Circular

Decarbonisation of the Shipping Industry

Part III – Practical Considerations

Following our previous circular which mainly covered the contractual aspects of decarbonisation, this time we offer some insights into the practical aspects involved in reducing the shipping industry's impact on climate change.

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During the last two centuries, the shipping industry has come to rely on mechanical propulsion systems in vessels. The fuel necessary to drive these systems has almost always been derived from what we now call fossil sources; coal, heavy fuel oil, diesel or petrol. These fossil fuels are all rich in hydrocarbons, which release a lot of energy when burned. This chemical energy is converted into kinetic energy which is used to drive a propeller shaft or generator. Unfortunately, this process creates harmful by-products such as particulates and CO2.

For operational purposes, a vessel's fuel consumption is often expressed as the amount of fuel needed to move one metric ton of cargo over a distance of one nautical mile. For generator engines, there is a relationship between the fuel consumed and the demand for electrical power (kWh or MWh). Consequently, the quantity of by-products such as CO2 can also be expressed in terms of the weight produced by moving the same metric ton of cargo over a distance of one nautical mile or, for generator engines, in the weight of by-product produced by generating one kWh of electrical energy.

Decarbonisation is about reducing the weight of the by-product while maintaining the desired performance. With regulations regarding CII and EEXI being implemented or already in place, following earlier developments regarding SEEMP and EEDI, the short-term and long-term practical matters and measures need to be considered.

1. Continue using fossil fuel

In the first place, this implies that the consumption of fossil fuel, which will undoubtedly prevail in the near future, must be optimised in a way that increases the mileage squeezed out of every ton of fuel. Basically; maintain a vessel's normal performance with as little fuel as possible. This enhances energy efficiency and reduces CO2 emissions per ton-mile at the same time.

What's important here is to avoid wasting energy and make sure as much of it as possible is exploited to boost the desired thrust. That means avoiding wasting energy to heat components, cause noise, move unnecessary weight, etc. So, what can a shipowner do to achieve this?

2. Existing fuel treatment systems

Needless to say, poor quality fuel reduces a vessel's performance and energy efficiency, and may even cause substantial damage. But even fossil fuels that fully comply with ISO8217 standards must be treated before they can actually be used. Heavy fuel oil, for example, must be heated and purified first. Diesel also has to be purified before it can be used. These measures help optimise the injection and combustion process. Vigilant Owners are advised to check and optimise these processes regularly, where applicable in conjunction with suppliers and engine OEMs, and if necessary amend their planned maintenance system accordingly.

3. Clean hull and propellers

Fouling of the hull and propeller blades by marine organisms (soft growth, barnacles etc) increases friction of the hull in water, and adds extra tons of unwanted weight to the vessel. Overcoming friction and putting weight into motion requires energy. Regular inspections by divers, ROVs etc, which can also be carried out between scheduled dry dockings, help monitor the quality and effect of the antifouling coating and the speed and volume of marine growth.

4. Trim

The propulsion characteristic of a vessel is influenced by the shape of the hull under the waterline, and the immersion of the propeller. The shape is largely determined by the vessel's design, but obviously the vessel's draft and trim also play a role. This may be challenging when a vessel is in ballast. If reasonably possible, the propeller's efficiency (and thus the energy efficiency of the vessel) can be improved by making sure the propeller is fully immersed, rather than allowing its blades to reach to the sky.

5. Planned maintenance related to performance

Prudent shipowners use a planned maintenance system (PMS) which covers works periodically necessary to keep their installations in the best possible condition and fit for duty. The engines manufacturer's maintenance intervals or other pre-determined intervals (in terms of time or running hours) are then used as base for inspecting, overhauling or renewing certain parts. Although regular or continuous performance monitoring is not always in place, it can be a useful early warning system about energy being lost or about to be lost. Continuous condition monitoring systems can likewise give advance warnings about excessive or premature wear, and the consequential loss of energy.

6. Energy savings

The engines play an important role, but so does the equipment run by the engines. Make sure frequent checks on avoidable energy losses are part of the PMS. Regularly check for fuel leakages, energy leakages, earthing faults, the condition of insulation in accommodation and refrigerating holds, the condition of freezing, defrosting, and heating equipment, cabling, lighting fixtures, etc. Use energy efficient bulbs, and switch off unused lights. Don't forget to have a critical look at the consumption of general appliances as well (HVAC, galley, laundry, cold stores).

7. Shaft Power Limitation and/or Engine Power Limitation systems

A Shaft Power Limitation (ShaPoLi) system controls and restricts the output power of the propeller shaft(s). ShaPoLi optimises a vessel's propulsion and blade design, and results in additional fuel savings and lower CO2 emissions. The system consists of measuring sensors, a data recording and processing device, and a control unit for calculating and limiting the power transmitted by the shaft to the propeller. Incidentally, if all parameters are properly set and calibrated, the ShaPoLi measurement results can also be used as an indicator of hull's fouling status.

