RINA

The shipping industry on its way to decarbonisation

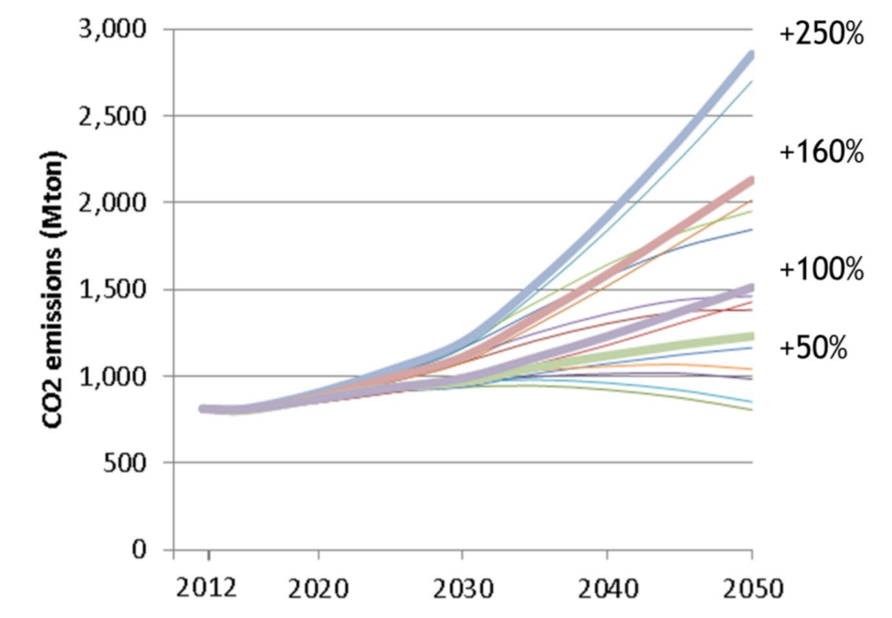
26 October 2020

The shipping industry impact on GHG

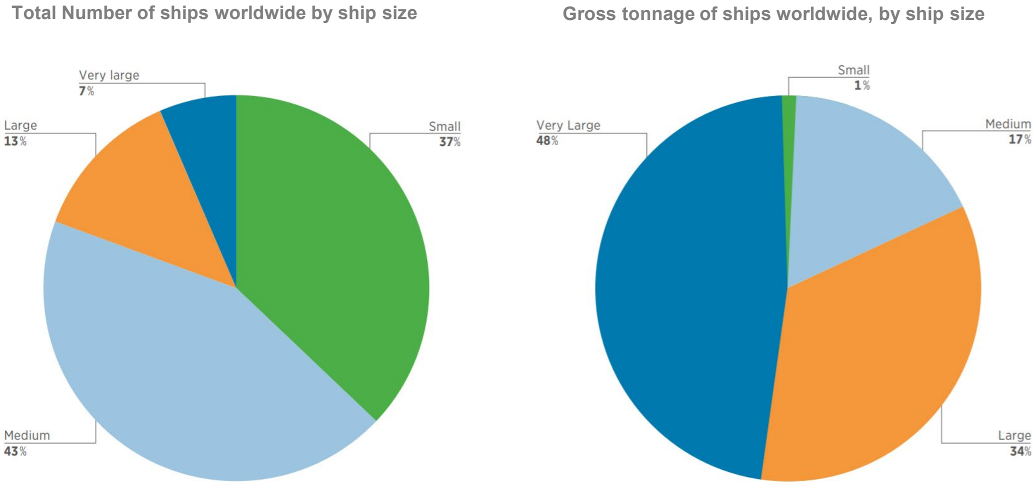
The International Monetary Fund forecasts that between 2019-2024, global GDP will grow at an average rate of 3.6% per year. Similarly, global trade volume is estimated to grow at 3.8% per year over the next five years. Under this context, in the absence of suitable mitigation policies, the International Maritime Organisation (IMO) states that greenhouse gas **(GHG) emissions associated with the shipping sector could grow between 50% and 250% by 2050**.

CO2 emissions associated with shipping account for around 3% of global CO2 emissions. In addition, given that HFO is so widely used in shipping, the sector is responsible for approximately 15% of global annual nitrogen oxide (NOx) (3.2 Mt/year) emissions and 13% of SOx (2.3 Mt/year) emissions.

On average, the **shipping sector** is responsible for **3% of annual global green-house gas (GHG)** emissions on a CO2 -equivalent basis. International shipping represents around 9% of the global emissions associated with the transport sector.



