Stena Line has a project to build an electric ferry to operate on its Gothenburg-Frederikshavn route

DECARBONIZATION FACES TECHNICAL AND FINANCIAL CHALLENGES

The cruise industry's efforts to decarbonize are taking various forms, with new fuels and technologies to reduce emissions being developed while existing ones are being used as well. The challenges are considerable, but progress is being made.

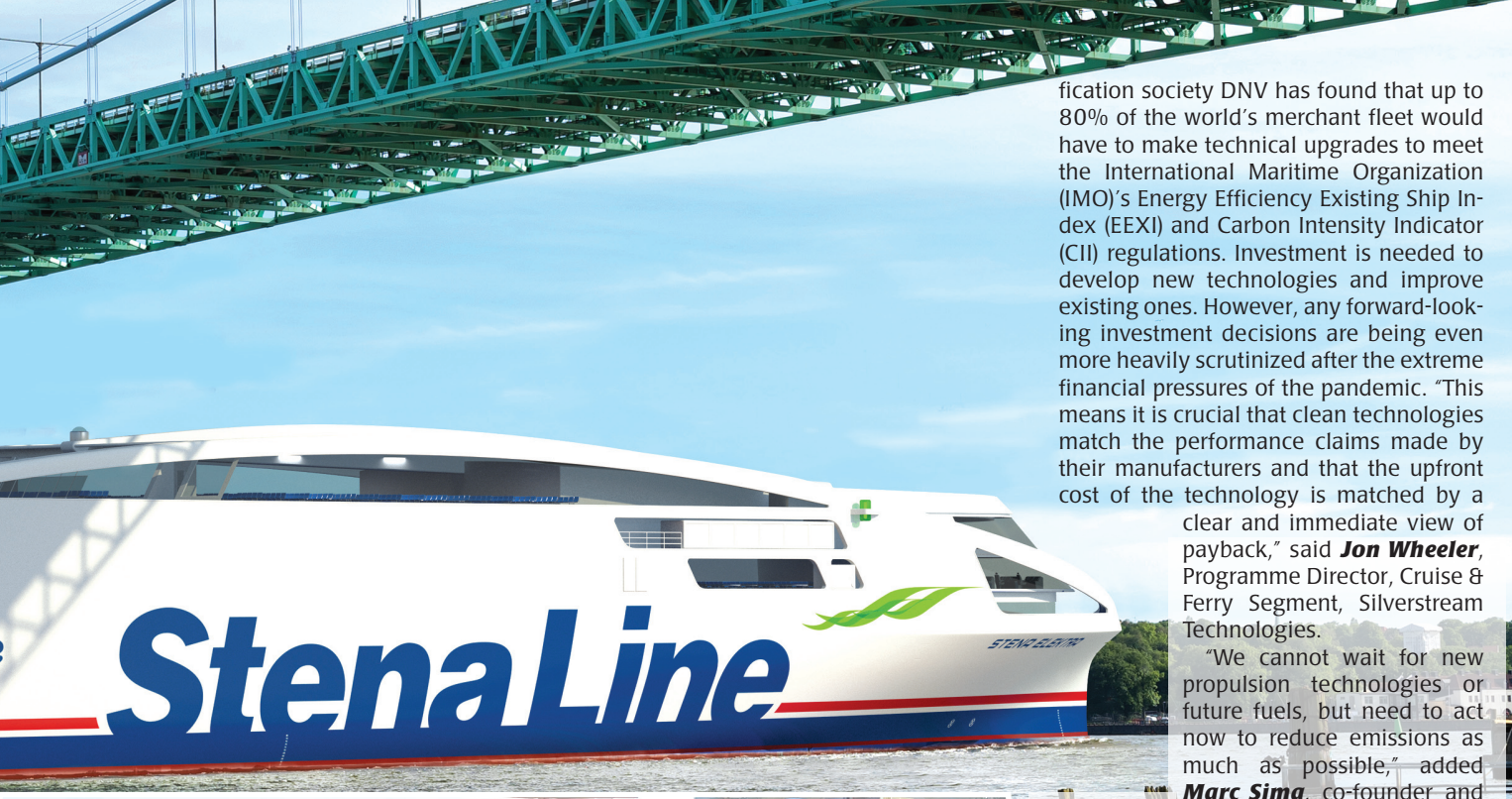
By Kari Reinikainen

In the groundbreaking announcement, Viking's Chairman ***Torstein Hagen*** announced, that the company's 11th ocean-going new building will have a hybrid propulsion based on liquid hydrogen and fuel cells. "We will be able to operate at zero-emissions in the Norwegian fjords," Hagen underlined. He has been also a vocal opponent of the LNG due to its methane emissions. Methane is considered more harmful than CO2. The new build is based on Viking Star platform, but will be 11 meters longer and fitted with pod propulsion.

