Potential for Biofuels and Wind Assist to Reduce Ocean Shipping Emissions

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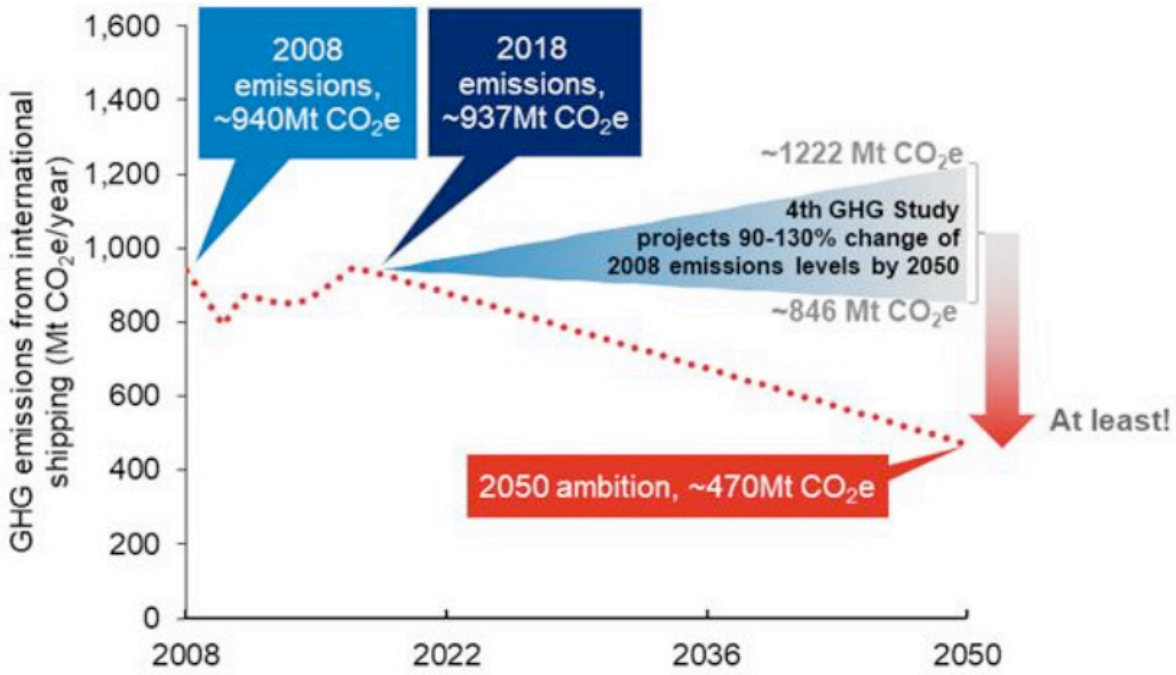
Where do we stand?

- 80-90% of global trade enabled by maritime shipping, the shipping sector is responsible for around 3% of annual global greenhouse gas (GHG) emissions on a carbon dioxide (CO2)-equivalent basis
- International shipping alone accounts for around 9% of global emissions associated with the transport sector.

Photo credit: IEA Bioenergy Report, Progress towards biofuels for marine shipping, June 2021

International Maritime Organization (IMO) GHG Targets

- By 2050 maritime trade could increase between 40% and 115% in comparison to 2020 levels
- IMO's targets to decrease the carbon intensity of the shipping sector **50%** by 2050 and mandates new ships to increase energy efficiency.
- Reducing the average carbon intensity by at least a 40% by 2030 and 70% in 2050 (compared to 2008 levels).



Current Emissions

- The exhaust gasses from the burning of fossil fuels for marine shipping produces a large amount of pollutants, and shipping alone represents 2-3% of global GHG emissions.
- The exhaust material of diesel engines consists primarily of nitrogen, carbon dioxide (CO_2) and water. Carbon monoxide (CO), sulphur oxides (SOx), nitrogen oxides (NOx) and particulate matter will also be part of the exhaust material to varying amounts.

New Regulations for Sulphur

- On January 1st 2020, strict regulations came into force limiting sulphur in fuels to 0.50 wt. % at a global level, restricting the use of heavy fuel oil to vessels equipped with an exhaust cleaning system (scrubber).
- To comply with the 0.5 wt. % Sulphur regulations, ships have turned to four options:
  - Using Marine Gas Oil (MGO) consisting of exclusively distillate oil.
  - Using desulphurized fuel oil - Very Low Sulphur Fuel Oil (VLSFO).
  - Using LNG requiring a retrofit of the vessels engine and fuel system
  - Installing exhaust gas cleaning systems (scrubbers) allowing the continued operation on High Sulphur Fuel Oil (HSFO)

Traditional Marine Fuels

Heavy fuel oil (HFO)

High viscosity fuel based on the residual fraction from oil distillation.

