Observatorio Tecnológico del Hidrógeno

TECHNICAL WORKSHOP

Decarbonising shipping with hydrogen and other green molecules

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Conclusions

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Main conclusions

- **Maritime transport accounts for 13.5% of GHG emissions in the transport sector**, and it is therefore **essential to develop a roadmap for its decarbonisation**, as established in the European Council's Fit for 55 Plan.
- **October 2025 is a key date**, as it is when the **IMO's regulatory agreement is due to be ratified**. This will establish a **global mechanism for pricing GHG emissions** from 2027 onwards. This could **encourage shipping companies to invest in alternative technologies and fuels** to help them meet decarbonisation targets.
- **By 2050, half of the world fleet** is expected to **operate on propulsion sources such as hydrogen, ammonia and methanol**, and the other half on alternative fuels, mainly LNG, according to DNV forecasts.
- **New fuel technologies** will reach a stage of **commercial readiness for deployment by 2027–2028**, with associated regulations planned for this period:
    - **Ammonia** is a medium-to long-term alternative that **can reduce GHG emissions by 90% compared to conventional fuels**, and it already has a global logistics infrastructure in place.
    - **Methanol** has great potential to become a carbon-neutral fuel if **produced from biogenic CO_2 and/or renewable electricity**.
    - **Hydrogen fuel cells** are seen as a long-haul alternative for short-and medium-haul routes.

State of the art engine and fuel cell technology for hydrogen and its derivatives

Fuel cell technology can meet the requirements of **short-and medium-haul shipping**, while **internal combustion engines** will be essential for **long-haul vessels** that require higher power.

- **Fuel cells** —systems that convert energy from a fuel into electricity— **will contribute to achieving carbon neutral emissions** if renewable hydrogen is used. These systems can also use green hydrogen derivatives, such as methanol or ammonia, via reforming processes to obtain hydrogen as the main element.
- **Proton Exchange Membrane (PEM**) fuel cells are currently **the most established and widely used technology** in the maritime sector, operating at low temperatures (around 65 °C). Promising alternatives include SOFCs (Solid Oxide Fuel Cells), which operate at temperatures between 800 and 1,000 °C and offer advantages such as cogeneration. **The most appropriate technology will depend on the characteristics of the ship and its specific needs.**
- There are several manufacturers of fuel cell modules with considerable power ratings: **Ballard Power Systems** (200 kW), **PowerCell** (225 kW) and **Nedstack** (600 kW), which can currently be scaled up to provide **6 MW of modular power**. However, depending on the type of vessel, **the maritime sector demands power outputs of over 60 MW**.

State of the art engine and fuel cell technology for hydrogen and its derivatives

There is no single solution, but there is a **winning strategy based on three key pillars: efficiency, use of low-emission fuels and carbon capture technologies.**

- **Wärtsilä** has been working since 2017 on the development of propulsion solutions based on new fuels such as methanol, ammonia, hydrogen-LNG blends or biofuels. The company will soon take delivery of the first pure hydrogen engine with a capacity of 5 MW for testing at its laboratory in Bermeo. It is also in the final stages of commercialising onboard carbon capture systems.

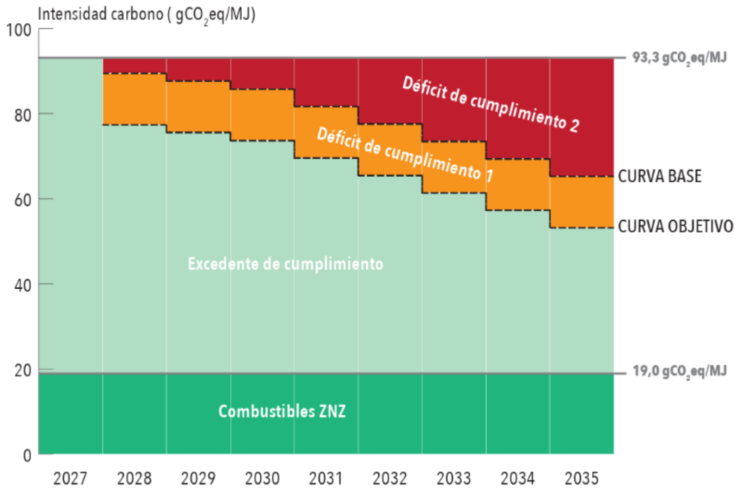
- **Everllence** (formerly MAN Energy Solutions) will deliver its first two-stroke ammonia engine in January, which will operate by the end of 2026. The manufacturer is also expanding its portfolio of four-stroke engines to include methanol engines. In addition to propulsion systems, Everllence is working on: onboard liquid hydrogen storage technologies (-253°C), dual hydrogen and LNG tank solutions to facilitate the transition between ICE and LNG engines and hydrogen fuel cells to enhance propulsion system efficiency.

