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In focus

A Voyage to Greener Shipping

Risks and opportunities

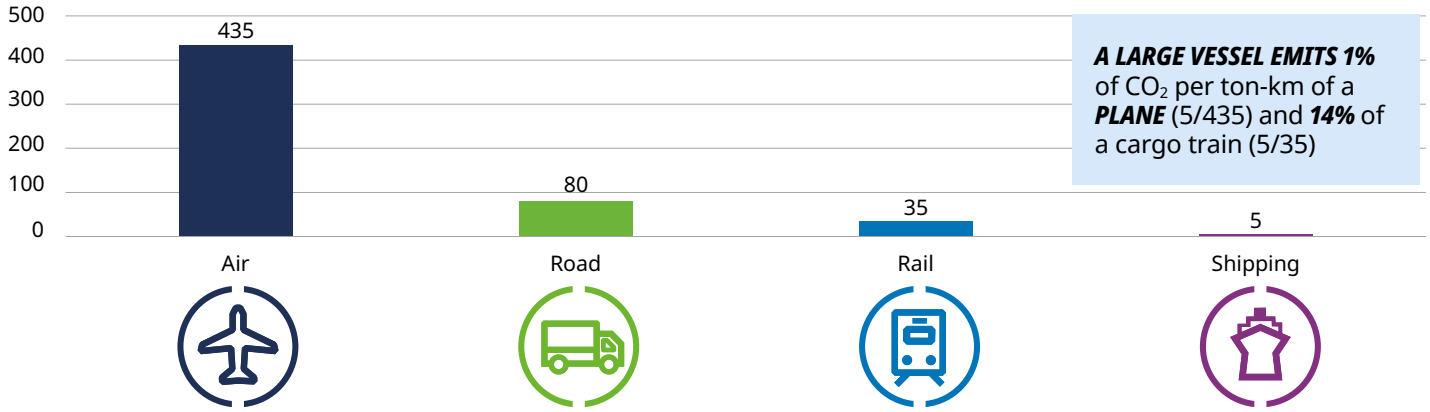
April 2023

Shipping is the most carbon efficient means of transportation (on a CO_2 per ton-km basis – see figure 1 below). However, global shipping still accounts for 1 billion tons of CO_2 per year, which is ca.3% of annual global GHG emissions.

Samuel Thomas
Sustainable Investment Analyst

Figure 1: Emissions by model of transport

(g CO_2/ton-km)



A LARGE VESSEL EMITS 1% of CO_2 per ton-km of a ***PLANE*** (5/435) and ***14%*** of a cargo train (5/35)

Source: Shell, IMO GHG study 2009.

Unsurprisingly, the largest source of carbon emissions comes from fuel combustion for propulsion. Fossil fuels (HFO, MGO, VLSFO and LNG[1]) currently provide 99% of sector's final energy demand and all have issues from contributing to CO_2 emissions, black carbon and methane leakage. International shipping provides 80–90% of global trade and accounts for 70% of global shipping emissions – **if it were a country, it would be the 6th largest emitting country[2].**

To reach a 1.5°C scenario the sector drastically needs to decarbonise. In a business-as-usual scenario, the OECD forecast maritime trade volumes to triple by 2050, bringing with it up to 250% increase in CO_2-equivalent emissions.

In this paper, we explore three key areas:

1 THE WAVE OF ENVIRONMENTAL REGULATION

- The shipping industry is facing of a wave of upcoming environmental regulations over the next 24 months and beyond. We look at the upcoming regulations and what they could mean for the industry
- Vessels that do nothing to reduce emissions could face a triple hit of financial penalties, higher carbon taxes and reduced consumer demand

2 PATHWAYS TO DECARBONISATION

- We revisit the decarbonisation strategy of the sector, examining the most likely short, medium and long-term pathways the industry can and will implement, including the pros and cons of each

3 GREEN SHIPPING – A $1.9TN MARKET OPPORTUNITY

- To meet the International Maritime Organization (IMO) 2050 emission targets, the scale of investment is estimated to be up to $1.9tn[3]

We have analysed over 100 decarbonisation projects being implemented across the industry and its value chain, focussing on engine technology, renewable fuel production, as well as bunkering and infrastructure projects.

