



Preparing for revolution

by Robert Haugen, *Managing Director, Hexagon Purus Maritime*

The global shipping industry, responsible for approximately 3% of total greenhouse gas (GHG) emissions, faces a crucial turning point. Clean fuels must be adopted at scale to achieve the International Maritime Organization's net-zero GHG target by the middle of the century. To that end, zero or near-zero GHG emission technologies, fuels and/or energy sources must represent at least 5% (striving for 10%) of the energy used by international shipping by 2030.

Various clean fuels – including ammonia, methanol, bio- and synthetic fuels, hydrogen, and battery electric technology – present viable options, each with unique advantages and challenges. High-energy clean fuels (such as ammonia, methanol, or synthetic) are essential for long-distance shipping. Challenges persist, with toxicity, handling and storage issues for ammonia, and availability and infrastructure for other options.

Battery electric technology is suitable for short-sea shipping and waterway operations, where vessels (e.g., ferries, inland or coastal cargo, supply and service, fish farming) have predictable routes and frequent access to charging infrastructure (including the night recharging option). Due to their low energy density, batteries are unsuitable for long-range voyages: one would need a battery pack the size of a 20-foot container to carry a megawatt-hour in energy storage.

Then again, the same container full of compressed hydrogen would produce 7.5MWh. Hydrogen as a fuel offers exciting decarbonization potential for the maritime segment in the long term because the storage volume is so significant. The addressable market for compressed hydrogen on board vessels is expected to approach around €430m by 2030 (a March 2021 study by the Global Maritime Forum highlighted hydrogen's prominence, with nearly half of initiatives aimed at achieving zero emissions in global maritime shipping focusing on hydrogen as a low-carbon fuel source). The sweet spot for hydrogen is where batteries alone aren't suitable.

Hydrogen fuel cells present a clean and efficient alternative to traditional diesel

engines. The first hydrogen-fuelled ferry, *Hydra*, operating in Norway, showcases the viability of hydrogen in maritime transport, emphasizing the importance of public and private collaboration.

How the magic happens

Hydrogen fuel cells generate electricity through an electrochemical reaction between hydrogen and oxygen. The electricity produced can then power the vessel's propulsion system, lights, and other electrical components.

A few key elements are needed to incorporate hydrogen fuel cells on a ship. Firstly, a storage system, typically high-pressure tanks or cryogenic storage. Secondly, a fuel cell stack – which is where the magic happens! – that contains multiple individual fuel cells that convert the stored hydrogen into electricity. Finally, to ensure a smooth operation, a power management system is needed to regulate the flow of electricity between the fuel cells and the vessel electrical systems, optimizing energy usage and ensuring a steady power supply.

Hydrogen fuel cells produce electricity with only water and heat as byproducts. Every kilogram of hydrogen fuel produces about nine kilograms of water at 50-60°C. This warm water can be utilized, e.g., on a passenger ship as a heat-up in the ventilation system, increasing the overall efficiency of the setup.

Educating for the future

Ship designs are evolving to incorporate hydrogen storage tanks and fuel cell systems to facilitate the integration of hydrogen as a marine fuel. Material compatibility, safety

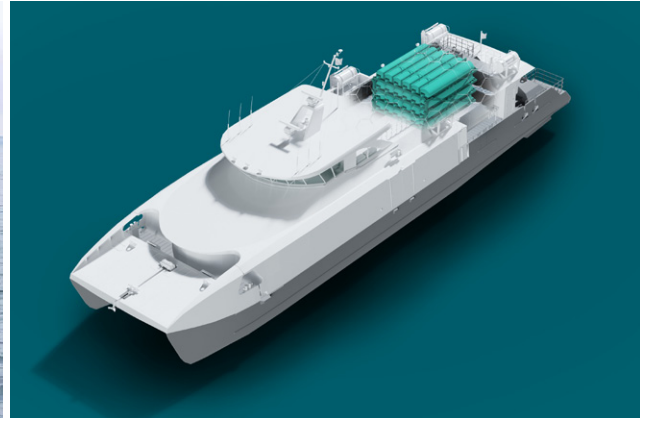
measures, and adaptations to meet safety and operational requirements are pivotal for making hydrogen a viable and efficient fuel source in the maritime industry. Also, overcoming barriers to widespread adoption necessitates international regulatory standards, maritime safety codes, financial incentives, standardized technologies, and training programs for the next generation of mariners.