- The **main challenges to the adoption of low-carbon solutions** include the **absence of a consolidated supply chain**, **regulatory uncertainty** and a **lack of incentives for the use of sustainable fuels**, as well as the **investments required** for ports and logistics operators to adapt.

The vision of shipping companies and shipyards: the challenges and opportunities of decarbonisation using hydrogen and other green molecules

Establishing a single, **international standard is key to maintaining global competitiveness** in the maritime sector. **Emission intensity below 19 gCO_2/MJ can only be achieved using bio-LNG, methanol, ammonia or green hydrogen solutions.**

- ANAVE discussed the **IMO's draft ZNZ (Zero Near Zero) regulatory agreement**, which is expected to be ratified in October 2025 and will establish stricter requirements than the current FuelEU Maritime agreement.
- From 2028, the IMO will implement a **system of incentives and penalties** based on the carbon intensity of marine fuels. Ships will pay **\$380/ton CO_2eq** on the base curve (Compliance Deficit 2) and **\$100/ton CO_2eq** on the target curve (Compliance Deficit 1). Below these curves (the compliance surplus zone), tradable reward units will be earned. In addition, **ships with emission intensities below 19 gCO_2/MJ (ZNZ** fuels) will be eligible for **direct financial incentives.**



IMO Agreement. Reference emission indices for ships

The vision of shipping companies and shipyards: the challenges and opportunities of decarbonisation using hydrogen and other green molecules

The main challenge for **new fuels** is that they **are competing with technologies that have been optimised over several decades**, so it is reasonable to assume that, at least initially, they will have a higher cost.

- **45% of the Baleària fleet's energy consumption is based on LNG**. The Spanish shipping company is primarily committed to **bio-LNG** as a decarbonisation alternative; despite its limited availability, it emits less than 19 gCO2/MJ in many cases. Baleària is also analysing the use of **synthetic methane** and, for short routes, **hydrogen fuel cells** or electric ships.
- **PYMAR** pointed out that one in every five ships contracted in Europe will be built in Spain to adapt to market demands. Spain currently builds 40% of ships that are ready for future hydrogen-derived fuels.
- **Scale Green Energy** is committed to using **green ammonia**, which can reduce **GHG emissions by 90%**. However, its implementation **depends on the approval of regulations governing its use as a fuel**.
- **NYK** operates over 800 large-tonnage vessels for all types of transport and is **committed to achieving net zero emissions by 2050**. Its decarbonisation strategy focuses on three areas: maximising energy efficiency to reduce fuel consumption; reducing GHG emissions through on-board capture and the use of bio-LNG; and using sustainable fuels, particularly green ammonia, from 2030 onwards.

Submarine S80, silent hydrogen-based propulsion

Navantia's PEM fuel cell solution can operate for 9,000 hours without the need to purify the reformed hydrogen

- There are two types of propulsion system for submarines: **nuclear propulsion** for large, long-range vessels, and **conventional propulsion** for smaller craft such as the S80. The latter uses electric motors powered by batteries that are recharged by diesel engines.

- The **submarine S80** is used for surveillance and intelligence gathering, and its **key feature is its silence**. However, when the submarine emerges to start the diesel engines, it exposes itself to detection. This is why **Air Independent Propulsion (AIP) systems play a key role in providing greater autonomy and submerged time**.

- These systems have been developed since 1860, although **challenges related to noise, efficiency and low power persist**. After 20 years of work, **Navantia Seanergies has developed a Spanish AIP system based on PEM fuel cell**. This system is highly efficient and produces minimal noise, and the challenges of fuel storage and safety on board have been overcome by using reformed bioethanol to produce the hydrogen for the cell.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