1 HFO = heavy fuel oil, MGO = marine gas oil, VLSFO = very low sulphur fuel oil, LNG = liquid natural gas

2 IRENA

3 Global Maritime Forum

Schroders

1. THE WAVE OF UPCOMING ENVIRONMENTAL REGULATION

1. IMO 2023 – GREEN SHIPPING REGS COME INTO FORCE

In January 2023, the IMO 2023 regulations came into effect. These are new environmental regulations that introduce **mandatory reductions in carbon emissions for ships** (both existing and new build).

The regulations mean all vessels (above 400 gross tonnage) will have to undertake two assessments:

1. The first is to assess the energy efficiency of the vessel using an **Energy Efficiency Existing Ship Index (EEXI)**. Non-compliant vessels that receive a rating below a certain threshold may face penalties and will have to take corrective action

2. The second assessment is an annual **Carbon Intensity Indicator (CII)**, which must be carried out to rank and monitor the efficiency of individual ships. The CII rating will then become stricter over time, with annual carbon reduction factors applied to each vessel. The ultimate aim is to force vessels to improve their carbon intensities to meet the IMO 2030 goal of a 40% reduction in global shipping carbon intensity by 2030

Reporting of data starts in 2023 and vessel ratings will be assigned in 2024. Vessels will be assigned a grade from A (good) to E (poor) and corrective action for D and E-rated vessels will be needed by 2025–26. Vessels with three years of D grades or one year of E grade will be required to put in place a corrective active plan and/or face potential fines.

What could this mean?

Essentially this means more vessels will be forced to retrofit (and/or slow steam) which is ton-milage negative event and could result in capacity tightening in the industry. Similarly, it will mean that services for all the areas of improving ship efficiency are likely to see strong demand over the next few years and into the coming decade.

To put things into perspective, it has been estimated that between 35 and 40% of the global fleet could fall into the D and E categories[4] and require retrofitting.

4 Maersk believes around 35% of vessels globally are likely to fall into the D and E categories, whilst Clarksons estimate that it could be up to 40% of the global fleet

2. IMO TO UPDATE ITS GHG REDUCTION STRATEGY

In 2023, the IMO is expected to update their Initial GHG Reduction 2018 Strategy. The initial strategy in 2018 introduced the current emissions targets for the sector (40% intensity reduction by 2030, 70% intensity reduction by 2050 and 50% absolute reduction by 2050).

The IMO considered upgrading its emissions reduction targets at the 79th Marine Environment Protection Committee (MEPC) conference in December 2022. However, at the conference ten member countries were still opposed to eliminating the industry's emissions by 2050 (down from 24 opposing at the 78th MEPC).

It is widely anticipated that the IMO will work towards adopting a **more ambitious climate target by the 80th MEPC 80, in early July 2023**.

What could this mean?

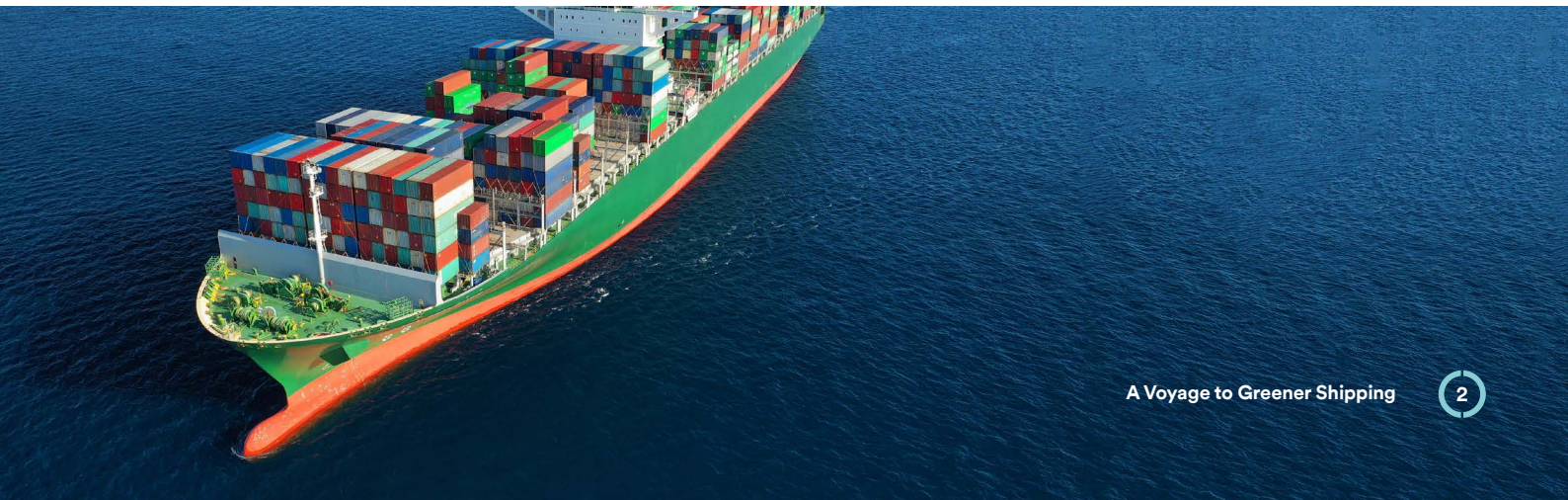
Many leading marine shipping companies have already set targets of achieving net zero by 2040–50, which is stretching compared to the IMO's current target of only halving the emissions by 2050, vs. a 2008 base year. Should the IMO's revised targets introduce net zero goals (or become significantly more aggressive), this would force a level playing field for the entire industry and accelerate investments in alternative fuels and propulsion technologies.