Marine gas oil (MGO)

A low viscosity fuel oil blend consisting only of distillates.

Marine diesel oil (MDO)

A fuel blend of distillate and residual oil with low viscosity.

Intermediate Fuel Oil (IFO)

A fuel blend of distillate and residual oil with high viscosity (180 or 380 mm2/s)

High Sulphur Fuel Oil (HSFO)

Heavy fuel oils with maximum sulphur content of 3.5%.

Low Sulphur Fuel Oil (LSFO)

Heavy fuel oils with maximum sulphur content of 1%.

Very Low Sulphur Fuel Oil (VLSFO)

Desulphurized Fuel oils with maximum sulphur content of 0.5%

Ultra-Low Sulphur Fuel Oil (ULSFO)

Fuel oils with maximum sulphur content of 0.1%

Liquid Natural Gas (LNG)

Natural gas rendered liquid by cooling. Used in specialized dual-fuel engines.

Marine propulsion technologies

- Engine manufacturers have a crucial role in the energy transition of the shipping sector.
- Modern marine propulsion is characterized by a mechanical system consisting of an engine or electric motor powering a propeller. Examples are diesel engines, gasoline and gas engines, multi-fuel engines, electric engines.
- Wind propulsion has been gaining in viability and thus could be considered for adoption on large vessels

Innovative Wind Assist Propulsion

- IWSA (International Windship Association) analysis suggests that wind propulsion can provide between **5-20%** of the energy required for vessels
- IWSA reports eight installations on large vessels with six more scheduled for delivery in 2022
- Final global deployment will depend on various factors i.e. fuel price variations, vessel routes and speed requirements, among other economic factors, such as the discount rate applied.

