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February 2021
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SPOTLIGHT

The second frontier

Towards low carbon shipping

Shipping represents 13% of global transport CO_2 emissions and has lagged other transport sectors in the drive to decarbonise

With global sea freight demand potentially tripling by 2050, policy and technological innovation are key to hitting emissions targets

The solutions will include greater use of batteries and LNG/LPG, and, longer term, ammonia and green hydrogen could play important roles

This is a redacted version of a report by the same title published on 10-Feb-21. Please contact your HSBC representative or email AskResearch@hsbc.com for more information.

Why read this report?

- Shipping represents 13% of global transport CO_2 emissions and has lagged other transport sectors in the drive to decarbonise
- With global sea freight demand potentially tripling by 2050, policy and technological innovation are key to hitting emissions targets
- The solutions will include greater use of batteries and LNG/LPG, and, longer term, ammonia and green hydrogen could play important roles

The marine sector needs to decarbonise: business as usual will not be sufficient

Shipping has lagged other transport sectors in reducing emissions

With COVID-19 accelerating a global focus on climate and biodiversity, we expect efforts to cut greenhouse gas emissions in the shipping sector to intensify. The maritime industry, and shipping in particular, remains a big polluter, accounting for 13% of the carbon dioxide emitted by the transport sector, and it has been slower than other sectors to respond. The International Maritime Organisation (IMO), the shipping sector's main regulator, is targetting a 50% reduction in GHG emissions and a 70% reduction of CO_2 by 2050. Yet in a business continues as usual scenario, GHGs could actually increase by 250% by 2050 relative to 2008 levels (see Charts 1 and 2), as global sea freight is set to triple by then. This highlights the scale of the challenge facing the sector.

Different intermediate technologies will help partial decarbonisation

A mix of policy and technology will be needed to decarbonise the complex marine landscape

Shipping has lagged other sectors in cutting emissions because it is a complex and fragmented industry, with a large range of vessel types and vessel lives averaging 20-30 years. However, momentum to change things is increasing with newly introduced IMO 2020 regulation driving a move away from highly polluting bunker fuel to low sulphur fuel oil (LSFO, akin to diesel).

This policy is focused on desulphurisation rather than decarbonisation – meaning far more stringent measures will be needed on the emissions side to meet the 2050 targets. Technology will be crucial to these efforts, which is why many marine industry executives are actively pursuing innovations that will help to cut fuel emissions and increase voyage efficiency.

LNG, batteries and digitisation will play a crucial intermediate role…

Intermediate technologies are emerging for lowering emissions

Key technologies that we see gaining traction on the route to 2050 are: 1) more widespread adoption of Liquefied Natural Gas (LNG) and Liquefied Petroleum Gas (LPG) in engines; 2) batteries and electrification (though we think these will remain limited to shorter-haul vessels); and 3) digitisation which drives greater voyage efficiency through integration with ports.

…while green hydrogen and ammonia offer longer-term zero carbon options

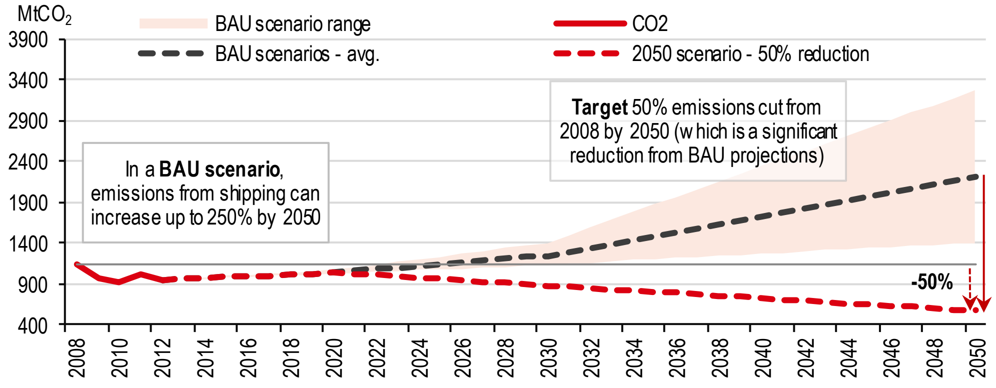
Green hydrogen and ammonia are promising zero carbon solutions