Vessels Segmentation



Source: Equasis (2017)

Vessels for goods transport, represent 20% of the global shipping fleet; together these vessels are responsible for **85% of the net GHG emissions** associated with the shipping sector.

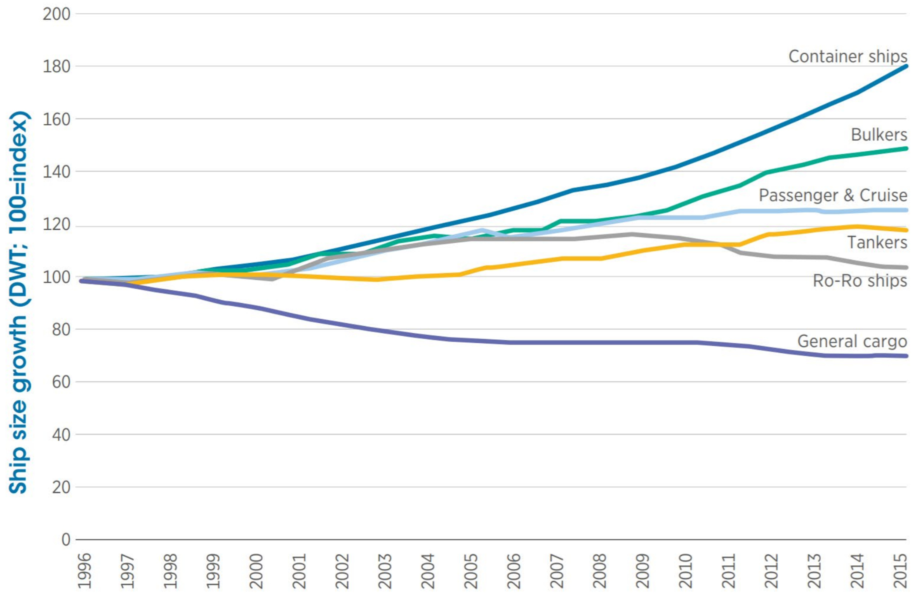
A substantial proportion of SS (47%) and MS (33%) ships are more than 25 years old, while the majority of LS (21%) and VLS (26%) are relatively new, between 0 and 14 years old.

The impact on Infrastructures

Considering the expected growth in trade in the coming years – and thus the increasing energy needs of the shipping sector – a shift towards a cleaner maritime transport industry will require changes not only in the vessels, but also in the supply infrastructure.

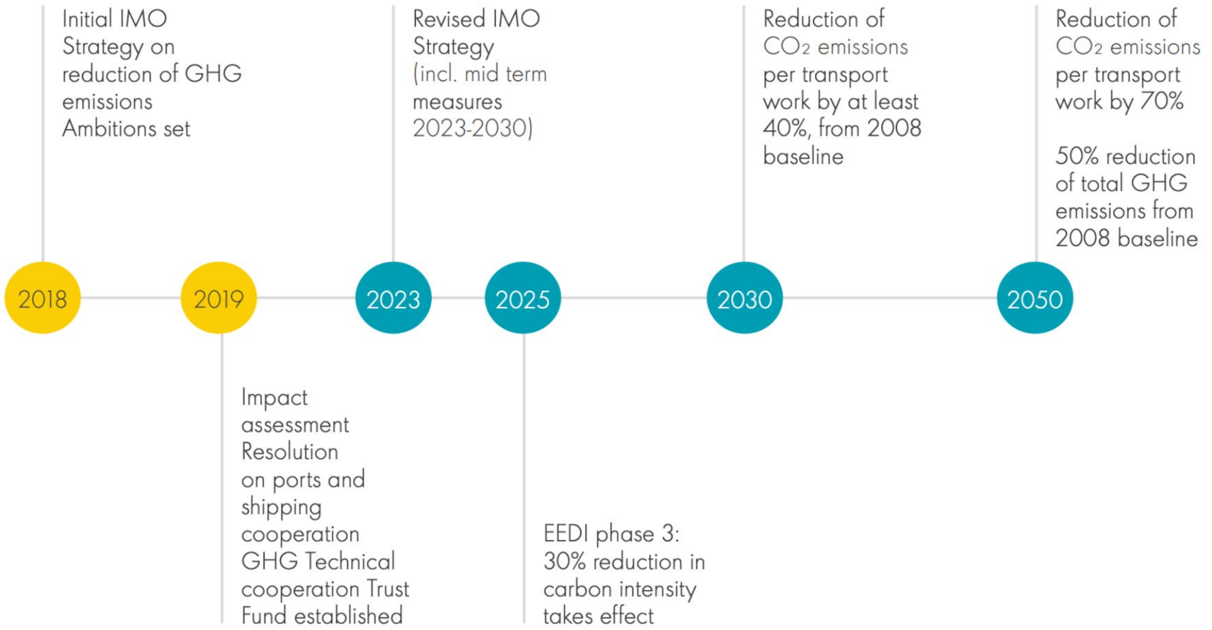
In this regard, **7 ports** are responsible for nearly **60% of all bunkering sales globally**, with as much as 22% of the today's bunkering concentrated in Singapore alone.

