



Low Emission Vessel Hydroville

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Content

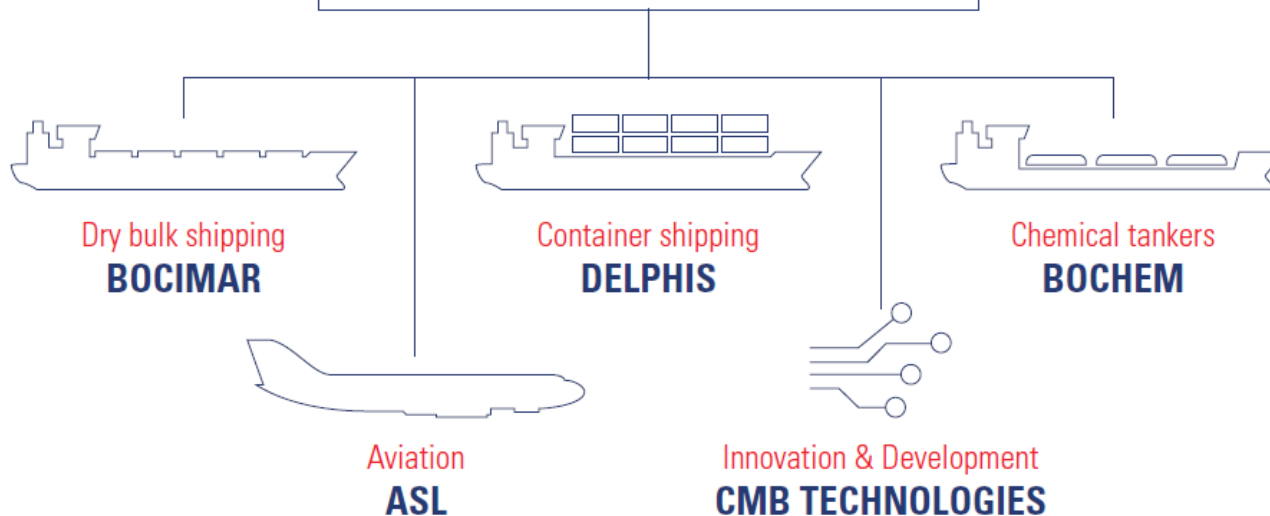
- Who is CMB?
- What is the Hydroville project?
- Legal aspects of the project:
 - Vessel design/construction
 - Dual fuel engines
 - Bunkering of hydrogen
 - Operation
- Some other projects
- Importance of a legal framework
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CMB (Compagnie Maritime Belge) owns and operates 95 ships and 140 aircraft

CMB TODAY

CMB is a privately owned company, based in Antwerp with offices in Singapore, Hong Kong and Tokyo.
At present CMB is active in the following areas:



HYDROVILLE



<https://www.youtube.com/watch?v=5kNxUqCIDno>



The complete project was realized within a timeframe of 1.5 year

- Developed by CMB Technologies which is the R&D department of the Group which focusses on innovation and technological advancements
- First ideas of the project were generated in June 2016
- The vessel was christened in Antwerp on 29th of November 2017
- Demonstration of the hydrogen technology for shipping

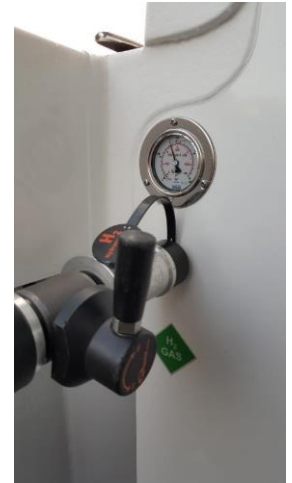
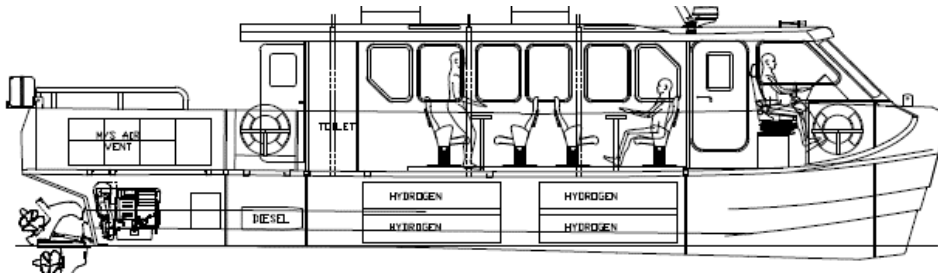