An Engine Power Limitation system (EPL) is a system which enables a vessel to limit its engine power and fuel consumption when the pre-set value is reached, thereby helping operators limit their ship's emissions during sailing. The system is fairly simple, and usually consists of a sealed stop on an engine's fuel governor in mechanically controlled engines, or a software module which maximises the engine's power output in electronically controlled engines.

Engines don't generally require modifications, but attention needs to be given to lubrication and cooling, in collaboration with engine OEMs. Installing ShaPoLi and EPL are subject to Class approval, as propulsion systems have to remain compliant with the applicable Minimum Power requirements (ice-class vessels, for example).

EPL and ShaPoli systems may be integrated. In this respect, we also refer to IMO Resolution MEPC.335(76).

8. Exhaust gases

A long-time practice in conserving energy is to use the residual heat in exhaust gases for operational purposes. The most commonly known device is the exhaust gas boiler or economiser, which is used to generate steam or heat thermal oil. Although heat is recovered, meaning potential savings on auxiliary power, the exhaust gas will still contain various pollutants and particulates.

Owners could consider installing scrubber installations to treat these gases. Scrubbing essentially means washing gases with water before they enter the atmosphere. This washing was originally designed to remove sulphur from exhaust gases, but ideally it also removes particulates; the resulting 'dirty water' is collected and stored for disposal in port.

9. Alternative fuels

A wide array of alternative fuels are emerging, in various stages of development and availability. They vary considerably in terms of characteristics, energy densities, bunkering, storage and treatment methods, methods of use (direct combustion, possible use of conventional pilot fuel, use in fuel cells etc) and risks. The infrastructure to produce these fuels and make them readily and globally available for international shipping is also under development.

Below, the most commonly known non-fossil fuel varieties to date, with a brief explanation:

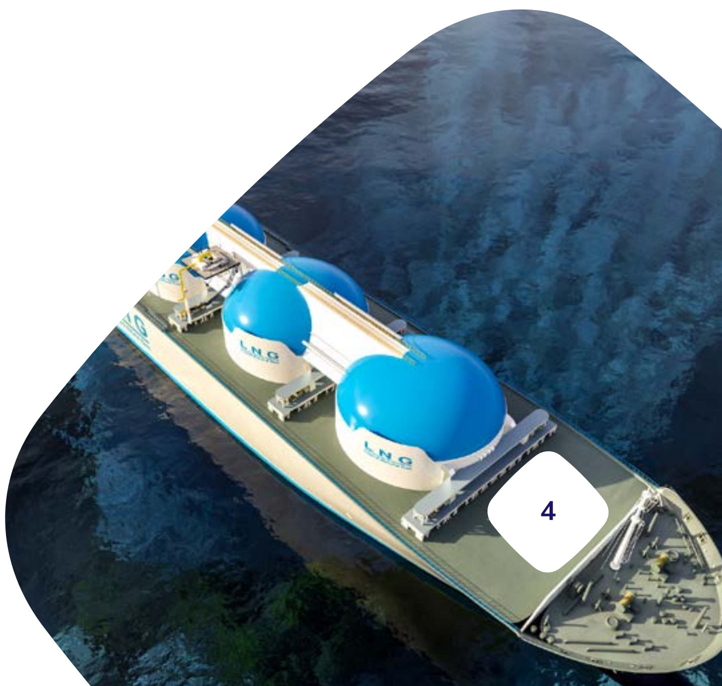
'Drop-in fuels', a collective name for fuels which can be used instead of or, as is more frequently the case, blended with fossil fuels without requiring major modifications to existing technical installations. Examples are renewable diesels such as HVO (hydrotreated vegetable oil) and biodiesels such as FAME (fatty acid methyl ester). They still contain carbon, although significantly less than fossil fuels. They are produced using feedstocks such as vegetable oil and fats, waste cooking oil, rapeseed oil and animal fats.

Methanol and **ethanol** are essentially alcohols, and contain carbon by definition. They are considered 'biofuels', and can be synthetically or naturally produced from biomass. At the moment, methanol is mainly produced industrially by the hydrogenation of carbon monoxide (CO). CO_2 from another source, such as a CCS system, can also be used as an ingredient, in combination with hydrogen. However, methanol is often produced from methane or even coal, so essentially using 'natural' carbon. Methanol is normally transported as a liquid, another reason it's gaining popularity as an alternative fuel. It can be used either for 'direct combustion' or as a carrier of the hydrogen used in fuel cells to generate electricity. Methanol is relatively cheaper and simpler to produce than ethanol, and has physical and chemical advantages over ethanol. On the other hand, methanol is highly toxic in both liquid and gaseous form, far more so than ethanol.