Further ahead, we expect fuels such as hydrogen and ammonia to emerge as zero carbon propulsion alternatives for the industry. If produced using renewable resources, hydrogen releases no harmful emissions and has enough energy density to be used on large ships and long voyages. The world's first liquid hydrogen powered ferry (developed by Norled) is set to launch in 2022. Combining hydrogen with nitrogen produces ammonia, which we believe could be even better suited to the industry due to its energy intensity and ease of storage.

In an accompanying stock report we highlight eight companies exposed to this theme: *Towards low carbon shipping: 8 stocks to play the theme* (10 February 2021).

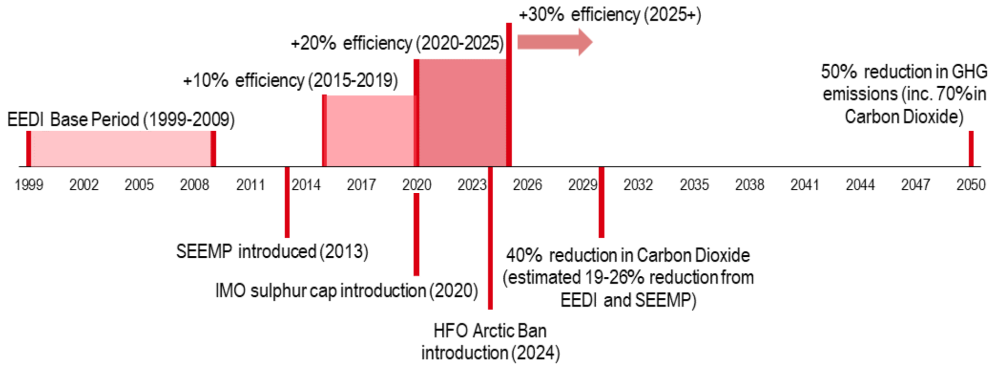
This is a redacted version of a report by the same title published on 10-Feb-21. Please contact your HSBC representative or email AskResearch@hsbc.com for more information.

Chart 1. Marine sector emissions rising 250% by 2050 in a business as usual scenario: the gap to meet 2050 reduction targets is huge



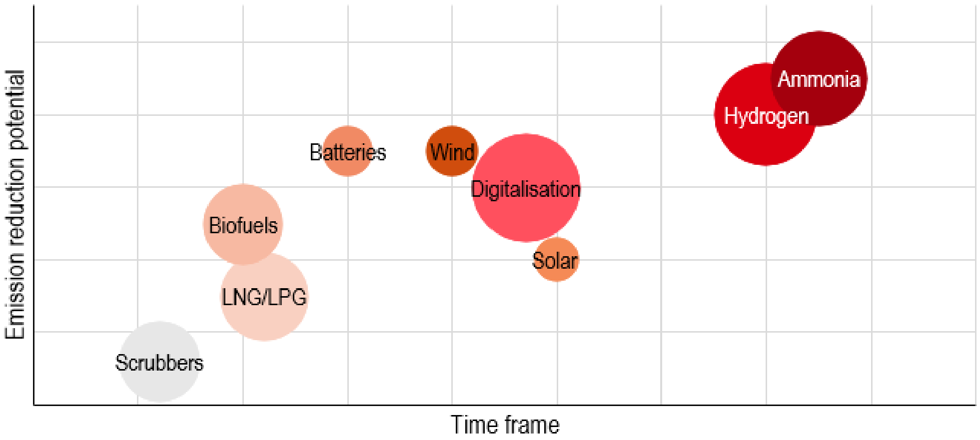
Source:IMO, HSBC. Note: Solid red line = historical CO_2 emissions

Chart 2. With IMO 2020, policy measures have stepped up, but more intervention will be required to drive the industry to comply with 2050 emissions reduction targets



