



HYDROGEN IMPLEMENTING AGREEMENT



Hydrogen in the maritime

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Hydrogen in the maritime

90% of all trade
between countries is
on ships

Ports in EU handled
400 million marine
passengers in 2013

Towards: smarter, safer, greener

- LNG fueled
- Batteries/fuel cells
- Bioethanol
- Battery hybrid



Challenges for hydrogen in the maritime

- Infrastructure
- Cost
- Lifetime and durability of vital parts (membrane, catalyst, ...)
- Size of H₂ tanks
- FCs are sensitive to the environment
- Requires significant change in ship design and operation
- Safety
- Regulations, codes and standards
- Social acceptance



Benefits by use of hydrogen in the maritime

- Environmental performance (H₂ source)
- CCS
- Easier co-generation of electricity and heat (high-temperature FCs)
- Storage of excess electricity from renewable energy surplus
- Improved efficiency (especially part-load)
- Modular and flexible design
- Reduced maintenance
- Alternative to cold-ironing
- Noise and vibration reduction (passenger ships, ...)
- Water generation (space)
- Reduced infrared signature (submarines)



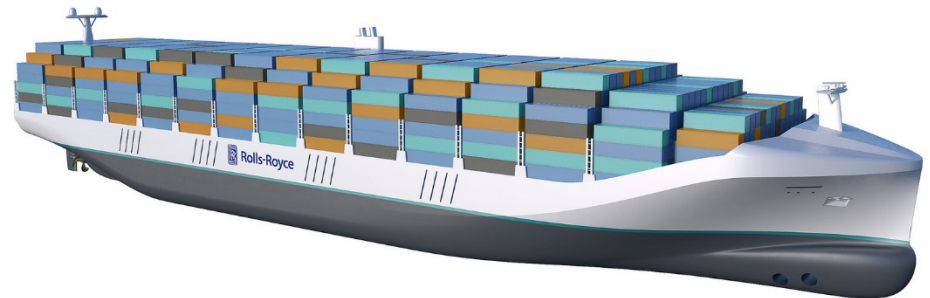
Drivers for use of hydrogen and fuel cells in maritime applications

- Reduction in fuel consumption
- Less local and global emissions to air
- Reduction in noise and vibration levels
- Reduced maintenance requirements
- Smart cities – local supply of hydrogen is available



Trend in the maritime

- Autonomy
- Fuel optimization
- Reduced emissions
- Increased safety and performance
- Operational flexibility
- Materials and design



IEA: International Energy Agency

HIA: Hydrogen Implementing Agreement –
An organization in the *IEA energy technology network*



- 40 Implementing Agreements
- 5000 energy experts



IEA – HIA : 22 countries involved



IEA Hydrogen Implementing Agreement Task 39 Hydrogen in maritime transport

Overall goal is to provide knowhow on the use of hydrogen and fuel cells in the maritime, evaluate concepts and initiate research and demonstration projects.



IEA Hydrogen Implementing Agreement

New task on Hydrogen in maritime transport



NT



Sub goals:

- Investigate possibilities for use of hydrogen in the maritime
- Monitor, review and contribute to new concepts, technologies and components
- Initiate research and demonstration projects
- Overview of regulations, codes and standards
- Dissemination
- Generate an international expert group on the subject



Subtask 1 Technology overview

Sub goal: Investigate opportunities and impact on the use of hydrogen in the maritime

- *Activities:*
 - Define system under investigation (short, deep sea, offshore)
 - Energy systems: fuel cell versus battery
 - Impact on emission
 - Peak power handling
 - Economic and business case analysis
 - Fuel supply logistics/infrastructure (harbour or on-board)

Subtask 2 New concepts

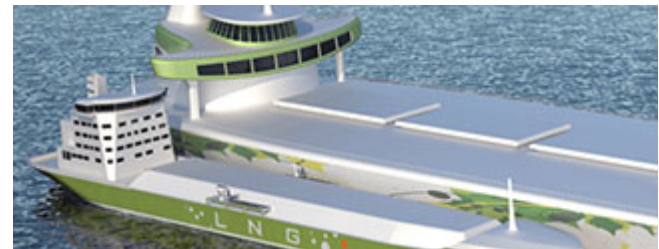
Sub goal: Contribute to concept evaluations and identification of challenges and opportunities

Activities:

- New build, design and impact

- Retrofitting existing vessels with fuel cell solutions

- Fuel cell system solutions
 - Marine applications
 - Design and configuration
 - System integration



Subtask 3 Safety and regulations

Sub goal: Contribute to safety and risk management

- Overview of regulations, codes and standards and up-coming regulations related to systems and emissions
- Safety methods and models
 - Safety analysis in the engine room/storage
- Risk management for design and operations