Hydroville: Hydrogen Powered Catamaran (hi-speed with non-planing hull)

GENERAL SPECIFICATIONS

Passenger shuttle

Length	14 m
# of passengers	16
Beam	4.2 m
Max Draft	0.65 m
Displacement at full load	14 ton
Lightweight	12 ton
Propulsion	2x dual fuel (diesel and hydrogen) internal combustion engines (H2ICED) with a total shaft power of 441kW
Fuel	12 hydrogen tanks (205 liter @ 220bar or 36kg of useable hydrogen) and 2 diesel fuel tanks (2x265 liter) as pilot/backup fuel
Max speed	27 kn
Cruise speed	22 kn
Classification notation	Lloyd's Register ⚠100A1 Special Service Craft, Crewboat, Catamaran, High Speed Craft, G2, MCH Descriptive note for Low Flash Point Fuels (Gas fuelled engines, Hydrogen gas)



SPECIFICATIONS H₂ TANKS

Cylinder life	20 years
Weight	66kg (35kg aluminium liner, 31kg composite laminate)
Water volume	205 liter
Service pressure	200 bar
Max. developed pressure	260 bar
Test pressure	300 bar
Min. burst pressure	558.4 bar
Working temperature	-40°c to +82°c
Hydrogen Cylinders Frame Structure	Stainless steel 316L
Supported frame accelerations	Forward 12g, afterwards 2g, transverse 2g, vertical 2g

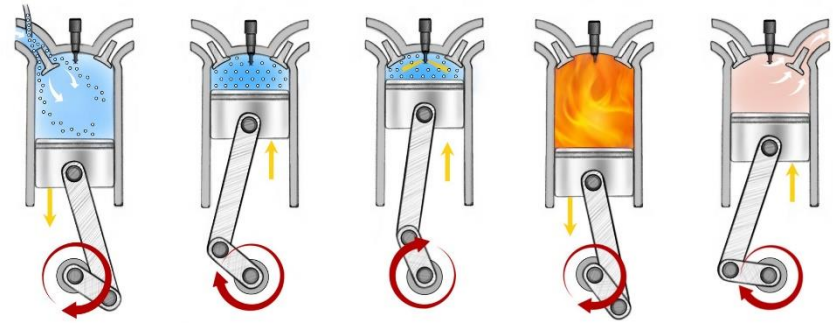
Legal aspects: Design & Construction

- BMI (Belgian Maritime Inspectorate) was very cooperative by writing the specific newbuilding procedure for a non-conventional vessel, intended for navigation in near coastal areas within the Belgian territorial waters.
- Royal Decree of November 1981 gives BMI the authority to allow H₂
- Type approval as inland water vessel would be too time-consuming
- IGF (the International code for safety of ships using gases or other low-flash point fuels) does not handle hydrogen as a marine fuel. But the same principals were considered during HAZID.
- Requirements of BMI:
 - Assessment of safety & radio equipment
 - Class involvement for hull and machinery
 - Equipment shall comply MCA Brown code
 - All equipment MED approved