3. MARITIME EMISSIONS INCLUDED IN EUROPEAN UNION EMISSIONS TRADING SYSTEM (EU ETS) IN 2024

For the first time, shipping is to be included in the EU ETS, meaning emissions from ships will have a statutory cost element attached to them. Although the EU ETS is a regional regulation, it will impact many vessels trading in or to/from countries in the European Union, covering c.10–15% of international shipping emissions.

Vessel operators will need to surrender EU Allowances (EUAs) for:

- 20% of verified emissions from 2023
- 45% for 2024 emissions
- 70% for 2025 emissions
- 100% of 2026 emissions
- Full coverage will continue thereafter



Emissions from intra-EU voyages will be fully accounted in the ETS, while 50% of the emissions during trips from and to non-EU countries will be covered. ETS for shipping will initially address CO_2 emissions in 2024–25, and nitrogen oxide, soot and methane will be included from 2026.

Below is a worked example of how the inclusion of maritime emissions in the EU ETS could impact freight costs. The example shows how carbon costs would increase freight costs between 10–20% for four commonly-traded tanker routes.

Table 1: Worked example: impact of inclusion of maritime emissions in EU ETS on freight costs

	Vessel A	Vessel B	Vessel C	Vessel D
Emissions (tonnes of CO_2)	700	450	1,700	4,700
Carbon cost (USD per tonne)	105	105	105	105
Added carbon cost per journey	$73,500	$47,250	$89,250	$247,000
Carbon cost as % of freight rate	**17%**	**19%**	**10%**	**15%**

Source: Schroders' analysis. U.S. Energy Information Administration, Siglar Carbon Efficient Chartering. For illustration only.

What could this mean?

The additional carbon cost may not be that punitive for operators that can pass on pricing to customers, however, where certain freight routes have excess capacity, this might prove more challenging.

Similarly, companies with a high proportion of internationally shipped goods in their operations/value chains could face higher logistics pricing going forward.

2. PATHWAYS TO DECARBONISATION FOR THE INDUSTRY

There are a number of routes to decarbonisation for the industry. We have grouped these into short, medium and long-term solutions.

Table 2: Decarbonisation routes for shipping industry

SHORT-TERM SOLUTIONS	MEDIUM-TERM SOLUTIONS	LONG-TERM SOLUTIONS
Energy efficiency improvements: – Vessel operations – Vessel design	– Advanced biofuels – Green hydrogen (in direct combustion or fuel cell)	– E-methanol – Green ammonia

SHORT-TERM SOLUTIONS: ENERGY EFFICIENCY

There a numerous short-term energy efficiency solutions that vessel owners and operators can and will implement.

