Powerfuels in Maritime Transport

Powerfuels are the most viable option to defossilise maritime transport within this century.

Greenhouse gas emissions from maritime transport account for approximately 2.89% of total anthropogenic emissions in 2018[1] and the sector consumes around 8% of global annual oil supply[2]. From year 2012 to 2018, greenhouse gas emissions rose from 977 million tons to 1056 million tons, even though the carbon intensity of maritime transport significantly improved since 2008[1]. International maritime transport, covering all types of cargo shipping (bulk, container, oil, chemicals, general cargo and liquefied gas) remain the dominant source of international shipping GHG emissions with a share of 86.5% when calculated on a voyage-based allocation[1].

Maritime transport is the backbone of global trade accounting for more than 80% of goods transported worldwide. Ships are capable of transporting huge volumes of cargo while being the most energy-efficient mode of transport[3]. Nonetheless, with increasing economic growth, based on OECD and IPCC projections, merchant shipping volumes are expected to rise further. Under business as usual scenarios, this would cause a projected increase of emissions of up to 50% from 2018 levels[1].

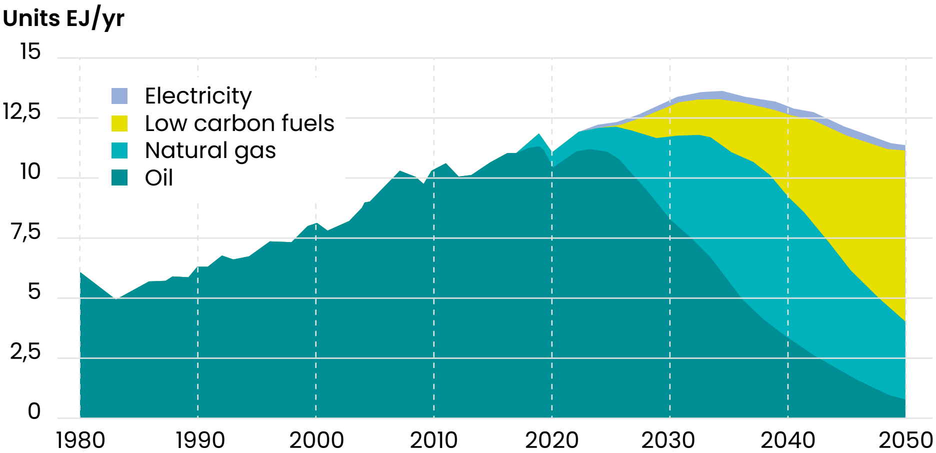
Shipping is regulated by the International Maritime Organisation (IMO) through international conventions of its 174 member states, setting global standards for the sector. In 2018, the IMO adopted its initial GHG strategy, targeting carbon intensity reduction per transport activity by 40% in 2030 and by 70% in 2050, compared to 2008.

2.89% of total anthropogenic emissions in 2018 were emitted by ships[1)]

50% CO_2 emissions reduction in 2050 compared to the 2008 levels can only be achieved with alternative fuels and propulsion systems[5)]

It also aims to reduce total emissions by at least 50% from 2008 levels by 2050 and become climate neutral within this century[4]. While the 2030 target can be achieved by using operational measures such as reducing the sailing speed combined with energy efficiency measures, the long-term targets can only be achieved using alternative fuels and propulsion systems. As seen in Figure 1, around 7.5EJ of alternative fuels could be needed to reach the 2050 IMO emissions reduction target.

The EU initiative FuelEU Maritime has developed a regulation on the uptake of renewable and low-carbon fuels in the maritime transport[6]. The target is to get the sector in line with the EU's ambition to become climate neutral by 2050.



Natural gas includes LNG and LPG. Biomass includes biodiesel and LBG.
Historical data source: IEA WEB (2019)

Figure 1: Possible development of the energy demand of the shipping sector by energy carrier. (Source DNV: Energy Transition Outlook 2020)

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Comparison of sustainable shipping fuels

Currently, the global shipping fleet mainly uses very low sulphur fuel oil (VLSFO) and marine gas oil burned in mono-fuel diesel engines as fuel. Today, most new ship orders still count on this technology. The only alternative fuel currently available for commercial use is fossil LNG which can reduce CO_2 emissions up to 25%[7]. However, fossil LNG is seen as a transition fuel, as it has very limited GHG reduction potential and a high risk of methane slip.