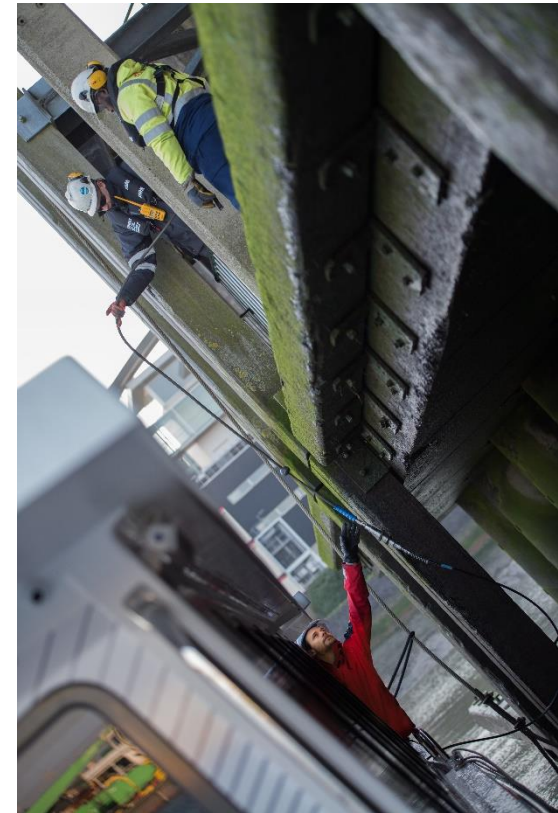
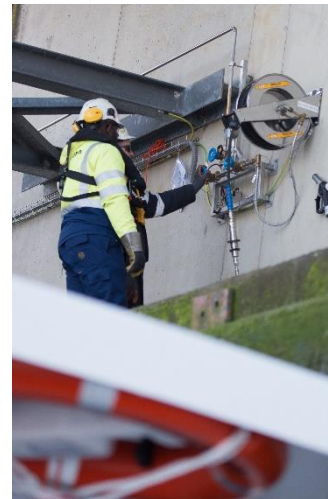
Legal aspects: 2 Volvo Penta D4s were retrofitted with a hydrogen injection system

- The ECU (engine control unit) nor engine hardware have changed:
 - When no H₂ can be supplied, the engines runs on usual MGO
 - If something fails on the H₂ system, the system is switched back to the original situation (pure MGO combustion)
- EIAPP (Engine International Air Pollution Prevention) certificate is only valid for pure diesel but BMI accepted a witness test showing that emissions are not higher
- Engines are tested for the full envelope on dyno (static + transient behaviour)



Legal aspects: H2 Bunkering

- Daily bunkering of Hydrogen is required and is done in Zwijndrecht
- Easy to learn and safe procedure (Hazid/Hazop by LRS)
- H2 storage is mobile and not remaining onsite
- 'Zoneringsdossier' was written (NPR 7910-1, NEN-EN-IEC 60079, EN 1127-1, CE, NPR-CLC-IEC/TR 60079-32-1, IN-SI-COM-005, etc)



Legal aspects: Operations

- BMI required ISM (International Safety Management Code) to be applied
- BNWAS (bridge navigational watch alarm system)
- Fully classed vessel → All modification have to be approved by IACS member (International Association of Classification Societies)
- Only approved to be operated in the Belgian territorial waters
- Voyage from Antwerp to Ostend is regarded as a national trip