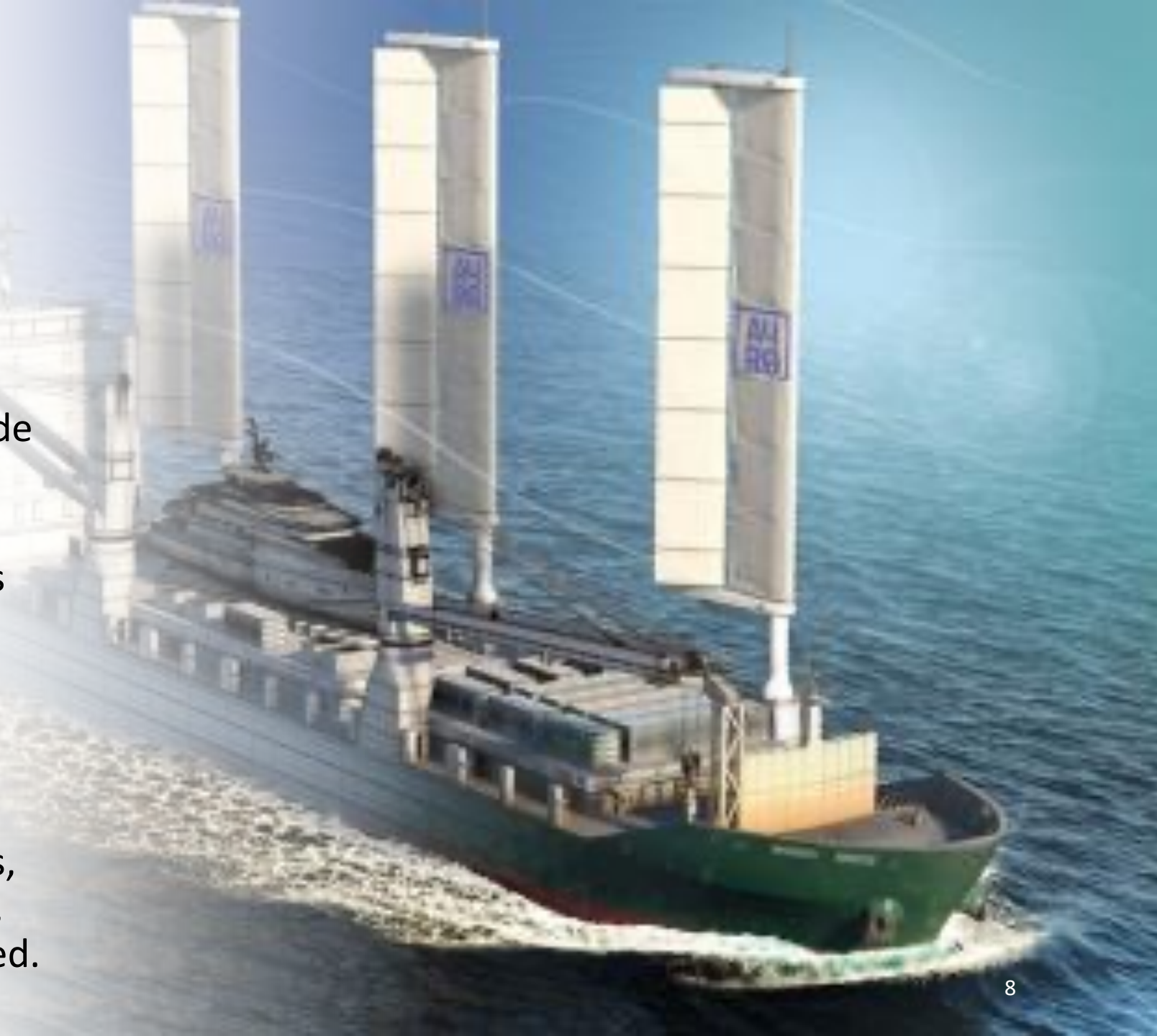


Photo by GoodFuels Marine

MARINE BIOFUEL TRIALS

- There have been a number of trials of biofuels in marine engines, as well as the development of new marine engines capable of running on biofuels.
- The goal is to run proof of concept use of these fuels, and to increase demand through marketing and feasibility tests
- The past 5 years have seen an increase in both worldwide production capacity and use of biofuels for marine applications, both in short sea routes and for long distance sea shipping.

MARINE BIOFUEL TRIALS

- GoodFuels has tested its bio distillate and bio residual fuel.
- In March 2020, they partnered with the short-sea shipowner UECC as well as BMW Group to test a biofuel based on used cooking on UECC's ro-ro M/V Autosky
- BMW claimed that shipment had 80% to 90% CO2 reduction.
- In **<u>Augusts 2022</u>**, Spar Shipping AS, Fleet Management Limited and GoodFuels announced they have successfully completed a 10-day trial of 100 per cent sustainable marine biofuel on board Spar Shipping AS' bulk carrier Spar Lynx.
- This trial enabled a reduction of at least 75 per cent in carbon and sulphur emissions.

Photo by GoodFuels Marine

Short- to Medium-term Solutions

- Biomass has the potential to fully supply the marine sector with sustainable energy, and is identified as the **most promising short- to mid-term solution for both reducing carbon emissions and meeting sulphur regulations**.
- With increasing international stringency on sulfur emissions and ship energy efficiency, the price gap between fossil- and biofuels is declining and provide a real opportunity for biofuels to compete with the fossil alternatives.
- Biofuels consist of many promising candidates as sustainable transportation fuels, and are closer to commercialization than other alternative fuels such as ammonia, or batteries.
- While some biofuels are already produced and available commercially, their suitability as sustainable and scalable fuel replacements for fossil fuels relies heavily on the source and availability of the feedstocks used to produce them.

Short- to Medium-term Solutions

- Techno-economic assessments coupled to LCAs have found that **biofuels could be a cost-effective means of reducing GHG, sulfur oxide, and particulate matter emissions** from the maritime shipping industry, and that the cost of CO_2 abatement is more favorable for purely biobased pathways than for pathways cofeeding with fossil fuels.
- For the short- to midterm future it is unlikely any ‘one-fits-all’ biofuel solutions will occur. As alternative fuel technologies mature and global and national policies develop, the maritime sector will have to learn how to navigate in more uncertainty.
- Fuel flexibility is key strength in the adaption through the unclear transition towards sustainable shipping .

Overview & Outlook

- There is no silver bullet to reduce emissions
- Liquid and gaseous biofuel pathways contain capable and obvious short- to midterm solutions to bring the marine sector closer towards its target
- Drop-in-fuels, require close to no adaptation on engine and fuel systems, however it is challenged by low supply and high production cost.
- Other emerging biofuels e.g. biocrude, alcohols, emulsion fuels, and gaseous fuels are all challenged by the lack of infrastructure and compatibility issues
- A barrier for implementing biofuels for shipping industry is if the short-term investment costs are expected to be absorbed by only a few stakeholder categories.

Overview & Outlook

- In the light of the large investment risks associated with biofuel technologies, technical as well as regulatory actions towards lowering these risks are in great demand
- A combination of energy efficiency improvements as well as gaseous and liquid biofuel pathways seem to be the quickest and most mature solutions to meet the both IMO 2030 40% and 2050 70% emission reduction by 2050.
- The next important task is to accelerate the development by lowering the investment risks related to sustainable biofuels for marine propulsion: de-risking fuel pathways through continued R&D of potential pathways, development of appropriate standards, and enabling suitable policies.

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