

Maritime Summary Note n°217 - February 2020

« Environment : Innovative Solutions for the ships of tomorrow »

This Summary Note follows the one published in January entitled "Global Sulphur Cap 2020: Current Status." Alongside the so-called "conventional" solutions to meet the IMO 2020 regulations, maritime operators are also studying other, more innovative solutions. Their objectives are to address the energy transition in maritime activities and to anticipate future regulations.

As a reminder, the IMO's objectives aim to reduce the total volume of annual GHG emissions by at least 50% by 2050 compared to 2008. They also aim to reduce the carbon intensity of vessels by at least 40% by 2030 compared to 2008, while pursuing efforts to reach 70% by 2050. As the quest for zero-carbon and/or carbon-neutral transport progresses, solutions that are still in their infancy are emerging, such as biofuels, methanol, ammonia, hydrogen, and electricity, provided they are produced from sustainable and/or acceptable resources. The structural network and global availability of these new fuels and propulsion methods—both on liner services and in tramp shipping—remain, for the most part, yet to be built. The competitiveness of these sectors is currently following its industrial learning curve. Their growth is closely linked to incentive-based public policies that enable industry players to invest. Time will tell which of these new fuels will serve as transition fuels and which will fully substitute fossil fuels.

Innovative solutions for tomorrow

As part of the GoodShipping program, CMA CGM and Ikea Transport & Logistics Services are committed to an innovative approach aimed at testing a new marine biofuel. Developed by the Dutch company GoodFuels, this second-generation biofuel is made from forest residue derivatives and waste oils (recycled cooking oils). GoodFuels announced the commissioning in 2025 of a new refinery in Rotterdam capable of supplying 300,000 tonnes per year. The goal is to move into the industrialization phase and thereby lower the price of this new fuel. CMA CGM has also reportedly entered into an agreement with Shell to be supplied with a blend of biofuels, 20% of which are derived from used cooking oil. Maersk will also test these biofuels on one of its Triple-E vessels. The oil company ExxonMobil is looking into a so-called third-generation biofuel¹ made from algae, which would yield a much higher output than that from palm oil, soybean, or corn for the same production surface area. Another advantage is that algae do not compete with food uses (meaning no diversion of arable land and no recourse to deforestation), which could otherwise disrupt global commodity prices and lead to humanitarian crises.

In a December 2019 report, the SSI (Sustainable Shipping Initiative) estimated, through its survey of various port operators, that biofuels could cover between 10% and 30% of the energy needs of maritime transport², but they seem to be only a short-term solution in the marine transport energy mix. Compared to the fossil fuels currently used in shipping, biofuels—when managed in a socially, economically, and environmentally responsible manner—reduce GHG emissions by 80% to 90% and emit no sulfur oxides. Apart from a few minor adjustments, no major modification to the vessel is required. However, shipowners still need to be convinced, as they remember that first-generation biodiesels caused engine malfunctions, thereby jeopardizing maritime safety.

¹ The first generation was reserved for cars, the second is derived from agricultural and forestry residues, and finally, the third generation uses algae and bacteria. The environmental assessment of a biofuel must take into account every stage of production, from cultivation to manufacturing, and finally to end-use

² The Role of Sustainable Biofuels in the Decarbonisation of Shipping The findings of an inquiry into the Sustainability and Availability of Biofuels for Shipping Report prepared by the Sustainable Shipping Initiative (SSI), December 11th 2019.

Methanol represents a 99% reduction in sulfur emissions, a 60% reduction in NO_x emissions, a 25% reduction in CO₂, and a 95% reduction in fine particulate matter emissions compared to HFO. The use of methanol in the maritime industry is currently limited, and its cost remains high at around \$400/tonne. Only the Swedish company Stena's vessel, the Ro-Pax Stena Germanica, uses a methanol primarily derived from natural gas. It can also be extracted from renewable raw materials such as domestic or industrial waste (paper pulp) or even biomass (forestry residues). This is known as bio-methanol. Stena's vessel orders are "gas ready," meaning they are compatible with both LNG and methanol. Regulations for methanol and low-flashpoint diesel fuels are currently being drafted at the IMO. Methanol storage should be available in most ports due to its widespread use in industry, but there are very few bunkering locations worldwide. The use of methanol is well-suited for short-sea shipping, offshore vessels, ferries, and passenger segments.