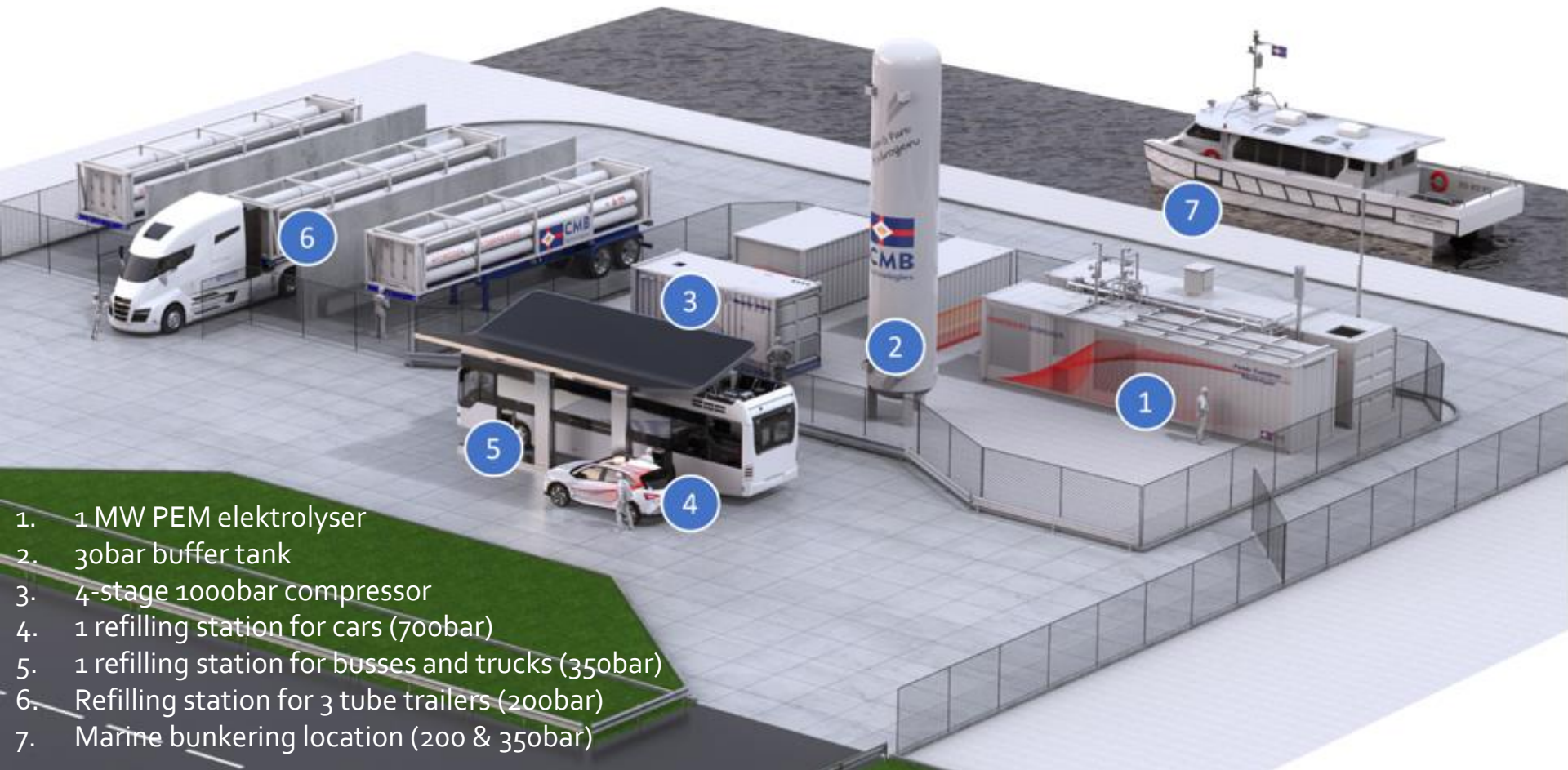


Other hydrogen projects (of CMB) will go easier if a proper legal framework is present

- Container vessel with containerized H₂ gen-set to power reefers
- Bulk carrier with H₂ auxiliary engine
- Cold ironing solution for ports
- Marine H₂ bunkering location with storage/compression
- H₂ storage solutions suitable for shipping (LOHC, formic acid, hydrides, methanol, etc)



A 1MW PEM elektrolyzer will be part of the the first H2 bunkering location for ships



1. 1 MW PEM elektrolyser
2. 30bar buffer tank
3. 4-stage 1000bar compressor
4. 1 refilling station for cars (700bar)
5. 1 refilling station for busses and trucks (350bar)
6. Refilling station for 3 tube trailers (200bar)
7. Marine bunkering location (200 & 350bar)

A legal framework for hydrogen will help the transition towards a green fuel

- Hydrogen projects are still expensive. Risk based approach can lead to design changes (at a late stage), which make the project even more expensive.
- The lack of legal framework enlarges the hurdle that one has to take to start with hydrogen.
- Governmental institutes have difficulty to operate without a legal framework, resulting in a slow process.
- Too many so called experts are involved, if no clear rules are present. A clear guideline should be available of what should be considered and what not.
- The scope of a risk based approach is often too wide.
- The outcome of HAZID is dependent on the appointed inspector, surveyor or classification society. An approved design code can avoid this.

Q&A



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