Ship size development of various ship types



Source: ITF (2015)

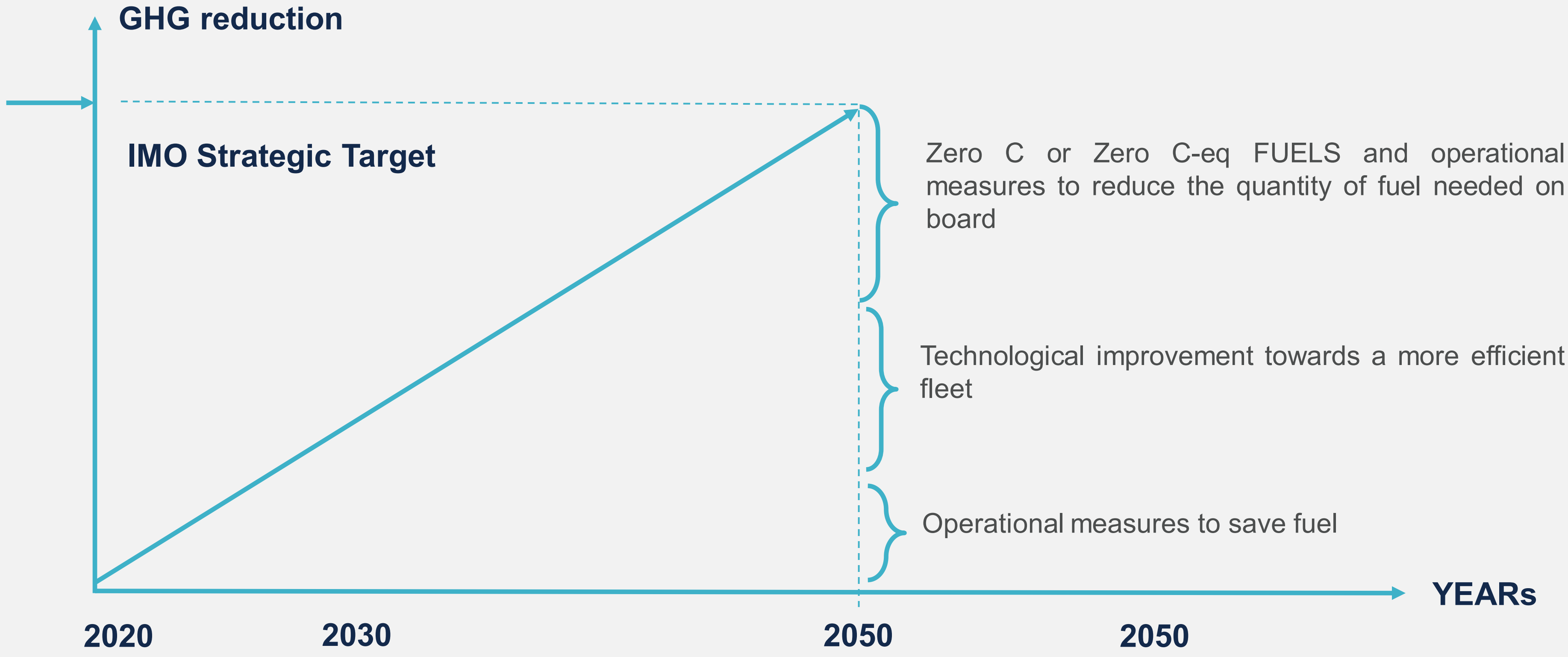
The IMO targets



To achieve these ambitious targets, the IMO suggests the following paths:

- Use a compliant fuel oil with low sulphur content (<0.50% m/m)
- If exceeding 0.50% sulphur content, use an equivalent cleaning means, e.g. exhaust sulphur scrubber.
- Replace the use of high sulphur fuels with alternative fuels, e.g. LNG, methanol and others.
- Use onshore power supply during docking periods.

