel Cell Technologies	PMFC – 650kW	PEMFC – 7.9 MW	PEMFC – 7.1 MW + OPS
Hydrogen Storage Technologies	CGH2 @350bar	LH2	LH2
Hydrogen Demand	375 kg / day	2.300 kg / day	10.000 kg / 4 days
Port Location	Riverside / Urban Port	Mainland Port	Island/mainland Port
Bunkering infrastructure	Tank refuelling infrastructure via refuelling station	Truck to ship	Port facility = H2 Valley

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Safety System Experiments

IGF Code gaps / Uncertainties

SAFETY SYSTEM DESIGN
Discharge mast design and Pressure relief, Emergency shut down, Explosion prevention, Fire and gas detection and alarm system, Hazardous area zone OPERATING PROCEDURES
Gas freeing, Explosion venting, Leakage of gas ventilation and venting processes

Studies and experiments

Machinery safety system GA

Hazardous area classification plan

H2 emergency discharge

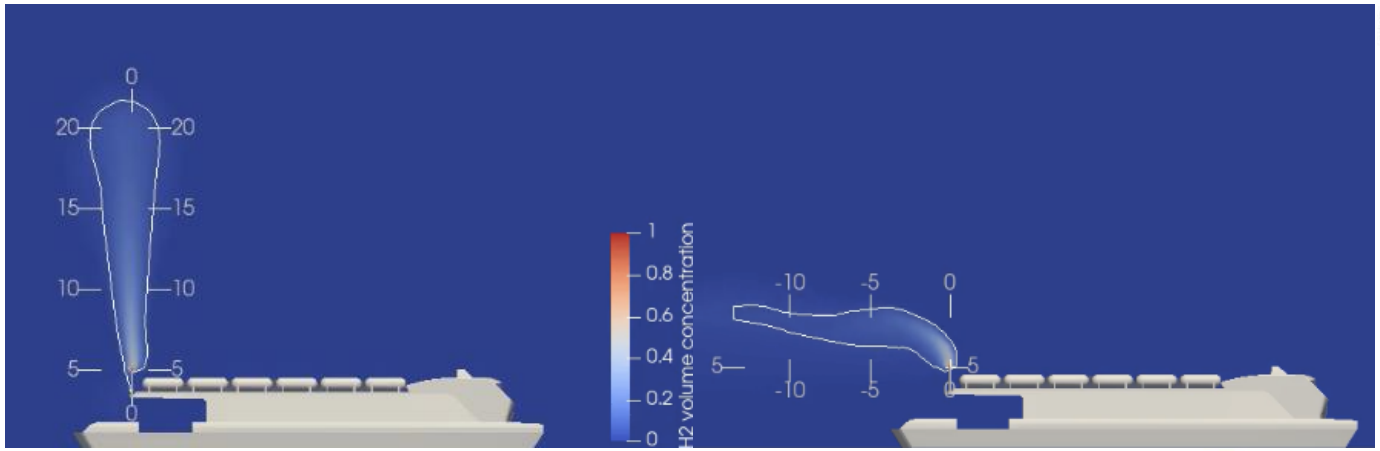
On board dispersions, ventilation and explosion