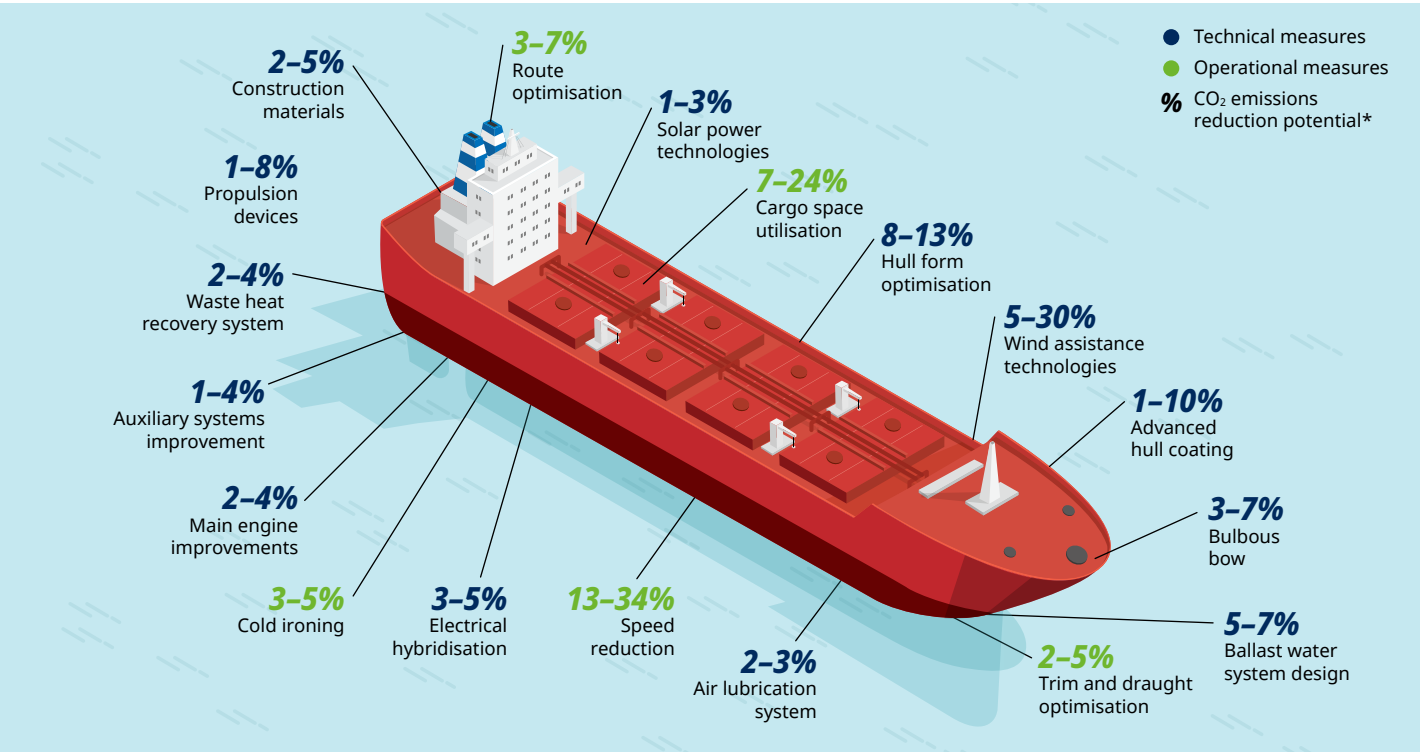
These can be split into operational solutions and design solutions, as outlined in the table and figure below:

Table 3: Short-term energy efficiency solutions

Operational	Design
Voyage performance management: – Just-in-time arrival – Ship speed optimisation – Weather routing – Autopilot improvements – Trim, draft and ballast optimisation	**Hull and superstructure:** – Ship sizing – Principal dimensions – Ship weight – Aftbody and forebody optimisation
Energy management systems: – Reduce onboard power – Fuel quality	**Propulsion systems:** – Propeller optimisation – Enhancement of propulsion drives – Air lubrication systems
Vessel maintenance measures: – Hull roughness management – Propeller roughness management	**Power systems:** – Main engines – Auxiliary equipment – Assisted propulsion by wind and solar

Source: IRENA, UMAS – University Maritime Advisory Services.

Figure 2: Short-term energy efficiency solutions



*Values associated with efficiency improvement measures are indicative of a typical ship operation and are not necessarily cumulative, due to technical incompatibilities
Source: UMAS