Efficiency and Fuel Saving



Alternative Fuels vs Barriers to Overcome

LNG Liquefied Natural Gas

Bio Fuels

Electric Stored Energy

E-Fuels (H2, Methanol, NH3)

Diesel + H2

LNG + H2

VS

Availability

HSE impact

Technical issues

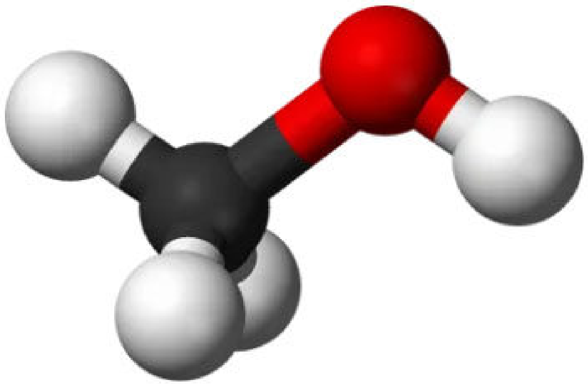
Logistic chain

Cost

Rule requirement availability

Social perception

Methanol



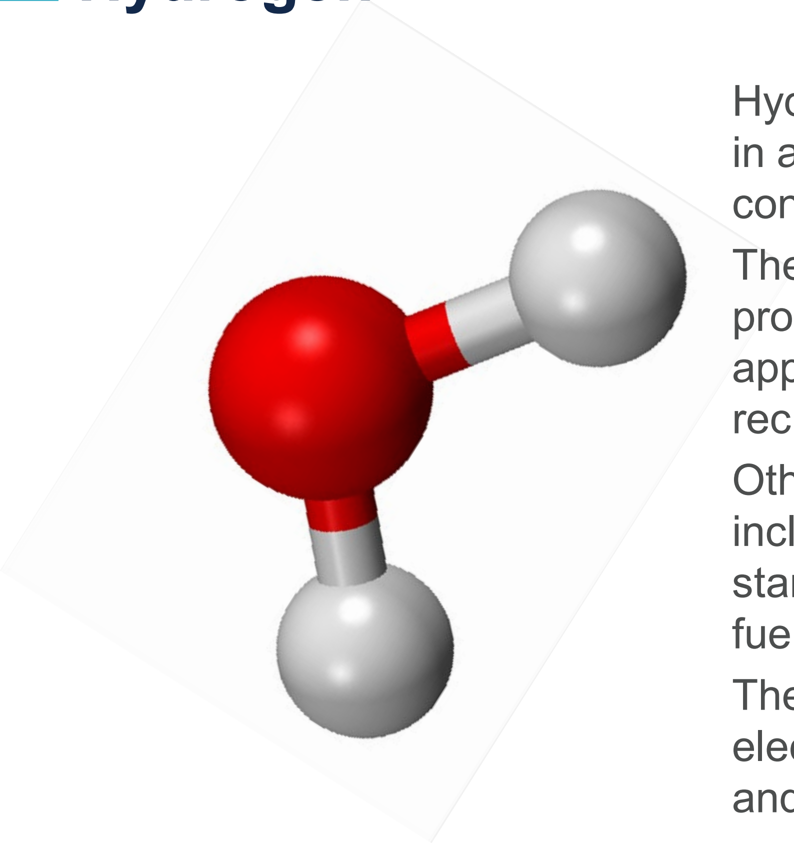
Methanol produces considerably less emissions than conventional marine fuels. It virtually eliminates SOx emissions and reduces NOx emissions by 60%, compared to HFO.

Methanol has been used in the marine sectors mostly in fuel cells in smaller vessels. There are now a small number of methanol-powered commercial vessels in operation, using commercially available marine engine technologies. Vessels can also be retrofitted relatively easily with methanol engines.

Because methanol is widely available and extensively used in other industries, there is industrial experience on best transport, handling and operation practices offering advantages in terms of bunkering requirements.

At ambient temperature, methanol is liquid and therefore more compatible with existing bunkering infrastructure, as it can be stored in regular, non pressurized tanks.

