e-SHyIPS
Ecosystemic knowledge in Standards for Hydrogen Implementation on Passenger Ship

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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
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 srl
• 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
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
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**
IGF Code review: GAPS identified

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
**Project Actions**

**Achievement to-date**

- **Complete**
- **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]
To reach the widest impact, the project approach is vessel independent.

EXPERIMENTATION SETTING TO FILL THE KNOWLEDGE GAP

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

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

Clean Hydrogen Partnership | European Hydrogen Partnership | Co-funded by the European Union
## Design case studies

### Waterbus (CGH2) vs RoPax (LH2) vs Cruise (LH2)

<table>
<thead>
<tr>
<th></th>
<th>Waterbus (CGH2)</th>
<th>RoPax (LH2)</th>
<th>Cruise (LH2)</th>
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<tbody>
<tr>
<td>Routing</td>
<td>inland navigation</td>
<td>Costal navigation</td>
<td>Offshore</td>
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<tr>
<td></td>
<td>22NM roundtrip</td>
<td>40 NM roundtrip</td>
<td>Up to 120 NM per day</td>
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<tr>
<td>NM</td>
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<tr>
<td>Energy Demand</td>
<td>780 kWh/roundtrip</td>
<td>39.300 kWh daily (6 trips)</td>
<td>65,000 kWh daily</td>
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<tr>
<td>Fuel Cell Technologies</td>
<td>PMFC – 650kW</td>
<td>PEMFC – 7.9 MW</td>
<td>PEMFC – 7.1 MW + OPS</td>
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<tr>
<td>Hydrogen Storage Technologies</td>
<td>CGH2 @350bar</td>
<td>LH2</td>
<td>LH2</td>
</tr>
<tr>
<td>Hydrogen Demand</td>
<td>375 kg / day</td>
<td>2.300 kg / day</td>
<td>10,000 kg / 4 days</td>
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<tr>
<td>Port Location</td>
<td>Riverside / Urban Port</td>
<td>Mainland Port</td>
<td>Island/mainland Port</td>
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<td>Bunkering infrastructure</td>
<td>Tank refuelling infrastructure via refuelling station</td>
<td>Truck to ship</td>
<td>Port facility = H2 Valley</td>
</tr>
</tbody>
</table>
Safety System Experiments

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)

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

IGF Code gaps / Uncertainties
Material and Components Experiments

IGF Code gaps / Uncertainties

Studied and experiments

Tools

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

Leak tightness of FCH stacks (inclination + vibration)
Component operating conditions and performance (salt spray test + vibration)
FCH stacks post mortem analysis

Lab tests:
FCH dynamic test bench
Multi Single Cell tests (MSC)
Sulphur cross-linked (EPDM)
Weather chambers
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 Assessment (FMECA)
H2 fuel based propulsion system Scenario simulation (COSSMOS)
Hull stability and motions in waves simulation (LINCOSIM)
Risks, Challenges and Lessons Learned

STANDARDS SYSTEM DESIGN OF DIFFERENT OPERATIONAL SCENARIOS
- Advisory Board involvement since early stage
- Knowledge from Cluster projects

SCALEING KNOWLEDGE 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 (especially for large vessel)
- Advisory Board involvement since early stage to evaluate exp. assumption
- Relation with EU ongoing projects
- Scale up from S to L
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/](https://e-shyips.com/publications/)
  - 8 scientific publication published (conference and journal)
  - 2 publications under review

  - 10 conference attended (project presentation)
  - 3 workshops organized (IGF code review and H2 in yachting)
Synergies With Other Projects And Programmes
Stay tuned!

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