MEDIUM-TERM SOLUTIONS: ADVANCE BIOFUELS

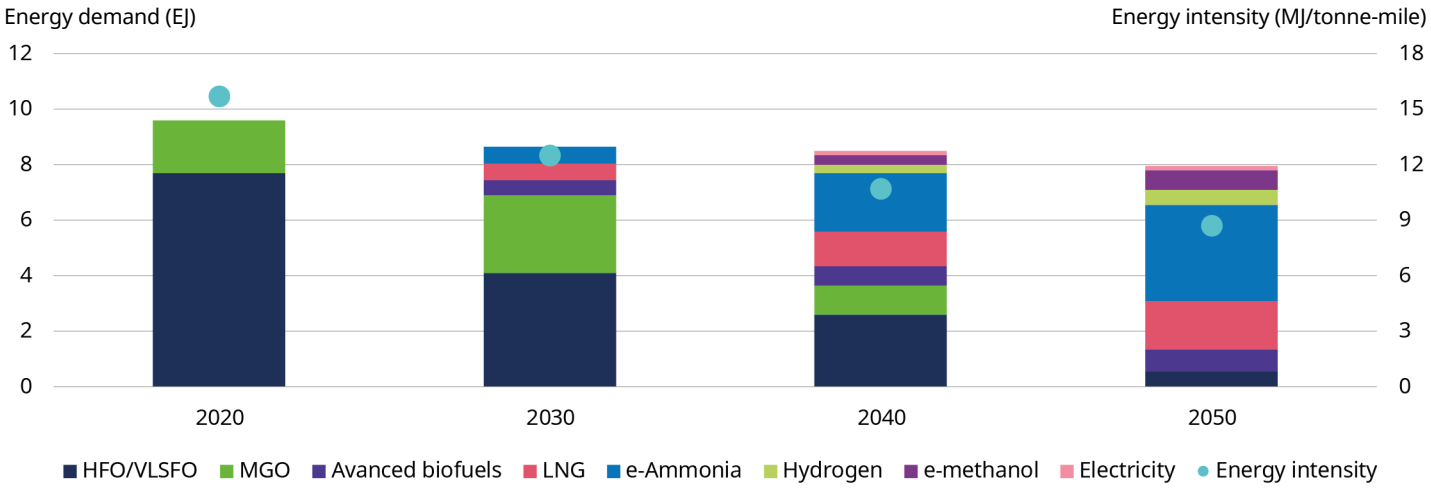
Advanced biofuels are a medium-term decarbonisation solution for the industry. They can only be considered a medium-term solution due to the issue of feedstock availability, due to competition with growing food demand and biodiversity concerns.

The vast majority of biofuels are first generation, meaning crops that are specifically grown for biofuel production. To minimise impact on food supply, biofuels from biowaste (fats, oils and grease – FOGs) can be used, however scalability issues prevent it from becoming a long-term, feasible option. Importantly, biofuels can be immediately applied within the industry, with up to 20–30% fuel blends without the need for engine modifications.

Despite not being a long-term solution, biofuels will play their part in decarbonising the industry. To reach IRENA's 1.5°C scenario, demand for advanced biofuels needs to grow 9% p.a., eventually reaching 10% of the total fuel mix by 2050 (from <1% in 2020)[5], as shown in Figure 3 below.

5 IRENA

Figure 3: 1.5°C scenario energy pathway, 2018–2050



Source: IRENA.

MEDIUM-TERM SOLUTIONS: GREEN HYDROGEN (INDIRECT COMBUSTION OR FUEL CELL)

Direct use of hydrogen is unlikely to be a long-term solution for the decarbonisation of the international shipping industry, as it is better suited for short sailing (ferries or passenger ships) due to its low energy density. The kilo-watt hours per litre equivalent of fuel for hydrogen is about 70–80% lower than that of diesel and 50% lower than LNG.

Hydrogen is also difficult to store and transport due to the fact that it needs to be kept in cryogenic conditions (-250°C). However, the indirect use of green hydrogen in the production of green ammonia and e-methanol will be critical for the decarbonisation of the industry.

LONG-TERM SOLUTIONS: E-METHANOL

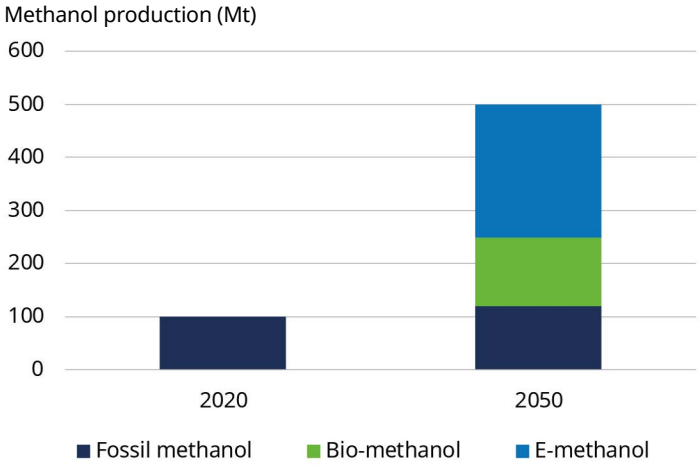
E-methanol is considered a long-term renewable fuel solution for the industry and is made by combining biogenic CO_2 from Carbon Capture and Storage (CCS) and green H_2. The benefit of e-methanol vs. existing fossil fuels is that the combustion is cleaner – no SO_2, reduced NOx and no black carbon.