As the industry strives toward a greener future, that drive is having an effect on ship design, especially as it applies to the optimal size of new vessels. Silversea Cruises, for instance, has decided to increase the size of its Project Evolution class of ships to 54,700 gross tons from the 40,700 gross tons of the Muse class, as the new ships will be hybrids that can use liquefied natural gas (LNG) in order to reduce emissions. However, the decision to go hybrid with dual-fuel engines that can use both oil and LNG has significantly affected the design and encouraged the company to opt for a larger platform, said ***Roberto Martinoli***, President and CEO of Silversea Cruises.

"I think that is more or less the smallest size where LNG makes sense. Smaller than that is going to be real challenging also because you need to have a dual-fuel vessel for sure," Martinoli told CruiseBusiness.com Magazine. "Ships of Silversea Cruises operate all over the world, and they make long ocean crossings as well, which means that they must have a long range. This again has two consequences: firstly, LNG is not available in everywhere that the company might need it. Secondly, LNG tanks take up more space than oil tanks, whereby a ship must have a certain size to make it economical." With a dual-fuel engine installation, the new ships that will be led by Silver Nova next year will have more or less the same range as the company's other vessels. Bunkering both oil and LNG simultaneously is not a viable option because one has to take into account the draft of the ship, he continued. Hydrogen is an option that also has been promoted for use as fuel onboard ships. It would completely eliminate CO2 emissions, but, according to Martinoli, it has other challenges. "The problem with hydrogen is that handling it onboard is going to be difficult," he pointed out. "So there are no rules that would allow you to use hydrogen except the way we do it, which is convert it from methane or LNG and supply your fuel cell." (For more on hydrogen as an alternative fuel, see below.)

Looking ahead, Martinoli said that the search for an optimal alternative fuel should be an area where cruise lines compete, but they should also cooperate to find the quickest, easiest and most affordable solution for everyone. The Royal Caribbean Group, of which Silversea Cruises is a part, is involved in its own research on fuel-cell technology, and Martinoli said the company will allow others access to the results of this work. The industry will



Captain Francois Bertin on the bridge of river cruise ship Viking Radgrid, which is fitted with battery packs

need to invest large amounts of money in this field, and, for that reason, an open-access approach should help the industry to channel investment into the best possible technology available, he concluded.

Meanwhile, on the rivers Viking recently introduced battery packs on its new Longships, which will also affect the technical configuration of the new generation. The previous ships have two large Caterpillar C32 and two smaller C128 diesel generators. However, the new ship will only have three generators and only one C32 and one C18 will be needed online while at river, according to the Captain ***Francois Bertin*** of the Viking Radgrid. Shore power will be used in various ports, which allows all the generators to be switched off. The battery packs will also supply power to the electric propulsion motors when high loads are required, he said.

New zero-emission fuels may not be available in the immediate future. For this reason, the cruise industry as part of the wider shipping sphere needs to look at ways to reduce emissions by using technologies aimed at doing this, but with fuels that are available today, said ***Mark Flips***, Head of Marine Applications at the German clean-tech company Orcan. Investment in technology always raises the question of payback time, and in the case of Orcan's systems, Flips told CBM that the targeted internal rate of return is up to 20% or a payback time from two to four years in the case of a retrofit. However, a newbuilding should start producing a positive cash flow from the date the ship enters service, he pointed out. For example, Orcan's system has been fitted on two Dutch domestic ferries to recover waste heat, and it saves 318 tons of CO2, 260,000 liters of fuel and 462,600 kilowatt-hours of electricity per vessel per year.

Investment needed but crutinized

To achieve the goals that forthcoming environmental legislation stipulates, a lot of work has to be done on a broad scale. Research by the Norwegian classification society DNV has found that up to 80% of the world's merchant fleet would have to make technical upgrades to meet the International Maritime Organization (IMO)'s Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) regulations. Investment is needed to develop new technologies and improve existing ones. However, any forward-looking investment decisions are being even more heavily scrutinized after the extreme financial pressures of the pandemic. "This means it is crucial that clean technologies match the performance claims made by their manufacturers and that the upfront cost of the technology is matched by a clear and immediate view of payback," said ***Jon Wheeler***, Programme Director, Cruise & Ferry Segment, Silverstream Technologies.