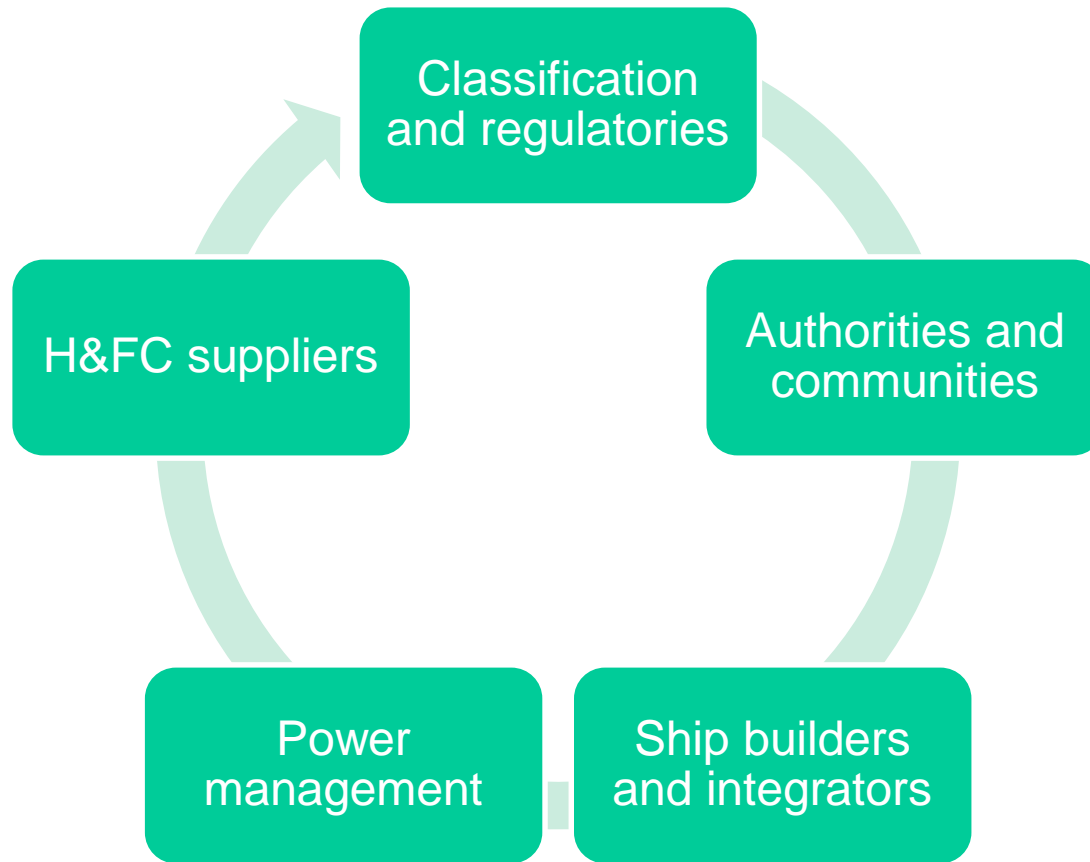
Subtask 4 Demonstration

Sub goal: Support, provide input to, evaluate and link international demonstration projects.

- Generate an overview of existing projects
- Create an international database
- Link communities, experience and practice



Task participation



IEA-HIA Task 39: Partners

- European Commission
 - Finland
 - France
 - Germany
 - Italy
 - Spain
 - Sweden
 - The UK
 - The Netherlands
 - Norway
-
- Japan, China



IEA-HIA Task 39: Partners

- NTNU Norwegian University of Science and Technology (Director)
- European Commission
- Norwegian Maritime Authority
- International Association of Classification Societies (IACS)
- DNV GL
- SINTEF Ocean
- Maritime Forening Sogn og Fjordane
- Institute for Energy Technology (IFE)
- University of Southampton
- University of Trieste
- cEnergy
- University of Genoa
- VTT Technical Research Centre of Finland
- Proton Motor
- PowerCell
- Hyseas Energy
- PersEE
- Technical University of Madrid
- National Institute of Aerospace Technology, Spain (INTA)
- Delft University of Technology

Maritime labs



Marine Cybernetics Laboratory



Research vessel "Gunnerus"

Case study, MoZEES RA3

- To gather data on operational profile of a similar diesel-fuelled vessel
 - Identified data to collect
 - Speed
 - Power
 - Fuel consumption
 - Location
 - ...
- Contacts made with Marcontrol A/S
 - Marcontrol will gather data for 3 days after agreeing on relevant costs



(Source: Brødrene Aa)