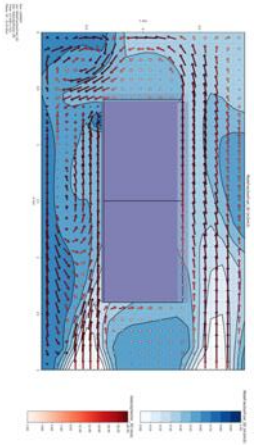
Tools

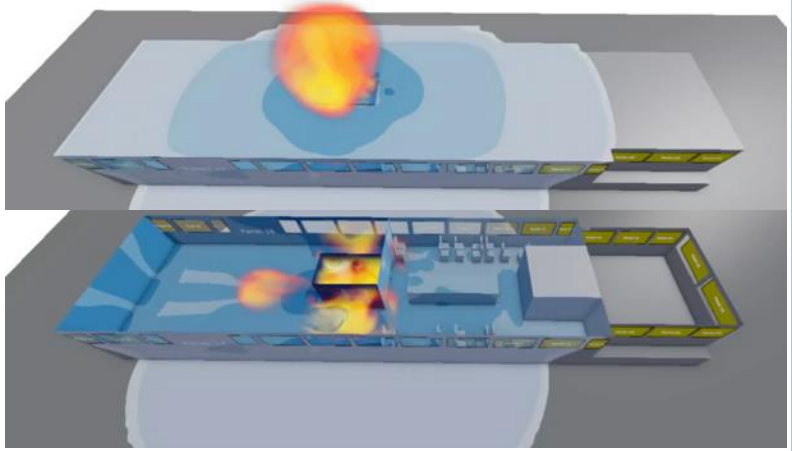
Design Risk Asses. (HAZOP+FMECA)

CFD simulation for Emergency Discharge (RANS-based SST)

CFD simulation for ventilation path, injection and explosion (FLACS)







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Material and Components Experiments

IGF Code gaps / Uncertainties

EQUIPMENT & COMPONENTS FCH VESSEL SYSTEM
Air side impurities effects, Fuel side impurities effects, Sailing effects (mechanical vibration, roll) on FCH, components and piping

Studies and experiments

Leak tightness of FCH stacks (inclination + vibration)

Component operating conditions and performance (salt spray test + vibration)

FCH stacks post mortem analysis

Tools

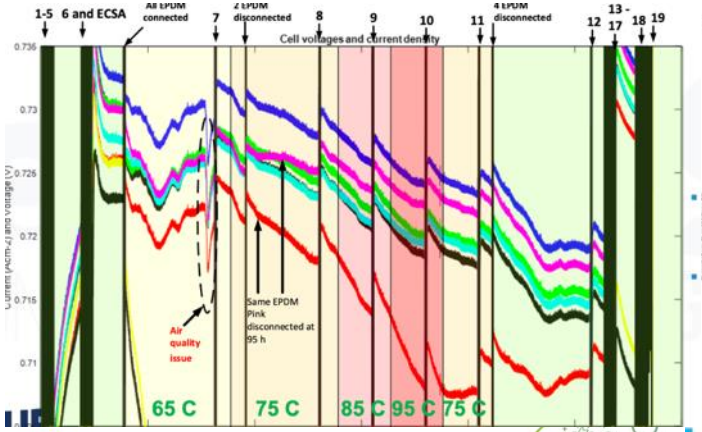
Lab tests:

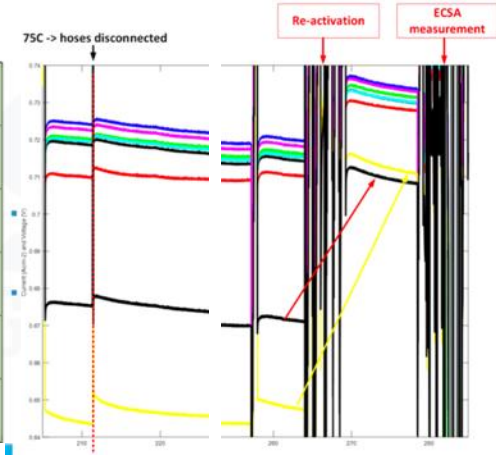
FCH dynamic test bench

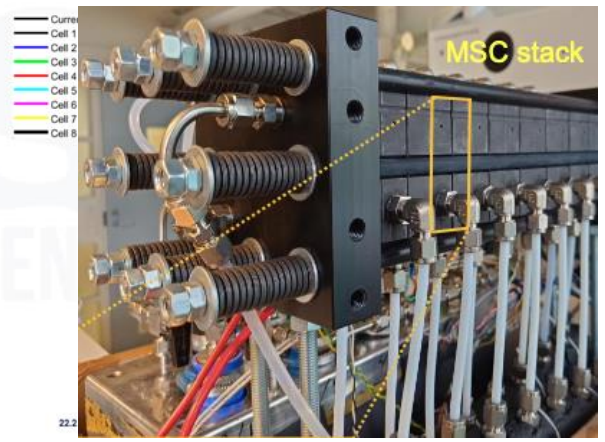
Multi Single Cell tests (MSC)

Sulphur cross-linked (EPDM)

Weather chambers







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Port and Bunkering Experiments