Source: HSBC

Chart 3. HSBC Decarbonisation Disruption Framework: an overview of key marine technologies to help close the gap to 2050



Source: HSBC

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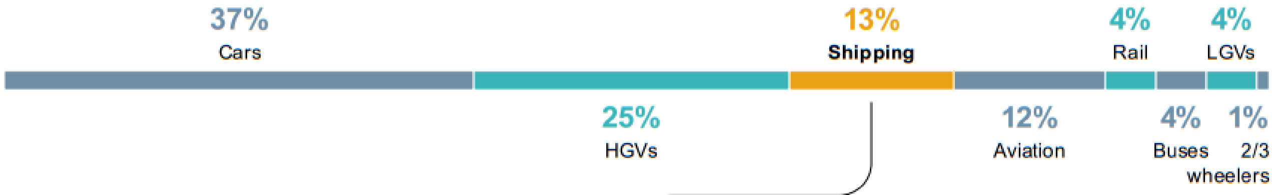
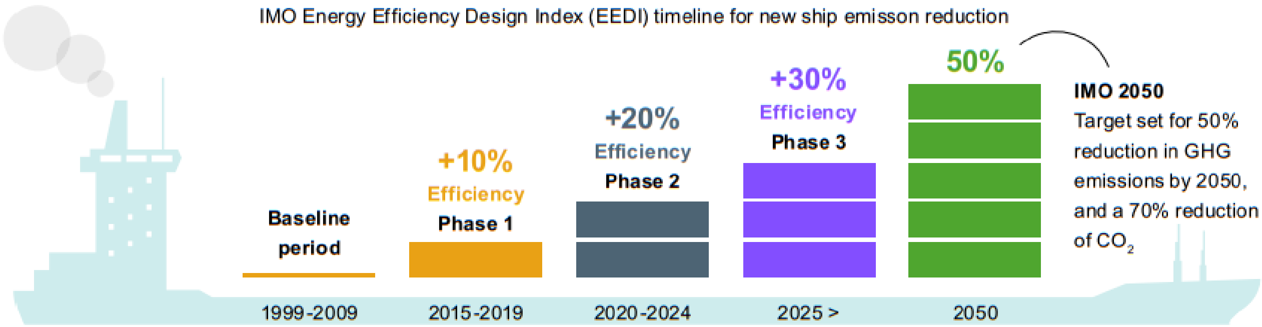
Routes to cleaner shipping