LNG, liquefied natural gas, is essentially methane, extracted from the soil and liquefied, transported and stored at extreme low temperatures (approximately -163 °C) at atmospheric pressure. As long as the liquid state is properly controlled and maintained, LNG presents relatively few immediate risks. In gaseous form, it's a major greenhouse gas: the use of LNG as fuel is unfortunately associated with 'methane slip'; the unintended release of methane which contributes to the greenhouse effect. The key risk with LNG is the uncontrolled release of cryogenic, toxic and flammable fluids which can cause bodily injury, pool fires, vapour clouds and fires or explosions.

Ammonia is free of carbon. It consists of nitrogen and hydrogen (NH_3), and has been identified as a potential long-term fuel that could enter the market relatively quickly and offer a zero, or near-zero, carbon solution (on a tank-to-wake basis and in some cases on a well-to-wake basis), irrespective of the origin of the fuel. Like methanol, it's a carrier of hydrogen, which makes it suitable for direct combustion (still under development) or a fuel cell. It is, however, highly toxic. At atmospheric pressure, ammonia is a gas under normal room temperature, and liquefies at about -30 °C. The resulting challenges and related risks are significant and, whilst manageable, they will add complexity to ship designs as well as safety features. This potentially limits the number of ships for which ammonia may be suitable.

Hydrogen. Nearly all the hydrogen produced at the moment (over 90%) comes from fossil fuels. Electrical power from wind farms and PV panels, particularly in times of surplus, can also be used to create hydrogen, which can then be transported and stored (either as a gas or liquid) as an energy carrier. Hydrogen can then be tapped and used on demand in a fuel cell to generate electrical power, either for direct use or to be stored in batteries. Alternatively, hydrogen can be used for direct combustion, sometimes with the aid of a small amount of pilot fuel.

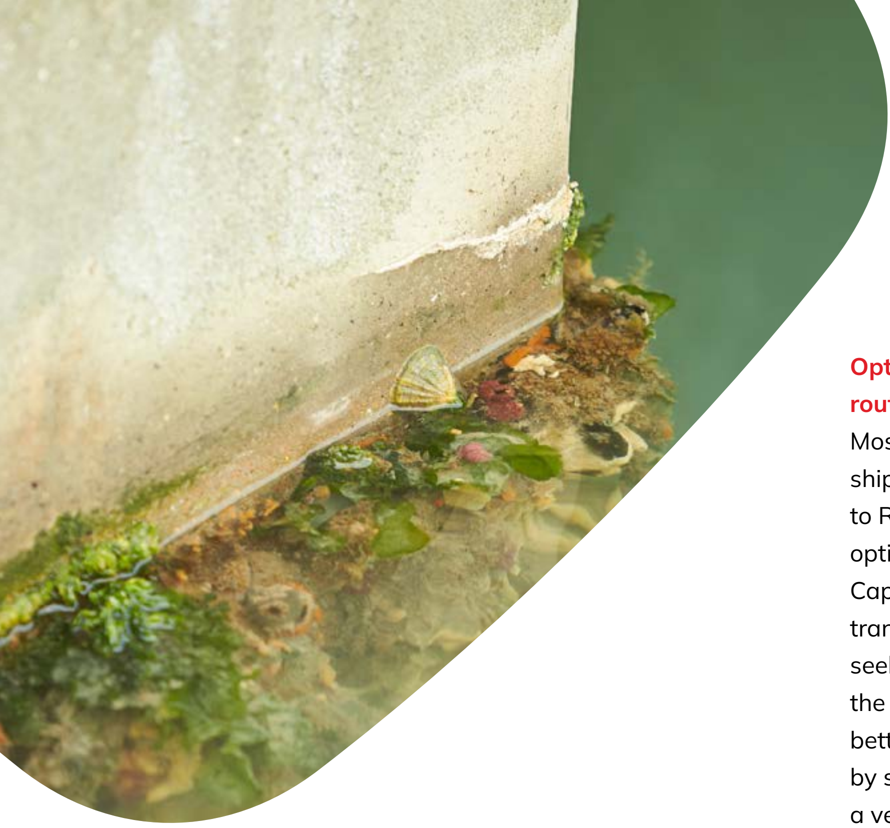


Electrical power can also be stored directly in **Energy Storage Systems**, basically giant battery packs, then used for electric drive systems or domestic appliances. At the moment, these battery packs tend to be comprised of lithium batteries due to their relatively high energy density. There are risks associated with these packs, however; predominantly fires, explosions and the release of toxic gases. For further details on those risks, refer to our previous circular.