Powerfuels are considered as the most viable option to decarbonize shipping within this century. Today's dual fuel marine engines can use synthetic methane or liquid FT (Fischer-Tropsch) as drop-in fuels and there are already engines in the market running on methanol. New engines are being developed for the use of ammonia as fuel. Additionally, fuel cells offer the opportunity to use hydrogen directly. However, powerfuels are neither commercially available yet nor cost competitive with fossil fuels.

It is difficult to identify clear winners among the various alternative fuel options. Factors that have to be taken into account include availability, infrastructure and storage, technology maturity (fuel and propulsion), energy density, price, and environmental credentials of the fuels (see figure 2). Since ships are typically in operation for two to three decades and fuel systems onboard are very costly to retrofit, there is a great uncertainty about how future of shipping fuels will look like. This uncertainty hinders investments due to the risk of creating stranded assets.

For international maritime trade on large ships, synthetic methanol and ammonia currently appear to be very promising fuel candidates. In addition to their GHG reduction potential and handling experience for use in the chemical and fertilizer industries, these energy sources have great potential in production scalability and cost competitiveness with fossil fuels. For the use of ammonia, technological maturity and commercial readiness are the major issues at present. For the use of synthetic methanol, production capacity and availability of sustainable carbon sources are great challenges.

Compared to other alternative fuel options, energy density of hydrogen and batteries is very low. This accounts for the biggest disadvantage in using hydrogen or direct electrification. For smaller ships, shorter transport distances and domestic shipping the use of hydrogen or direct electrification could be viable options. Overall, most likely, maritime transport will see a multi-fuel future, where different fuels are used for different types of ships. However, ports will have to provide the necessary bunkering infrastructure and only the largest will be able to provide all different types of fuels. Smaller ports will focus on two to three different bunkering systems, on the one hand for very low sulphur fuel oil (VLSFO) and marine gas oil with sustainable blends, and on the other hand for non-drop-in solutions, for example ammonia for seagoing vessels and hydrogen for inland vessels.

At this time, what is most needed for the decarbonisation of the shipping sector are clear and ambitious market signals regarding the future of shipping fuels from the IMO. As shippers themselves have shown a high willingness to act, initiatives such as Fuel EU Maritime will be important drivers to accelerate international political action.

	Fuel	Availability	Infrastructure & Storage	Maturity of technology	Energy density	Price	Green credentials
Fossil Fuels	VLSFO/MGO	high	high	high	high	high	low
	LNG	high	medium	high	medium	high	medium
Renewable Fuels	E-MFO/MGO	low	high	medium	high	low	low–high
	E-LNG	low	high	medium	medium	low	low–high
	E-Methanol	low	medium–high	medium–high	medium	medium	low–high
	Biofuels	medium	high	high	high	medium	low–high
	Hydrogen	low	low	low	low	low	low–high
	E-Ammonia	low	medium	low	medium	medium	low–high

low / medium / high

Figure 2: Characteristics of alternative shipping fuels. LPG is excluded as it is expected to play only a minor role (Source: Own illustration)

References: 1) IMO, 2020, Fourth GHG Study; 2) DNV 2020, Energy transition outlook; 3) European Parliament, 2020, Decarbonising maritime transport: The EU perspective; 4) IMO, 2018, GHG Strategy; 5) IMO 2018; 6) EU Commission, 2021: Leak for a proposal for a regulation of the European parliament and of the council on the uptake of renewable and low carbon fuels in maritime transport-FuelEU Maritime; 7) DNV 2020, Maritime Forecast to 2050

Publisher: Global Alliance Powerfuels, Deutsche Energie-Agentur GmbH (dena), German Energy Agency, Chausseestrasse 128 a, 10115 Berlin, Germany, Tel: +49 (0)30 66 777-0, www.powerfuels.org, powerfuels@dena.de.
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