"We cannot wait for new propulsion technologies or future fuels, but need to act now to reduce emissions as much as possible," added ***Marc Sima***, co-founder and CEO of Fuel Save GmbH in Germany. The company, founded in 2012, started business by focusing on how to reduce emissions from trucks and utility vehicles, but quickly expanded its scope to include the maritime sector. Its FS Marine system uses an intelligently controlled hydrogen syngas generator and injector, which combines proprietary gas injection with other processes to enhance the efficiency of diesel engines. The system reduces fuel consumption between 10% and 15%, cuts CO2 emissions by about the same amount, filter smoke number (FSN) by 40% and NOx by between 30% and 80%, the company says. Engine wear and tear will also be reduced by the use of the system, which cuts maintenance and repair costs.

A payback time between three and five years is the target for Climeon, a provider of energy-efficiency technology headquartered in Stockholm, Sweden. Running hours, available waste heat, fuel type, whether the ship in question is a newbuilding or retrofit and generator type all affect the payback time, said ***Fredrik Thoren***, Head of Maritime at Climeon. Its waste-heat recovery technology, the Climeon Heat Power System, uses principals of an Organic Rankine Cycle (ORC), but at much lower pressure levels. "The patented low-pressure technology allows for optimal efficiency from low-temperature heat sources such as jacket cooling water. Exploiting the temperature difference between the hot and cold water sources, Climeon's Heat Power System produces usable electric power for the ship's electrical demand, reducing the load on the ship's generators." A control system automatically and continuously ensures that the power output is maximized or optimized, based on site preferences. "The system's compact and modular design, highest efficiency conversion of low-grade waste heat within the ORC

Chantiers de l'Atlantique has launched SilenSeas project

ability to utilize sea water as the cooling source, allows for simple integration with the vessel's existing systems and makes it highly suitable for marine applications," he said.

As a proven technology since 2015, the Climeon Heat Power System has received approval from major certification companies and helped ship owners like the Finnish cruise ferry company Viking Line and Virgin Voyages, the new cruise shipping unit in ***Sir Richard Branson's*** business empire, to increase their energy efficiency, saving fuel costs and reducing impact on the environment. "We have had a pilot installation Climeon Ocean 100 installed on Viking Grace. This was the first generation of Ocean system with a nominal power output of 100 kW [maximum 120 kW]. This installation was a part of an EU project, so the cost of equipment and installation was partly paid by the EU," recalled ***Kari Shao***, Project Manager at Viking Line.

Wind power and bubbles to reduce friction

Norsepower, the Finnish company that offers rotor sails as an option for shipowners to reduce emissions, is constantly developing and making incremental design adaptations to the rotor sail to maximize efficiencies and versatility, said ***Tuomas Riski***, CEO of the company. "In the past, Norsepower has added a range of sizes to the rotor sail portfolio, offering five different model sizes to ensure the optimal dimensions for different vessel types and applications. This ensures we are meeting different vessel requirements and maximizing its capabilities. In addition, the tilting rotor sail design has already opened up opportunities for vessels navigating height-restricted routes. It means that the sail can be lowered almost horizontally when necessary during their voyage. This illustrates how Norsepower's flexibility and consultative approach can develop innovative adaptations to meet particular vessel requirements," Riski said.

Meanwhile, another development in the sail sector took a step forward in the winter when the French classification society Bureau Veritas granted Approval in Principle (AiP) for solid-sail technology developed by its compatriot shipbuilder Chantiers de l' Atlantique. Solid sail is a 1,200-square-meter rigid sail made of composite panels assembled together, which was developed specifically for large vessels. The system overcomes the usual size limitations of standard fabric sails. Moreover, the rigidity of the sail panels induces less flapping and therefore increases the estimated life compared to a soft sail, the two companies said in a joint statement.

Creating bubbles by pumping compressed air though small holes in the underwater part of the hull of a ship is another way to cut emissions, as this reduces the friction of the hull as it moves through the water. This is what Silverstream Technologies in the UK offers, and their product has been installed onboard a number of cruise ships. The Silverstream System works by reducing the frictional resistance of a ship's hull through the water using a series of air-release units in the flat bottom of a vessel, which generate a uniform carpet of microbubbles that travel the full length of the hull. The microbubble carpet cuts fuel consumption and associated emissions by 5% to 10% net – depending on the vessel's characteristics – and reduces hull fouling, the dampening of onboard noise and vibrations, and the suppression of a vessel's underwater radiated noise signature.