It is considered green as carbon emissions emitted during e-methanol combustion are offset by the carbon captured during its synthesis. So long as the hydrogen and carbon dioxide come from green sources, the fuel is categorised as renewable. Additionally, it is a liquid fuel, so transportation and storage infrastructure does not need to change. Lastly, the need for engine modifications is lower compared to other renewable fuels.

The main disadvantage, however, is the availability of cheap and renewable carbon sources. Whilst CCS may be technically feasible, at present economic feasibility remains the key challenge (particularly when compared to other fuel sources).

Nevertheless, e-methanol is forecast to be a key renewable fuel for shipping. From less than 0.2Mt p.a. of production today, renewable methanol production is expect to increase exponentially to 250Mt by 2050. Market forecasts currently expect this to reach $3.14bn by 2030 (from <$150m today)[6].

Figure 4: Revewable methanol production forecasts



Source: IRENA.

6 IRENA

LONG-TERM SOLUTIONS: GREEN AMMONIA

Green ammonia is made by combining green hydrogen and nitrogen (from air separation) and is another key renewable fuel enabling the shipping industry to decarbonise[7].

Green ammonia as a renewable fuel has a number of benefits including:

- Mature production and transport logistics
- Carbon-free combustion
- High energy density
- No need for costly CO_2 in synthesis (unlike e-methanol)

However, it also has the disadvantages of high toxicity (hard to store/corrosive), harder to combust and demand competition from other industry applications. Nonetheless, global ammonia demand is forecast to increase from 183 Mt in 2020 to 688 Mt in 2050, of which, 566mt (more than 80%), expected to be renewable[8]. At present, the combined capacity of announced renewable ammonia plants will be 15Mt by 2030.

7 IRENA

8 IRENA

OTHER AREAS TO CONSIDER

Scrubbers

Scrubbers are designed to capture sulphur oxide (SOx), nitrogen oxide (NOx) and particulate matter, but not greenhouse gas emissions. In fact, scrubbers have sometimes been found to boost CO_2 emissions due to the energy needed to run them. There are some scrubber manufactures that are developing scrubbers that can capture CO_2, however this technology is still very early stage. The IMO has stated they would allow for the use of on-board carbon capture and storage technology to meet its 2030 target, however no guidelines have yet been developed.

Wind propulsion

In perfect conditions wind propulsion can provide between 5–20% of the energy required by vessels. Installations have been happening on large vessels but adoption has been extremely slow. This is likely due to a few factors; most wind technologies (as well as solar) are deck-space negative and therefore costly. Furthermore, most port logistics operations would require the blades to be retractable. We do not believe wind propulsion technologies will play a major role in the decarbonisation plan of the industry.

3. GREEN SHIPPING: THE $1.9TN INVESTMENT OPPORTUNITY

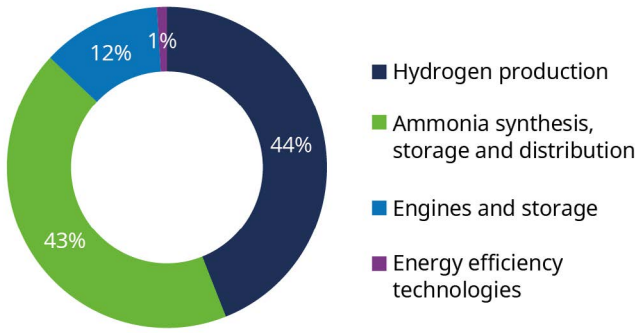
It will require between $1–1.4tn of cumulative investment across the shipping industry and its value chain, to reach the IMO's target of reducing absolute emissions by **at least 50% by 2050** (or $50–70bn annually between 2030–2050). To fully decarbonise the industry, cumulative investment between $1.4–1.9tn will be required between 2030–2050[9].

These estimates are based on a scenario in which ammonia becomes the primary zero carbon fuel choice. However, even if other fuels such as hydrogen or e-methanol become more dominant, the magnitude of investment needed does not significantly change.