Hexagon Purus Maritime is playing its part here, with an order for a hydrogen fuel storage system incorporating type 4 hydrogen cylinders to Hvide Sande Shipyards in Denmark. Hexagon Purus Maritime's hydrogen fuel storage system will be used on board *Skulebas*, a training ship owned by Vestland County in Norway and operated by a technical college in Maaløy to educate the country's future seafarers.

While some shipowners express concerns about retrofitting to hydrogen, the process can be relatively straightforward during major inspections, occurring every five years. Even partial adoption of zero-emission modes, making it possible, e.g., to turn off auxiliary engines in port waters, aligns with evolving seaport emission targets and noise pollution concerns.

Hydrogen goes north

Collaborative efforts among governments, industry stakeholders, and regulatory bodies are essential to create a supportive framework for hydrogen integration. Despite challenges, positive developments are emerging, with national strategies from countries like France, Germany, and Norway outlining the use of hydrogen for maritime mobility. EU initiatives, such as REpowerEU and the Alternative



Photos: Hexagon Purus Maritime



Fuel Infrastructure Regulation, coupled with substantial investments in the hydrogen sector, underscore the commitment to a cleaner maritime future.

Norway, where Hexagon Purus Maritime is headquartered, is supporting several new green hydrogen projects for maritime use, such as the **Hellesylt Hydrogen Hub** project in Geirangerfjord (a UNESCO World Heritage fjord with a zero-emission requirement from 2026). In Norway, there are many ships sailing predefined cargo routes continually up the country's coast, such as boats transporting consumables for aquaculture or vessels serving oil & gas platforms. These are the ideal test cast for hydrogen as a marine fuel.

As such, Hexagon Purus Maritime will deliver a hydrogen fuel storage system with type 4 hydrogen cylinders to Moen Marin, the world's largest supplier of working boats to the aquaculture industry. The system will be used for fuel storage aboard a zero-emission working ship in Norway. Already a development partner in Moen Marin's Pilot-E zero-emission work boat program, Hexagon Purus Maritime will continue working on the development and testing, with final system delivery scheduled for 2024.

The Netherlands is also establishing several hydrogen-fuelled inland shipping projects. **Condor H2** brings more than 40 partners together to enable emission-free inland and near-shore shipping using an innovative system of hydrogen 'tanktainers.' The project is part of RH2INE (short for Rhine Hydrogen Integration Network of Excellence), a cooperation between ports, regional governments, and other players active across the Rhine corridor.

BalticSeaH2, another project worthy of spotlighting, intends to create the largest cross-border hydrogen valley in Europe, focusing in the first place on connecting Finland and Estonia to foster energy self-sufficiency and minimize industrial carbon emissions. Results from the so-called main valley will be replicated in other project regions (the consortium counts 40 partners from the Baltic Sea).

Hexagon Purus, at the forefront of this evolving ecosystem, emphasizes a holistic

approach to zero-emission maritime solutions. The company's early involvement in initiatives and commitment to showcasing hydrogen's potential, position it as a key player in the anticipated growth of the hydrogen maritime sector post-2030.

The promise

As the shipping sector prepares to utilize hydrogen as a fuel and ports, together with bunkering companies, prepare to cater to that demand, supply becomes crucial. Hexagon Purus, aligning its maritime and distribution businesses, plays a vital role in providing comprehensive solutions, including onboard fuel storage systems and distribution modules for quick fuelling.

With a collaborative effort, evolving technologies, and strategic initiatives, a hydrogen revolution can be realized, promising a cleaner, greener, and more efficient future for maritime transport. □



Hexagon Purus is at the forefront of developing innovative hydrogen storage solutions with lightweight composite tanks that are ideal for maritime applications. With our systems solutions for distribution and onboard hydrogen fuel systems, we can together with partners cover major parts of the maritime hydrogen value chain. Go to hexagonpurus.com/markets/maritime to learn more.