Hydrogen



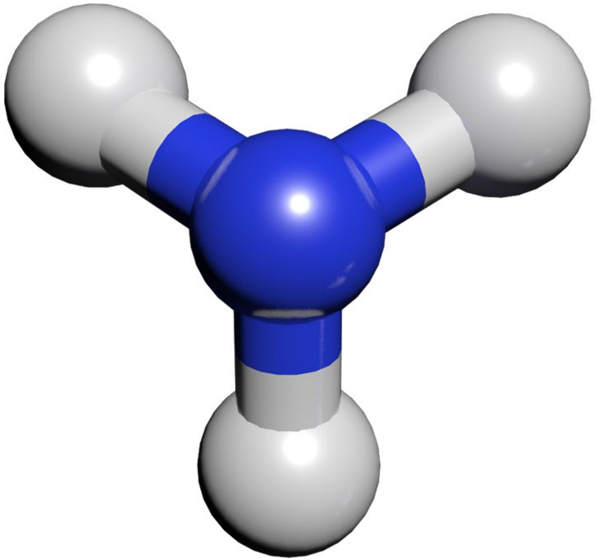
Hydrogen can be used to power a fuel cell or combusted in an internal combustion engine eventually with conventional marine fuels in duel-fuel engines.

The use of hydrogen-powered fuel cells for ship propulsion is still at an early design or trial phase – with applications in smaller passenger ships, ferries or recreational craft.

Other applications are also under consideration, including gas turbines or internal combustion engines in stand-alone operation or in arrangements incorporating fuel cells.

The cost of H2 depends to a large extent on the price of electricity as well as on the scale of the production plant and its use in the overall industry.

Ammonia



As H2 the NH3 can be used directly as fuels in internal combustion engine as well as in fuel cells.

If used in fuel cells, it creates no carbon or sulphur and nearly no nitrous emissions. When combusted, however, it can produce nitrous emissions, depending on the ignition temperature and thus it requires the use of a selective catalytic.

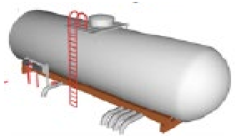
Ammonia presents some advantages compared to hydrogen technologies, though:

- it does not require cryogenic temperatures or very high pressure to be stored as a liquid;
- is a widely used commodity, so there is considerable experience in its handling and transport. Bunkering and storage infrastructure would require some modification, though, given the need to refrigerate or pressurize.

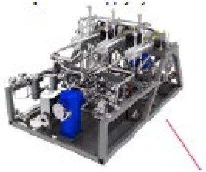
Decarbonization = Alternative Fuels + …?

FUEL TYPE	Energy Density [MJ/kg]	Volumetric Energy Density [GJ/m^3]	Storage Pressure [bar]	Storage Temperature [°C]
Marine Gas Oil	42,8	36,6	Atm	Ambient
Liquid Methane	50.0	23.4	Atm	-162
Ethanol	26.7	21.1	Atm	Ambient
Methanol	19.9	15.8	Atm	Ambient
Liquid Ammonia	18.6	12.7	Atm up to 10	-34 or 20
Liquid Hydrogen	120.0	8.5	Atm	-253
Compressed Hydrogen	120.1	7.5	700	Ambient

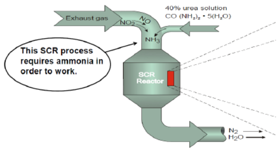
Ammonia & Hydrogen: the impact on design



Fuel Tank

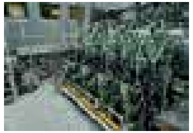


Fuel Preparation



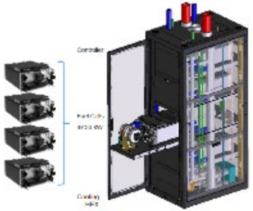
Selective Catalitic (NOx abatment)

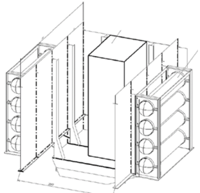
Bottles Rack for Metal Hydrates



I.C.E.

Fuel Cell Rack 120 kW (4x30 kW)





On board arrangement

The regulatory framework
Ongoing discussion on fuel cell and hydrogen

Due to the postponement of IMO meeting during 2020:

- The **Interim Guidelines for the safety of ships using methyl/ethyl alcohol as fuel** are expected to be approved in November 2020
- The **Interim guidelines for the safety of ships using fuel cell power installations** are expected to be finalized in 2021 and approved in 2022

At the moment, there is no mention to the use of hydrogen and other fuels due to the lack of concrete agreed proposals.

Make it sure, make it simple.