Shipping is the third largest CO_2 emitter within the global transport sector …

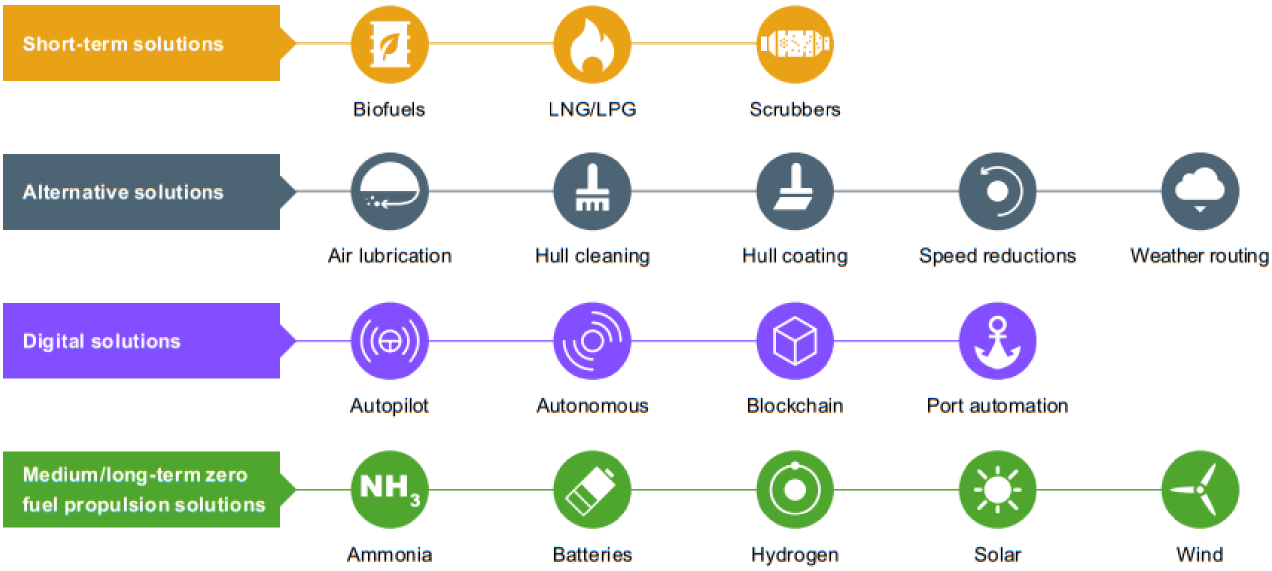


… and needs to hit these targets to decarbonise by 2050

IMO Energy Efficiency Design Index (EEDI) timeline for new ship emisson reduction



Fuel technology and digitalisation should enable shipping companies to reduce carbon and sulphur emissions



>USD310bn

Cost savings across the marine industry by implementing the IMOs 'Ship Energy Efficiency Management Plan' (SEEMP) and the EEDI efficiency plan by 2030

USD38bn

Annual sector savings from utilising digital technologies. With expensive paperwork and processes reduced, there is potential for R&D in clean technologies

USD1trn

Switching to green ammonia as a primary source of propulsion fuel to meet the IMO's GHG emissions targets would require significant investment

Source: IBM, UCL, HSBC (2015)

Why decarbonise marine?

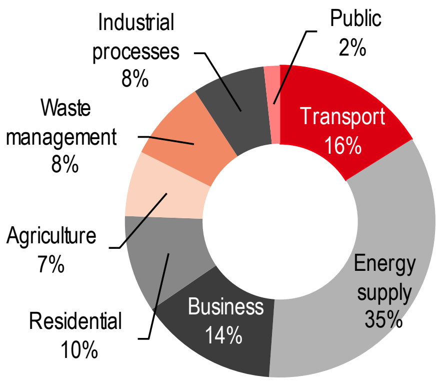
- Marine accounts for 13% of global transport CO_2 emissions and is considered a hard-to-abate sector
- To hit IMO 2050 emission and decarbonisation targets, the complex marine ecosystem will need to deploy a number of technologies
- This includes short to longer-term tech solutions: LNG/LPG and biofuels for reducing carbon today; digitisation technologies for more efficiency in marine; and longer-term goals of zero emission fuels like hydrogen and ammonia

The second frontier… towards decarbonising marine

The transport sector produces 24% of CO_2 emissions globally

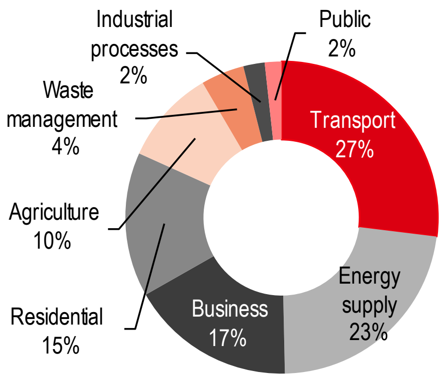
In January 2019, our HSBC Global Research ESG team published a report (*The Second Frontier*) highlighting that even with the power generation sector (the first frontier) fully decarbonised, this wouldn't be sufficient to meet the 2015 Paris Agreement to limit global warming by less than 2°C. The transport sector (the second frontier) is the next focus of decarbonising efforts to help achieve this target, as it produces 24% of CO_2 emissions globally.