IGF Code gaps / Uncertainties

BUNKERING AND LOCATION

Market needs, H2 transp. strategy, Safety barriers/safety distances, Hazardous areas

EQUIPMENT & COMPONENTS BUNKERING

Sailing effects (mechanical vibration, roll, pressure and thermal stresses on hoses and manifolds

Studies and experiments

Bunkering station feasibility/ strategy arrangement

Vessel stability in refueling process

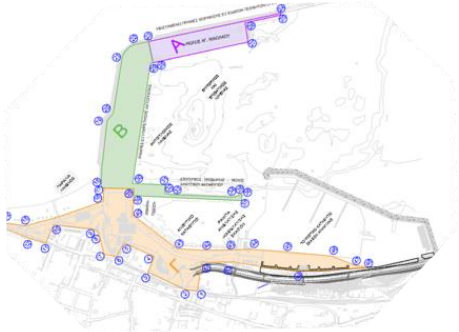
Component operating conditions and performance (thermal and pressure stress + salt environment)

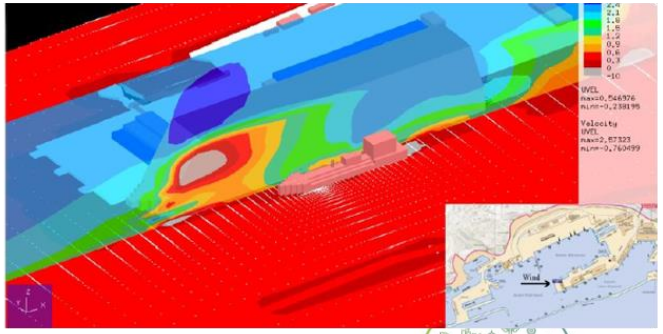
Tools

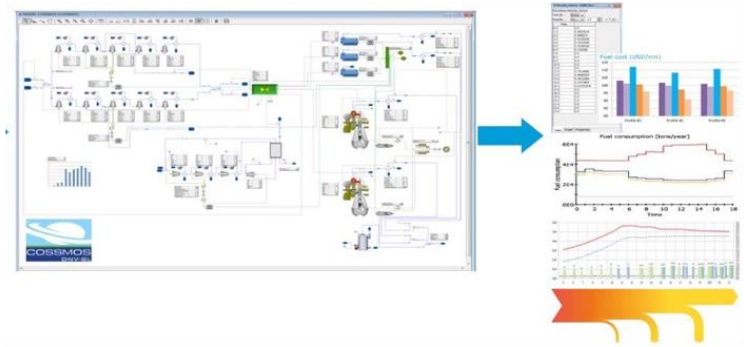
Design Risk Assesment (FMECA)

H2 fuel based propulsion system Scenario simulation (COSSMOS)

Hull stability and motions in waves simulation (LINCOSIM)







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Risks, Challenges and Lessons Learned

STANDARDS SYSTEM DESIGN OF DIFFERENT OPERATIONAL SCENARIOS

- Advisory Board involvement since early stage
- Knowledge from Cluster projects

SCALING KNOWLEADGE FROM ONE EXP. TO OTHERS

- Experiments based on IGF review
- Progressing set up (from S to L) with verification loops

LACK OF INFO ON SPECIFIC COMPONENTS (expecially for large vessel)

- Advisory Board involvement since early stage to evaluate exp. assumption
- Relation with EU ongoing projects
- Scale up from S to L

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Exploitations, Dissemination and Communications Activities

STRATEGIC STANDARDIZATION PLAN FOR IGF CODE UPDATE

- Pre normative plan proposal for IGF code update
- Liaison with ISO TC and IMO

ROADMAP FOR FCH PASSENGER SHIPS

- Market best practices and value proposition models
- models and tools for ship design and safety assessment

- **Publications** - https://e-shyips.com/publications/
  - 8 scientific publication published (conference and journal)
  - 2 publications under review

- **Events and Workshops** - https://e-shyips.com/news-events-and-media-2/#events
  - 10 conference attended (project presentation)
  - 3 workshops organized (IGF code review and H2 in yachting)

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Synergies With Other Projects And Programmes

Ship Design Experiments

Safety System Experiments

Material and Components Experiments

Port -and Bunkering Experiments

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