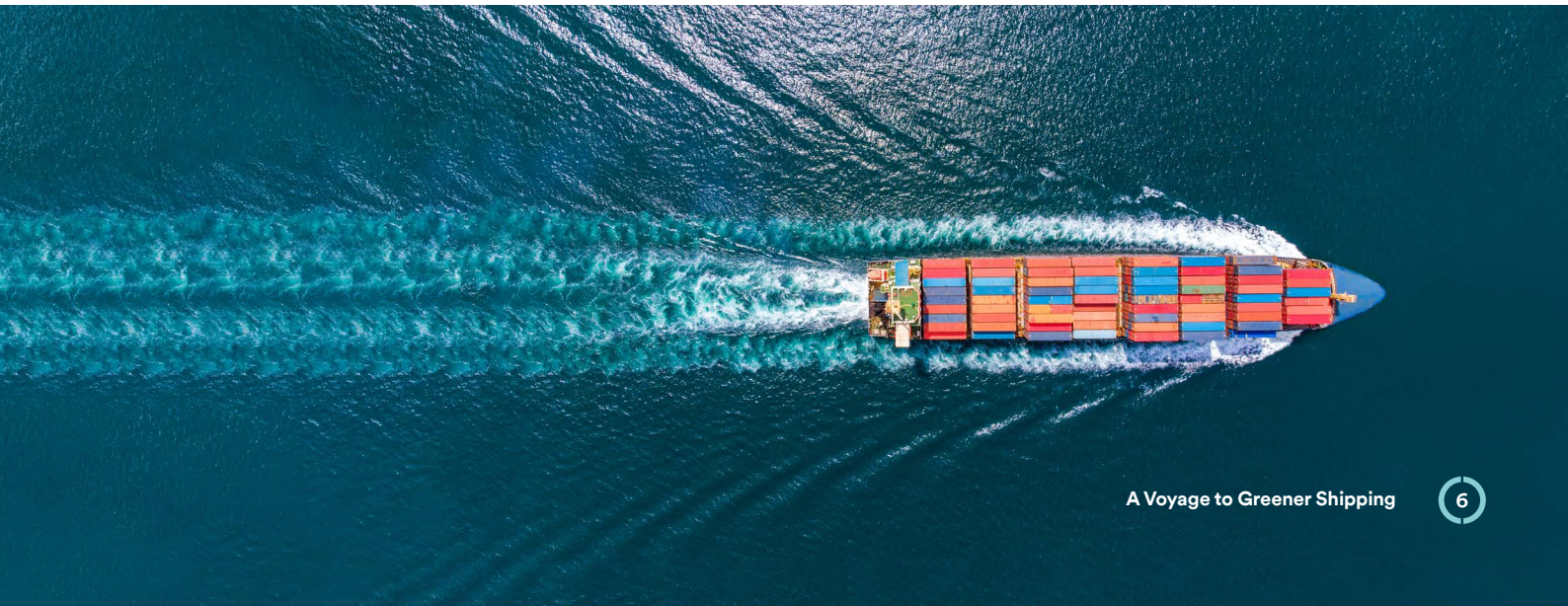
The vast majority of decarbonisation will come from the fuels and therefore, unsurprisingly, that is where the majority of investment is needed. The pie chart below shows the breakdown of the $1.9tn by decarbonisation pathway.

9 IMO

Figure 5: Decarbonisation investment breakdown by sub-theme



Source: Global Maritime Forum.