Chart 4. Transport accounted for 16% of the UK's total emissions in 1990…



Source: UK Government, HSBC (2018)

Chart 5. …this rose to 27% by 2018



Source: UK Government, HSBC (2018)

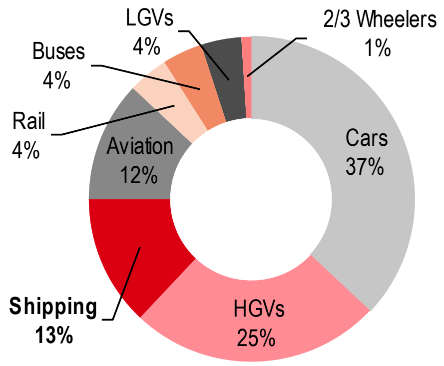
Many economies are observing their transport sector emissions falling in absolute terms, however, rising in relative terms due to a greater rate of decarbonisation in other sectors, highlighting the importance of transport-focused technological and policy developments. Charts 4 and 5 illustrate such changes, with transport emissions in the UK reaching 128.1MtCO_2e in 1990 and falling to 124.4MtCO_2e by 2018, however, accounting for a greater share of total emissions[1].

The Second Frontier report introduced the Clean-Power-and-Transport-2040 scenario (CPT-2040), which assumes full decarbonisation of the power generation sector and a 76% emission

1 '2018 UK Greenhouse Gas Emissions, Final figures', UK Government, 2018

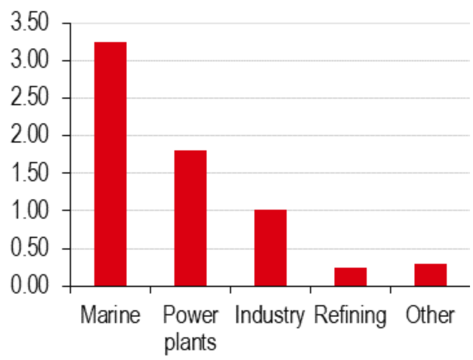
reduction in the transport sector, between 2020 and 2040. This incorporates the advances of hydrogen, electricity and biofuels to replace oil for transport modes. The scenario highlights the more hard-to-abate transport sectors, including shipping, aviation and trucks. Through increased policy and low carbon technology adoption, shipping is modelled to produce 38% lower emissions in 2040 compared to 2008 levels.

Chart 6. Shipping is the third largest CO_2 emitter within the global transport sector



Source: UCL, HSBC (2015)

Chart 7. Marine generates the largest oil demand by sector (mbpd)

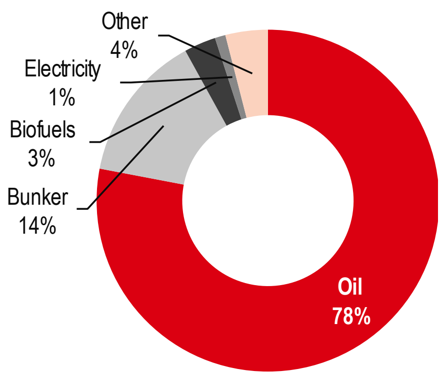


Source: IEA, HSBC (2016)

Last year we tackled decarbonising HGVs, the 2nd highest transport emittor

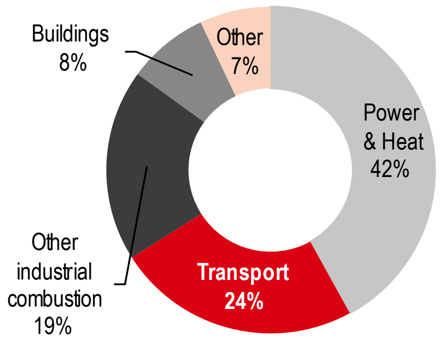
Our *Towards Low Carbon Trucks* report, published in May 2020, illustrated the range of potential alternative fuels for HGVs (heavy goods vehicles). The report highlights the drive of hydrogen and batteries to achieve decarbonisation of this section of the transport sector, which produces 25% of global transport CO_2 emissions. See Chart 6.