OMAE Conference, June 2017

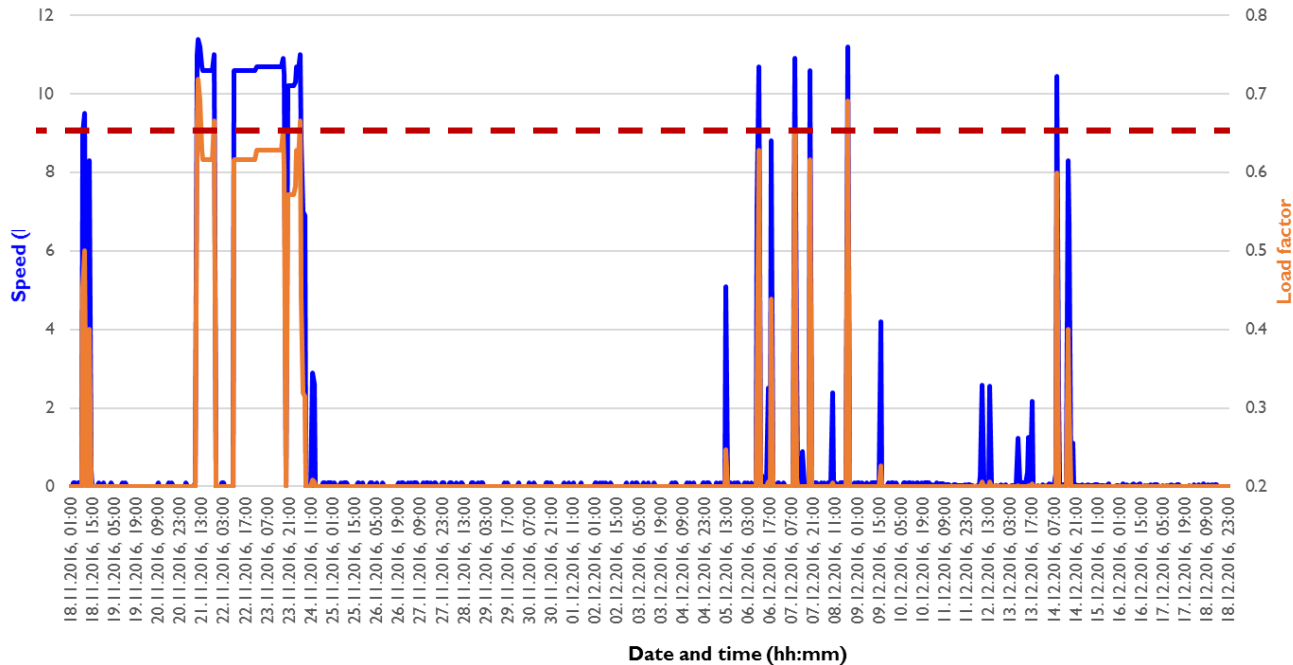
R/V Gunnerus

- Length overall: 31.25 m
- Breadth extreme: 9.90 m
- Depth moulded at main deck: 4.20 m
- Main propulsion: 1000 kW
- Speed at 100% MCR: 12.60 kn
- Cruising speed: 9.40 kn

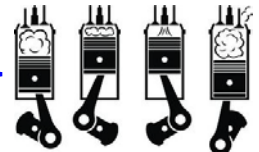


Speed and load factor during a month

65%
MCR



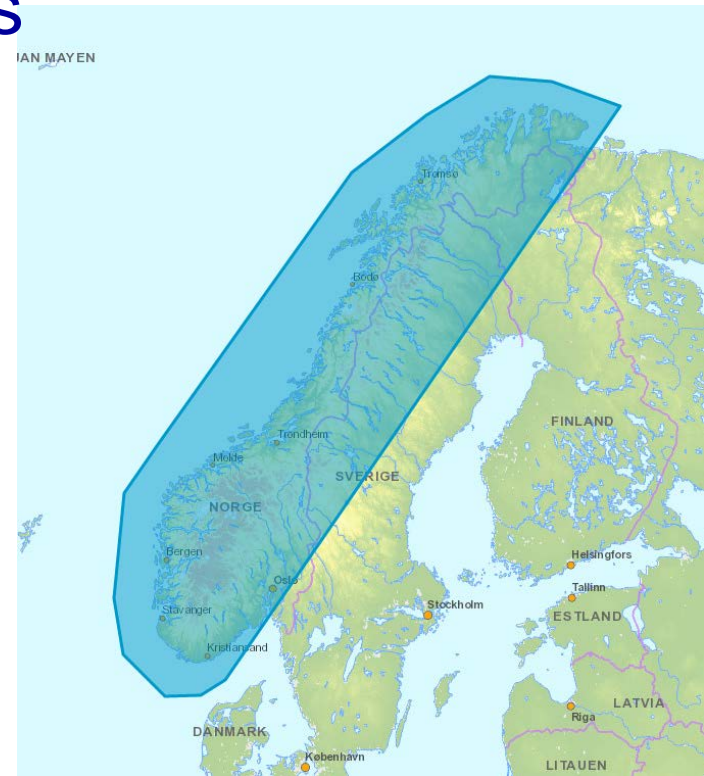
Hydrogen
and fuel
cells



EFCI7 Conference, December 2017



- AIS data
- Operational profile of ships



- Power management of hybrid fuel cell propulsion systems
- Fish feed vessel
- ABB
- Gas engine, Shaft generator, Auxiliary engines
- Fuel cell and battery