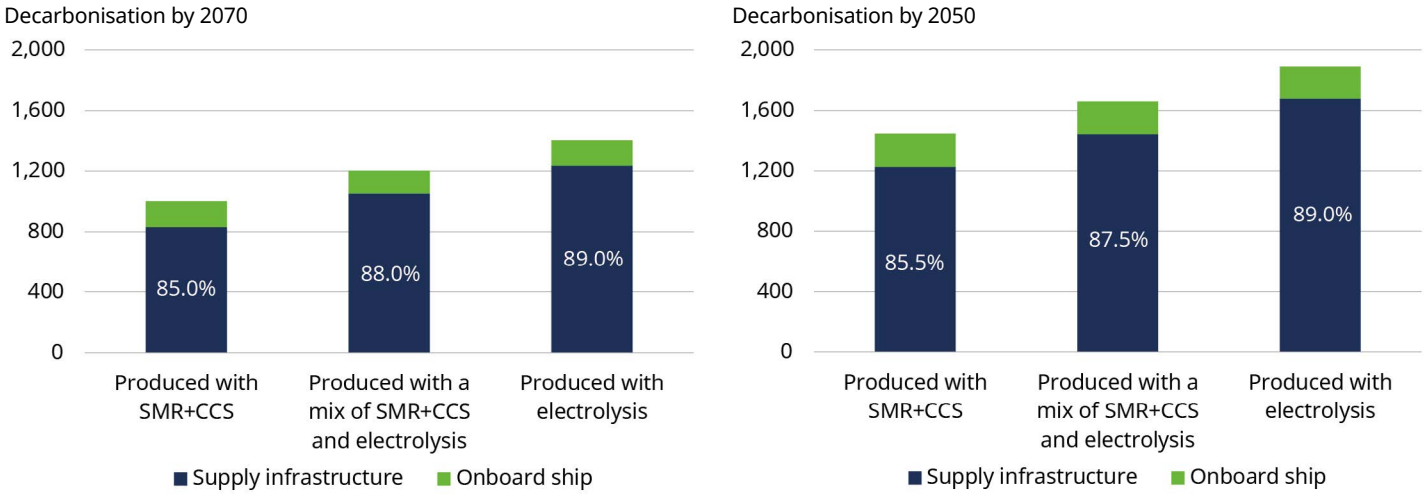


Broadly speaking, the investment opportunity can be split into two different areas:

1. Investments needed to improve the ships themselves (energy efficiency and engines) which account for 13% of the total required investment and
2. The land-based storage and bunkering infrastructure investment needed for ammonia and hydrogen synthesis (87% of required investment).

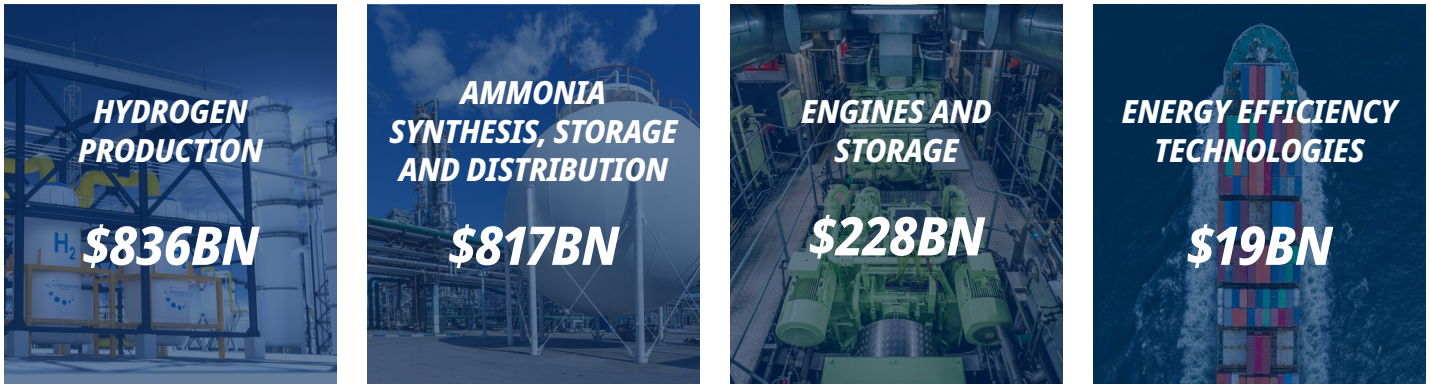
The bar charts below outline the quantum of investment required in these two areas when adopting various methodologies of ammonia production for the two decarbonisation scenarios.

Figure 6 and 7: Total investment required by decarbonisation scenario and ammonia production methodology



Source: Global Maritime Forum.

ACCESSING THE INVESTMENT OPPORTUNITY



Source: Schroders.

As an investor, one way of accessing this investment opportunity is to create a basket a companies which are well-placed to facilitate and benefit from the greening of the shipping industry.

To do this, we have used our proprietary tool, ThemEx, which aligns companies to sustainable investment themes including the UN Sustainable Development Goals based on their products and services. This analysis can be overlayed with fundamental analysis to identify those companies exposed to the four 'green shipping' sub-themes outlined above.

To be included in a green shipping universe, we would suggest that companies should have one or more of the following:

1. Derive the majority of revenues from sales of technology, equipment or services related to marine decarbonization, within our four green shipping sub-themes
2. or, have made substantial investment commitment, typically a majority of their research and development budget, in marine decarbonization technologies, equipment or services, including lower carbon fuel development, distribution or consumption
3. or, be a stakeholder in a marine decarbonization demonstration project recognized by the Global Maritime Forum.

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