Chart 8. Oil dominates the global transport fuel consumption mix



Source: IEA, World Energy Outlook 2017 (2016)

Chart 9. Total CO_2 emissions from fossil fuels by sector



Source: IEA (2016)

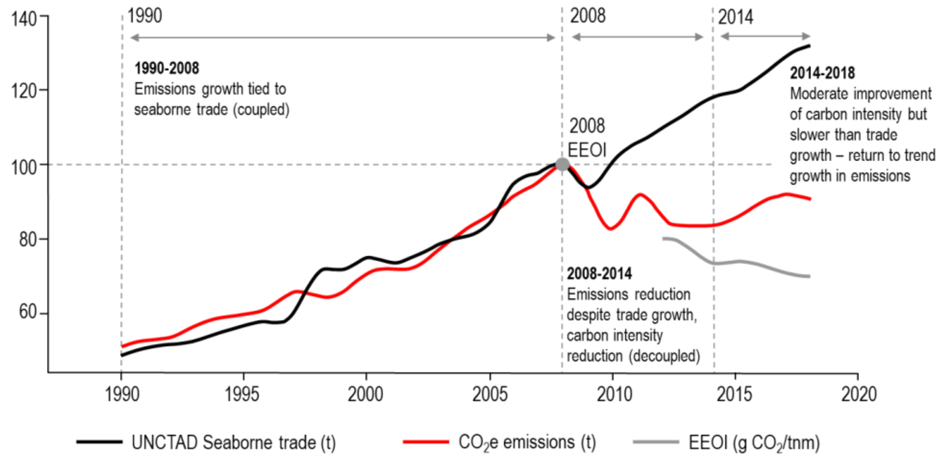
Shipping is the third highest emitter of CO_2 in the transport sector at 13%

The aim of this report, is to analyse the potential alternative fuel technologies and strategies, which can help disrupt and decarbonise the shipping industry, which is the third highest producer of CO_2 in the transport sector at 13%, behind cars (37%) and HGVs (25%). Shipping has seen a lack of progress to reduce emissions due to its global scale, range of vessel types and longevity of vessel life, averaging 20-30 years.

Global CO_2 emissions from shipping rose by 10% between 2012 and 2018

The 4th IMO GHG study from 2020 highlighted that, although trade volumes rose by around 20% during 2012- 2018, global CO_2 emissions from shipping increased by only 10% (from 962Mt to 1,056M). We also note that, in the longer timeframe, from 2008 to 2018, CO_2 emissions actually fell by 7% (Chart 10). This is thought to be a consequence of the Global Financial Crisis, whereby trade volumes fell and vessel speeds were reduced to provide fuel cost savings (and thus lower emissions). Between 2012 and 2018, carbon intensity fell by 11%, however, these efficiency gains were offset by the significant increase in trade volume.

Chart 10. Shipping emissions at an inflection point? (indexed to 2008)



Source: IMO, HSBC (2021)

Table 1. Global trade and CO_2 emissions rose by 20% and 10%, respectively, while carbon intensity fell by 11% between 2012 and 2018

Year	Total shipping CO_2 (Mt)	Global seaborne trade (Bt)	EEOI (g CO_2/tnm)
2012	962	9.2	13.16
2013	957	9.5	12.87
2014	964	9.8	12.34
2015	991	10.0	12.33
2016	1,026	10.3	12.22
2017	1,064	10.7	11.87
2018	1,056	11.0	11.67

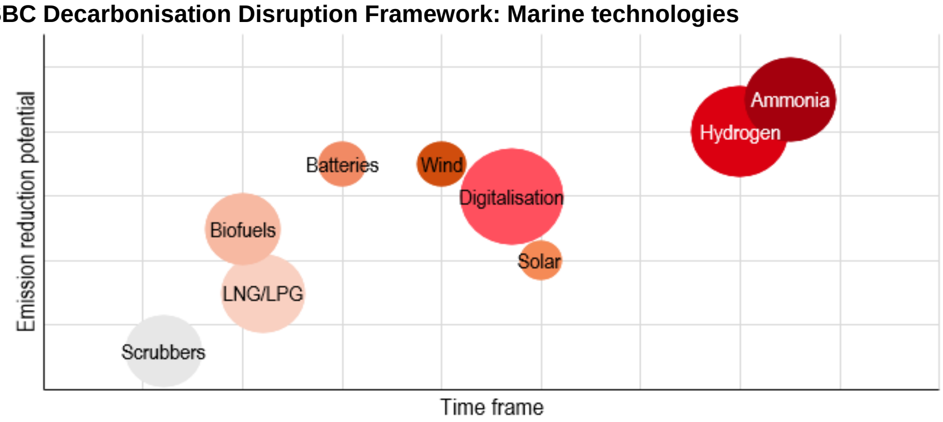
Source: IMO, UNCTAD (2020), Note: EEOI (Energy efficiency operational indicator) – vessel-based vales.

