Here & now

by Thomas Therkild Petersen, ***Product Line Manager Marine, Ballard Power Systems Europe***

Hydrogen fuel cells are successfully powering thousands of commercial vehicles on roads around the world. Fuel cells are also being integrated into marine vessels building on their success in the heavy-duty transport sector. Why? Because fuel cells are plug-and-play zero-emission replacements for internal combustion engines. They are an essential technology that will help the marine industry address its greenhouse gas emissions (GHG-E) on the water and in ports.

For shipowners and operators globally, zero-emission mandates and regulations are a fast-approaching reality in an industry which currently accounts for 3% of the world's GHG-E. However, with a worldwide commercial fleet of 90k+ ships, 'going green' is not easy.

The pace of decarbonisation has largely depended on new and emerging technologies, often involving long development time, proof of concept, and pilot testing. This is where Ballard's FCwave™ fuel cell module is breaking new ground, type-approved by DNV earlier this year as the first implementation-ready solution for next-gen zero-emission vessels. This type approval represents a breakthrough in commercialising fuel cell modules for ships and a significant industry recognition certifying that FCwave™ meets the stringent safety, functional, design, and documentation requirements necessary for decarbonising the marine industry.

Modular & scalable

Hydrogen fuel cells are compatible with modern electric and hybrid architectures – and they generate the electricity that powers the vessel. Like batteries, they produce electricity, but hydrogen fuel is the energy carrier with fuel cells – meaning the power system will produce electricity for the ship for as long as hydrogen is available. FCwave™ is a high-power, adaptable power generator in a hybrid electric system that incorporates fuel cells and batteries working seamlessly together to deliver efficient, zero-emission power.

The modular & scalable design of fuel cells (200kW/module) facilitates easy and adjustable deployment, which integrators can configure for specific vessel requirements. They provide long-range operations with consistent power delivery throughout the duty cycle. Refuelling is fast, and fuel cells are proven reliable in many critical heavy-duty applications, with long service life and few maintenance intervals.

Hydrogen is a safe and flexible energy storage solution, highly suitable for marine vessels. Like onboard modules, the refuelling infrastructure is scalable and can easily grow along with the fleet as hydrogen consumption increases. Additionally, large-scale projects focused on producing hydrogen from renewables are emerging worldwide. When a ship is fuelled with renewable hydrogen, it becomes a true well-to-wake zero-emission vessel, as the only 'emissions' released are water vapour and heat.

New & existing

The first fuel cells are already beginning to prove their value at sea and in ports, currently powering many smaller vessels and handling equipment. In November 2022, two 200kW FCwave™ fuel cell modules were successfully installed on Norled's *Hydra*. With the first sea trials beginning in December 2022, *Hydra* will start using liquid hydrogen and proton exchange membrane (PEM) fuel cells as the world's first ferry.

Taking the leap into commercial passenger operations with one of Norway's largest ferry operators, we can showcase how zero-emission operations can be made possible here & now. The technology is further being harnessed for use in larger ships, and in 2023 several other vessels will embark on their maiden voyages powered by zero-emission fuel cells.

The fuel cell technology also represents a future-proof solution for retrofitting vessels, allowing shipowners to extend the lifetime of their fleet, reduce fuel consumption, and adhere to new and adaptive regulations set forth by the International Maritime Organization and the EU.

As a case in point, Future Proof Shipping's *FPS Waal* will be retrofitted with six FCwave™ modules, giving the inland waterways container vessel a fuel cell capacity of 1.2MW. The vessel's internal combustion engine will be removed, while a new zero-emission propulsion system (including PEM fuel cells from Ballard,

FCwave™ installation on board *Hydra*; photos: Ballard Power Systems

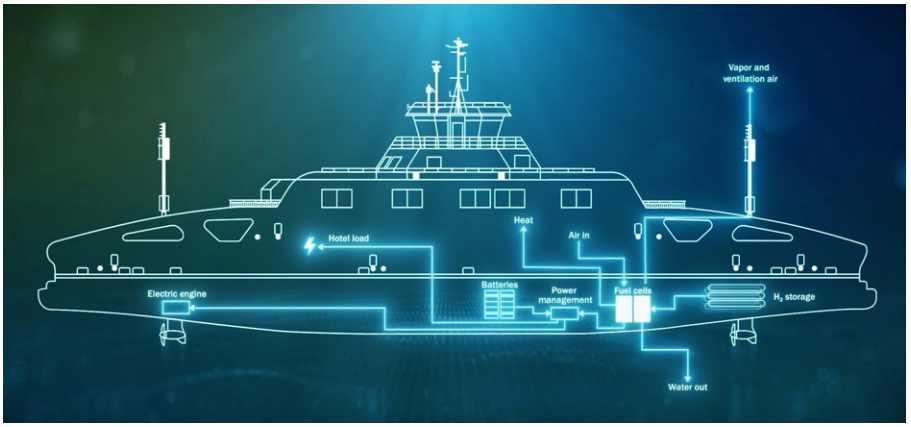

Photo: Norled

Photo: Future Proof Shipping

hydrogen storage, battery packs, and an electric drive train) will be installed to sail 100% green. Up & running again, *FPS Waal* will sail on the 240 km-long stretch between Duisburg and Rotterdam.

Positive catalyst

The marine industry is undergoing significant changes, and we can expect more regulations to be implemented in an effort to reduce GHG-E. Undoubtedly, the time is now to shift to zero-emission technologies.

FCwave™, as the first commercially available solution – designed for and together with the marine industry – is a significant step in accelerating the adoption of hydrogen power for vessels of various sizes, serving short- and long-haul routes, providing shipowners and operators confidence in fuel cells as a viable, zero-emission technology.

The solution offers ease of integration, shorter implementation time, and a reduction in overall cost through proven technology. Thus, ship operators now have access to a deployment-ready alternative that can pave the way for volume applications, including fleets. Also, the system uses proven components from Ballard's four decades of experience with heavy-duty applications, delivering reliable performance, high-power density, and flexible onboard integration.

For operators transitioning to zero-emission propulsion systems for marine applications, hydrogen and fuel cell solutions are now certified to offer the most promising route to meeting future emission requirements. Modular & scalable hydrogen fuel cells have what it takes to be a catalyst in accelerating net-zero technology to meet the ambitious global targets of halving shipping emissions by mid-century. □