Others are venturing into ammonia-based fuel (NH₃). When burned, ammonia does not emit CO₂ or sulfur oxides, but it does emit nitrogen oxides and is known for its instability and toxicity. While its production requires fossil fuels, it can also be produced through electrolysis driven by renewable energy. The Norwegian company Equinor has signed an agreement with the shipowner Eidesvik Offshore to test an NH₃-based fuel on board the supply vessel *Viking Energy*. This ship is already powered by LNG and features a hybrid propulsion system with batteries. Equinor has set a five-year timeline to overcome these challenges and plans to test an ammonia power supply covering 60% to 70% of the vessel's energy needs via a 2 MW fuel cell, starting in 2024.

Hydrogen (H₂) accounts for only 55 Mt/year, mainly supplying the chemical and petroleum industries, and very few liquefaction facilities currently exist. The EU has approximately 250 ongoing or planned hydrogen-related projects, 20 of which concern the maritime sector. Compressed hydrogen-powered ferry projects are underway in California, Scotland, and Norway. Container handling equipment is also powered by hydrogen today in the ports of Valencia and Los Angeles. In France, the river shuttle *Jules Verne 2* in Nantes and the *Energy Observer*, a high-tech experimental catamaran, utilize it. Hydrogen is three times more energy-dense than oil and would serve both as fuel for ship propulsion and to generate electricity through a hydrogen fuel cell. It is not found alone in a natural state; it is always combined with other molecules, the most common being water (H₂O). For the time being, hydrogen cannot meet all maritime requirements, particularly those of high-powered or transoceanic vessels. It is predominantly obtained through the steam reforming of hydrocarbons (extracting natural gas under the action of superheated steam). This hydrogen gas then powers a fuel cell. However, this technique releases a massive amount of CO₂. For every tonne of H₂ produced, 10 to 11 tonnes of CO₂ are generated and, in general, emitted into the atmosphere. Currently, this is the most economical process for producing industrial hydrogen. Nevertheless, its cost per kilogram remains triple that of natural gas. To bring down costs, projects of several tens of MW would be required right from the initial phase. This technique is doomed in the more or less short term because it emits too much CO₂ into the atmosphere. Yet, other carbon-free hydrogen production techniques exist via alkaline electrolysis. The fact remains that production costs are still prohibitive today (three times those of steam reforming) and depend on low-carbon electricity. Another drawback is hydrogen storage. It must be liquefied at atmospheric pressure and at an extremely low temperature (-253°C), which represents a significant energy cost. Another solution consists of compressing hydrogen at very high pressure (700 bar), while managing the risks of leaks, corrosion, and explosion. This will also require very large tanks, thereby excluding small vessels. Green hydrogen production projects using water electrolysis driven by renewable energy are under study. Toyota is currently setting up a renewable energy power plant at the Port of Long Beach, California. Scheduled to open in 2020, it will be able to generate 2.35 MW of electricity and 1.2 tonnes of hydrogen per day. The plant will thus be able to fuel vehicles transiting through the port. Toyota has also built a hydrogen station on-site. The oil group BP, Nouryon (a chemical company), and the Port of Rotterdam wish to convert the refinery, which currently uses hydrocarbon-derived hydrogen, to green hydrogen, which could reduce CO₂ emissions by 350,000 tonnes per year. The agreement provides for a 250 MW water electrolysis facility capable of producing up to 45,000 tonnes of green hydrogen per year. This would be the largest facility of its kind in Europe. For a widespread adoption of green hydrogen as a means of marine propulsion, a network of refueling stations as well as new storage methods would need to be created.