Let's not forget good old-fashioned **wind**. Everybody is familiar with conventional sails, but the industry is continuously developing more advanced systems which use wind to help propel vessels, such as ventifoils, Magnus rotors or Flettner rotors (the latter, by the way, date back to the mid-1920s) or even kites. Instead of modifying a vessel's engine or machinery space for this, the suitability of a vessel's structure will have to be assessed for these systems. Modifications will then also be subject to Class approval.

Nuclear power is mentioned here, but only because it exist.
The first cargo vessel using nuclear power entered operation in 1962, followed by just three others until 1988: only one of these four is still in service. This type of power is further only found in naval surroundings and on ice breakers operating in predominantly polar areas. Whether this type of power generation in modernised versions will have a new and viable future on a larger commercial scale remains to be seen, but research is ongoing.

Each and every measure, energy source and system has its pros and cons, and each has to be assessed and weighed for every individual case. Based on, for example, the EEXI of their ship, shipowners are in any case advised to actively consult their Classification Societies as well as engine manufacturers and other technical advisors to define a combination of measures which will suit their purpose. This may well be a complicated task, since the ideal combination varies per vessel, vessel type, operational circumstance, trading area, etc. In the course of such a process and pending its outcomes, measures can be taken as outlined above. In addition to all this, operational measures can also be considered, where applicable in conjunction with partners in the transport chain.



Operational aspects

Relatively independent of the type of fuel used, operational measures can always be taken to reduce consumption of any kind of fuel – and consequently the amount of unwanted by-products.

Lower speed and/or speed adjusted to delivery times (just-in-time)

Active and frequent communication regarding port and cargo prospects provides useful input for optimising fuel consumption. This could involve slow steaming, which however may require extra attention in terms of adjustments to fuel injection, scavenging air, lubrication, cooling and avoidance of poor combustion.
In this respect, we refer to publications such as the 2020 IMO Just in Time Arrival Guide.

Efficient port operations

The less time spent in port, the less fuel is spent by the vessel's auxiliary engines on power generation when stationary.

Use shore power connections if available

Some major ports are currently investing in facilities to accommodate seagoing vessels' demand for electrical power whilst moored. Vessel may also need modifications to connect their full grid to a shore power facility without risking interruptions to normal operations.
For further information, we refer to the publications issued by the International Association of Ports and Harbours regarding Onshore Power Supply.

Optimise voyage and route planning and use weather routeing

Most goods are transported worldwide over established shipping routes and lanes. A voyage from Singapore to Rotterdam via the Suez Canal presents few realistic options for significant diversions, unless passage via the Cape of Good Hope is on the cards. For transatlantic or transpacific passages however, it can be worthwhile to seek advice from a weather routeing bureau to assess the possibilities of avoiding adverse weather. Even better, it may be possible to let "nature help in the effort" by seeking favourable winds and currents which reduce a vessel's resistance through water.

Government and private meteorological offices are using more and more sophisticated calculations to analyse weather data to such an extent that they are able to provide Masters with concrete, real-time advices on how to avoid adverse conditions on a journey.

Avoid "empty" voyages

Obviously, vessels have to go somewhere to load cargo and, more often than not, take on ballast to do so. The energy required for this leg is much better spent if cargo can be taken instead of ballast.

Takeaways

It is not possible to provide general advice on what fuel to choose to replace conventional fossil fuels in the future. This choice depends on a broad spectrum of variables, both external (e.g. availability of “fuel”, legislation and regulations) and internal (e.g. ship type, nature of operation, trade areas). What is important, in any case, is to assess all the risks involved. The general or specific training and certification of vessel crews also requires timely and thorough attention.

Ship designers and builders, engine manufacturers and other partners in the supply chain are carrying out research, development and engineering to design and optimise propulsion installations to suit various types of vessels, trades and fuels. A significant part of this research and development concerns the use of alternative fuels in existing propulsion installations. This will often require modifications to be carried out to these installations, and potentially a vessel’s lay-out (e.g. fuel storage spaces, machinery spaces and safety measures).

Simultaneously, Classification Societies, in conjunction with Flag states, are in the process of developing Rules and Regulations to address the safety issues attached to each alternative. These issues mainly revolve around fire safety, health risks and environmental risks, which then need to be translated into design, building and maintenance criteria. Engine OEMs and Classification Societies are therefore the most obvious go-to places for first advice regarding issues such as the modifications themselves, technical warranties, type-approvals, machinery items within the realm of a vessel’s classification.

As technology and regulations develop, making the shipping industry more environmentally friendly is a continuous and iterative process. We therefore encourage parties to hold discussions on this topic with stakeholders such as commercial business partners, Classification Societies, authorities, crews and terminal personnel.
If you have any questions or comments regarding this circular, please feel free to contact our Loss Prevention Services at LPS@msigspecialtymarine.com.

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