From the beginning of its conception over a decade ago, Silverstream has recognized the effectiveness of its technology in supporting the decarbonization of the cruise sector, with two of its first installations with Princess Cruises and Norwegian Cruise Line. "To this day, we continue to work closely with some of the key players in the cruise space," said Silverstream's Programme Director Jon Wheeler. "A Silverstream air-lubrication system is being installed on Carnival Corporation & plc's LNG-fueled Excel-class cruise vessel currently under construction at Meyer Werft shipyard. The system is expected to reduce fuel consumption and emissions by 5% when the vessel debuts in 2023."

Meyer Werft is also installing a Silverstream system on P&O Cruises' Arvia, another Excel-class vessel currently under construction. Both orders follow the 2017 installation of Silverstream's technology on Princess Cruises' Diamond Princess, which has achieved over 5% net fuel and emissions savings. Silverstream also retrofitted a system on the Sapphire Princess during a scheduled dry-docking at Sembcorp Marine Admiralty Yard in Singapore, a successful project despite the ongoing challenges of the pandemic. "Today, Silverstream is creating an operational and commercial blueprint for installing air-lubrication technology in the cruise market by carefully considering its unique demands, challenges and consumer-facing nature. This blueprint alleviates operational pressures for cruise lines by putting in place bespoke project teams and creating unique supply-chain arrangements that suit the segment, ultimately helping it to meet its decarbonization objectives," Wheeler concluded.

Fuel-cell technology moves forward

On the fuel-cell front, Ballard Power Systems based in Canada has announced with ABB – a leading global technology company – that they have received a groundbreaking Approval in Principle from DNV for a jointly developed fuel-cell concept capable of generating 3 megawatts, or 4,000 HP, of electrical power. "The AiP represents an important milestone in developing new technology, as independent assessment of the concept confirms feasibility of the design and no significant obstacles exist to prevent the concept from being realized. With the AiP in place, the jointly developed solution can be initiated with confidence that it is eligible to receive final approval for application onboard a wide range of vessels," the two companies said in a joint statement. Ballard Power Systems is already working with the Danish ferry company DFDS to build a large hydrogen/fuel-cell-powered ropax ferry for the company's overnight service between Copenhagen and Oslo.

A consortium of companies including Wärtsilä, ABB, RINA, Hellion, the Liberian Registry and an unnamed energy major aim to develop a scalable solution with hydrogen as fuel that would exceed the IMO 2050 target to cut emissions by 70% in carbon intensity without the need to invest large amounts of money in infrastructure. At the moment, difficulties and costs related to production, distribution and onboard storage have limited the shipping industry's interest in hydrogen. "However, by producing hydrogen onboard and using readily available LNG, the solution becomes far more viable and in a much faster time than would otherwise be possible," the companies said in a statement.

Another consortium of shipping stakeholders is aiming to develop demonstrators for two-stroke and four-stroke marine engines running on ammonia fuel. The

project is coordinated by Wärtsilä, with participation from naval architects C-Job, classification society DNV, shipowner MSC and the National Research Council (CNR) of Italy. It has secured funding of €10 million from the European Union through the Horizon Europe research funding initiative. "Ammonia is one of main candidates in shipping's search for future fuels," said ***Sebastian Bleuanus***, General Manager, Research Coordination & Funding, Wärtsilä Marine Power, in a statement. "Wärtsilä has already proven an engine concept running on blends of up to 70% ammonia so far and will have a concept running on pure ammonia by 2023. This project is a fantastic opportunity to accelerate development of the solutions shipping will need."

The aims of the project will include a lab-based demonstrator for the four-stroke ammonia engine and a lab-based test engine followed by a vessel retrofit for the two-stroke version by 2025. The project will further develop concepts around fuel handling and safety as well as contributing inputs towards a regulatory framework for ammonia. ***Niels de Vries***, Lead Naval Architect at C-Job Naval Architects, said, "Thanks to the project set-up, we'll be able to show the application of ammonia as a marine fuel for both ships using fuel-direct configurations and ships using fuel-electric configurations. We're excited to take this next step and apply our knowledge and experience in Ammonia 2-4 together with our partners."

Last but not least among the many developments towards zero-emission cruising, the Brodosplit shipyard in Croatia has started the construction of a 63.5-meter-long and 10-meter-wide, three-masted schooner with the hull and superstructure built of steel and the masts of aluminum alloy. "When not under sail, the ship will be powered by two 150 kW electric motors, each fed by a system of batteries continuously charged from different sources," the shipyard said. When it reaches a speed of 6 knots, it will require only 60 kilowatts of power, which is fairly unobtrusive for a 500 gross ton vessel. It will be equipped with 30 tons of batteries with a maximum capacity of 2300 kWh, but due to legal requirements, it will also have two diesel generators that will be turned on only when needed or in emergencies. ■