ArianeGroup, Enabler in the deployment of hydrogen for naval / maritime domain

Webinar Cluster Energie Stockage

24th March, 2021

WHY ARIANEGROUP?

- 40 years of experience in hydrogen mobility
- Operator of the largest H2 test area in Europe
- First consumer of liquid H2 in Europe
- Safety and reliability track-record
- Unique know-how (LH2 / high power / embarked systems)
- A unique experience of European program management
- Two world leaders as shareholders: Airbus & Safran

ariane GROUP

ArianeGroup is a world leader in hydrogen mobility since 40 years

40 YEARS OF ARIANE SUCCES RELY ON LIQUID HYDROGEN PROPULSION & INFRASTRUCTURES

MAKING HYDROGEN ACCESSIBLE AND SAFE TO ENABLE ENERGY TRANSITION ACROSS INDUSTRIES IS OUR AMBITION

LH2 legitimacy in the maritime energy mix

Among greener alternative fuels, LH2 is the favoured solution for small and medium sized ships sailing on coastal and regional distance with power needs between 2 and 10 MW.

	Ship category	Example	Favoured fuel	Associated reasons
	Very high power, Long distance, Large tonnage	• Oil/chemicals tankers, • Gas tankers, • Bulk carriers, …	HFO/MDO LPG LNG	• No existing 100% renewable solution available for such power and autonomy needs. • NH3 volumetric energy density is ~14000 kWh/m3, HFO (diesel) have around 40000 kWh/m3.
	High power, Long distance, Large tonnage	• Container ships, • General cargo ships, • Cruise ships, • Large ferries, ….	LNG Methanol Ammonia	• Mainstream cruise ship ~20MW power and deep-sea shipping usually onboard 11MW. • LH2 volumetric energy density is ~8500 kWh/m³ and is not sufficient.
	High power, Short distance, Large tonnage	• Small cruise ships, • Ro-ro, • RoPax, • Dredgers, …	LNG Methanol Ammonia **LH2**	• A mix of solution exist = case by case choice. • GH2 volumetric energy density is ~5000 kWh/m3 and is not sufficient for large tonnage.
	High power, Short distance, Small tonnage	• High speed ferries, • Tugboats (port and fluvial), • Car/passengers' ferries, • Platform support vessels, …	**LH2** GH2	• Short sea ships usually onboard 2 MW power, not reachable by batterie performance. • LH2, costly to produce in energy, but allowing a better volumetric density enter the “game”
	Low power, Short distance, Small tonnage	• Small fishing boats, • Barges, …	GH2 Batterie	• Batteries are cheapest way to achieve “zero emission”, however their autonomy is limited.

Definitions

Small tonnage: <10 000 GT
Large tonnage : >10 000 GT

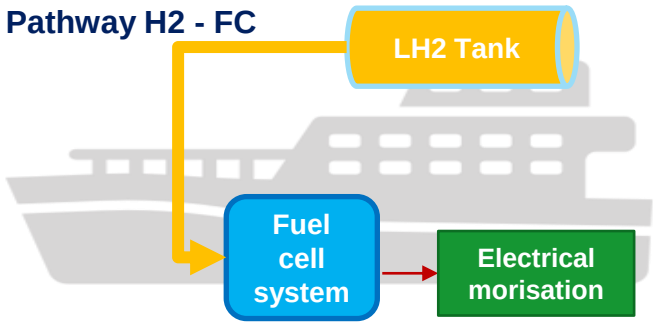
Very high power: >10MW
High power: from 2MW to 10MW
Low power: <2MW

Short distance: coastal or regional
Long distance: several days of shipping time

Fossil | Renewable

LH2 ship architecture

The architecture concepts for LH2 ships place the LH2 tanks on the upper deck.



Architecture of LH2 ships

- **The first concepts place the LH2 tank on the roof of the ship**
  - Easy to design and implement
  - Safe approach: boil-off, potential leakages
  - Easy to refuel: 1 concept identified with a removable tank
- Current tank capacity: c. 4 tons, which is the volume of one LH2 truckload.
- **« Long » distribution line from the tank to the propulsion system**
  - No need for compact systems
  - Standard vaporizers and H2 lines
- **Two motorisations:**
  - Electric motorisation (*via* Fuel Cells) for most of the identified projects.
  - Internal combustion engines (ICEs):
    - Wärtsilä has successfully developed an engine operating with a gas mix containing 20% H2
    - Projects exist for 100 % H2 ICEs but are still in R&D.