As for electric propulsion, whose major advantage is emitting zero GHG emissions, ferry companies often favor it with hybrid propulsion systems (diesel, LNG, biodiesel/electric). This is particularly true in Norway with coastal ferries. An all-electric propulsion system is well-suited for cross-fjord crossings

lasting 10 to 30 minutes. According to the Norwegian Centres of Expertise, 74 electric vessels are expected to be operational along the Norwegian coast by 2021. The Grimaldi Group recently inaugurated the retrofitted ferry *Cruise Roma*, which operates on lithium batteries and solar panels during port calls—at a cost of €40 million nonetheless. Grimaldi aims to equip a dozen Ro-Ro vessels by 2022. Maersk has also embarked on the electrification of its fleet and terminals to achieve fuel savings. It is worth noting that the rise of electric propulsion in road transport will create a leverage effect in the maritime sector. However, care must be taken with false good ideas: the impact of carbon emissions must not simply be shifted upstream. To be coherent, operators' choices must turn toward renewable energy sources. And what could be better than using the inexhaustible power of the wind to sail a ship?

Wind propulsion, which encompasses a wide array of technologies (both auxiliary and primary propulsion), is increasingly being studied by shipowners such as Louis Dreyfus Armateurs, Maersk, CMA CGM, MOL, or Viking Line, as well as by shippers including Airbus, Renault, Shell, and Cargill. Innovative projects relating to the ecological ship of the future are blooming all over the world, with a dominant European presence. A wide variety of technologies exists. Fuel savings fluctuate between 5% and 30% for auxiliary propulsion, whereas for primary propulsion, this saving can reach nearly 90%. The solution is technologically mature; it remains to convince the market. Through their energy policies, States must encourage clean energy by supporting project leaders. The decade that is beginning must give credibility to these alternative technologies and ensure they are scaled to the needs of maritime stakeholders. In the first instance, the solution lies in an energy mix combining green and fossil energies.

What funding mechanisms?

This ecological transition of maritime transport must be accompanied by deterrent measures regarding the use of fossil fuels, through the application of the "polluter-pays" principle (via stricter regulations and taxation). Today, global maritime transport benefits from a tax exemption on marine fuel. Yet, if applied internationally, carbon pricing could be an effective instrument to incentivize investment in new technologies. According to the NGO European Federation for Transport and Environment, this tax exemption on marine fuels sold to ships within the EU territory results in a €24 billion shortfall³. Abolishing this tax exemption cannot be achieved without the unanimity of Member States. Each State would then be free to tax marine fuels or not. Competitive distortions could subsequently arise within the EU and on its periphery, particularly in the context of Brexit. The risk is that ships might no longer bunker in Europe (except for captive fleets such as ferries and feeders), unless a global tax is implemented.

In parallel, the European Commission, supported by the European Parliament, is considering integrating the maritime sector into the EU Emissions Trading System (EU ETS). Through its emissions trading system, the EU has already taken steps to reduce emissions from aviation, the electricity and heat production sector, as well as energy-intensive industrial sectors (oil refineries, steel mills, paper pulp factories, etc.). The European Commission intends to include maritime transport in its Green Deal, which aims to achieve carbon neutrality by 2050. Legislative proposals to this effect are expected by June 2021, along with the potential creation of a transition fund. It remains to convince the Council of the EU, where certain States will certainly voice their opposition.

Faced with this regional measure, maritime operators warn of a major risk of competitive distortion that would undermine European competitiveness. They would prefer to see it applied globally through a decision made at the IMO. In response to positions deemed slow and sometimes too consensus-driven to have a real impact, the European Commission has chosen to spearhead the movement—knowing that, ultimately, the citizen-consumer will foot the bill. But in the name of environmental preservation, shouldn't we restore maritime transport to its fair price and thus rethink our consumption habits? Very recently, the main international professional maritime organizations spoke out in favor of creating a fund financed directly by the maritime industry to support R&D in decarbonization. This fund could represent \$5 billion over 10 years, thanks to a \$2 contribution levied on each tonne of fuel consumed by shipping companies. This new taxation will be submitted to IMO members next April, with a view to implementation "by 2023."

³ This calculation was based on marine fuel deliveries and national diesel tax rates across the 28 EU Member States.

In addition to deterrent measures, which some may view as punitive, there are also incentive schemes. To encourage shipowners to adopt an environmentally "virtuous behavior," six ports in the Northern European range introduced the Environmental Ship Index (ESI) in 2010. The ESI measures the performance of vessels calling at ports in terms of reducing their atmospheric emissions (NOx, SOx, CO2) and the ship's energy efficiency (engine performance, fuel quality, shore-power systems, etc.). These performance levels must exceed international regulations. Shipowners achieving a high score benefit from tariff advantages, such as reductions on port dues. Other indices exist that integrate environmental obligations and allow shippers to select greener operators, including the Clean Shipping Index and the RightShip Index. In France, the 2019 Finance Bill included a tax windfall mechanism via accelerated depreciation for investments made by shipowners. This was intended to incentivize shipping companies to commit to the energy transition of their vessels by setting a 30% accelerated depreciation rate for carbon-free propulsion systems (hydrogen, electric, wind). However, this subsidy rate was rejected by the European Commission, which deemed it too high. Following revisions, the 2020 Finance Act allows for an accelerated depreciation of up to 125% of the additional cost (and not the total cost) for installing equipment enabling carbon-free primary propulsion, 105% for the extra cost linked to LNG equipment installation, and 85% for scrubbers, applicable to vessels or installations built between 2020 and 2022. It maintains a 20% asset value depreciation for scrubbers, cold ironing, or carbon-free auxiliary propulsion⁴.

What developments in the years to come ?

Whether at a global, regional, or local scale, this momentum toward clean maritime transport will intensify in the coming years as further standards gradually come into force. As of January 1, 2021, the North Sea and the Baltic Sea will be designated as Nitrogen Oxide Emission Control Areas (NECAs) under Annex VI of MARPOL 73/78. Another world region set to undergo major shifts is the Arctic. The use and transport of heavy fuel oil have been prohibited in the Antarctic since 2011. This ban could well extend in the years to come to the Arctic, where 75% of vessels use HFO, contributing to global warming and posing a major oil spill risk to this fragile ecosystem. For the time being, States are working on impact studies. Other IMO agenda items include tolerance thresholds for CO2, nitrogen, as well as fine and ultrafine particulate matter present in fuels. The IMO is also considering mandatory measures to address underwater noise from ships, ocean pollution caused by fishing gear, and the loss of containers at sea.

Beyond future developments in international environmental law, coalitions of States and/or individual States within the limits of their territorial waters can take binding action. In December 2019, driven by France's leadership, the Mediterranean coastal States and the EU spoke out in favor of creating an Emission Control Area (ECA) in the Mediterranean, where the sulfur content of marine fuels would be capped at 0.1% m/m. An economic impact assessment has been launched to determine the financial requirements of countries along the Southern Mediterranean. Following IMO approval, this new Mediterranean ECA could come into effect in 2024. As of January 1, 2020, Iceland lowered its sulfur cap to 0.1% m/m throughout its territorial waters (ECA).

National courts can also seize vessels belonging to shipping companies that violate their environmental regulations. In December 2016, the cruise company Carnival was fined \$40 million and placed under a five-year vessel monitoring program by a Florida court for using heavy fuel oil in regulated zones between 2005 and 2013, as well as for unauthorized discharges (plastic waste). An action plan had to be presented to comply with current regulations, under penalty of further fines. Today, the forced energy transition sweeping through maritime transport is part of a deeper, global movement affecting all economic sectors. This awareness is rooted in an unprecedented climate urgency and calls for systemic changes, challenging, in a way, the missteps of economic liberalism in recent years. It remains to be seen whether the Marine Environment Protection Committee (MEPC75), the IMO's supreme environmental authority meeting in April 2020, will have the courage to make binding decisions.

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⁴ For merchant vessels flying a European Economic Area flag, with 30% of port calls in French ports and 30% of navigation within the French EEZ.