Regulations and technologies will play a key role in the shift to green marine

The global pursuit of tackling the decarbonistion of marine sector has resulted in increased regulations and policies by both governments and non-state actors, sparking the acceleration of applicable technological developments in alternative fuels, including hydrogen, batteries and wind. Today, the transport sector predominantly uses oil as its fuel, making up 78% of its consumption, producing 24% of global CO_2 emissions from fossil fuel (Charts 8 and 9). With increasing economic development and rising population, demand for transport will inevitably rise and thus the level of emissions. The transport sector has an opportunity to limit the expected rise in emissions through adopting alternatives to oil and decarbonising.

Hydrogen and ammonia likely to be the main zero emission propulsion fuels in the long term but in the meantime, there are a number of possible intermediatary steps

HSBC Decarbonisation Disruption Framework: Marine technologies



Source: HSBC (2021), Note: Bubble size represents range of vessel applicability, orange/red = decarbonisation, grey = desulphurisation

Journey to decarbonisation, including desulphurisation

LNG and biofuels already in play as medium-term solutions… …however, they are not the long-term solutions

…however, they are not the long-term solutions

- **Short/medium-term solutions –** These include scrubbers, LNG/LPG and biofuels, which assist the industry in meeting the current emissions regulations by reducing levels of pollutants such as CO_2 and SO_x.

  However, these solutions have less scope for longer-term use due to factors such as inability to be scaled up to meet demand, whilst harmful emissions and pollutants are still released.

Zero emission fuels like hydrogen are the holy grail for marine

- **Medium/long-term solutions –** In the longer term, we expect fuels such as hydrogen and ammonia (by combining hydrogen with nitrogen) to emerge as zero carbon propulsion alternatives for the industry. If produced using renewable sources, hydrogen releases zero harmful emissions and has sufficient energy density required for use on large, long voyage vessels.

Companies are starting to develop and deploy green marine

  The challenge lies in the development of the technologies and infrastructure, as well as the significant costs that this will incur. However, we note promising progress by companies looking to integrate these fuels into the industry.

Reduction of fuels helps with lowering emissions

- **Alternative solutions (efficiency gains) –** Reducing overall fuel consumption limits the quantity of emissions produced. Efficiency strategies such as *speed reductions* and *hull cleaning* can be implemented with little investment and return fuel savings of 10-30% and 1-10%, respectively.

Wind and solar can play a role in some vessels, reducing fuel use

  Wind and solar technologies provide the ship with a renewable source of propulsion, helping to reduce fuel consumption and improving efficiencies further. A study by the International Council on Clean Transportation (ICCT) found that one rotor sail can reduce fuel consumption by 1-12%, with savings increasing as more sails are adopted. Tilting rotor sails could achieve a CO_2 reduction of 25% for two sails. Incorporating solar panels on sails to harness both solar and wind power could mean fuel savings of 15% for a vessel utilising the dozen sail system. However, these technologies are unlikely to become a ship's main source of propulsion power, therefore, alternatives are required to replace heavy fuel oil (HFO) and decarbonise the shipping industry.

Batteries a solution for zero emissions in small vessels

  Batteries have emerged as contenders and have been installed on ferries with success. However, challenges remain with the size of vessel able to utilise this technology, therefore, isn't suitable for a significant share of vessels.

Digitisation is key for marine until longer-term solutions

- **Digital solutions (digitisation gains) –** To assist in decarbonisation targets, digital technologies can be applied to the marine sector from today.

Autonomous vessels reduce fuel use

  The use of autopilot and autonomous vessels reduces human error, which currently accounts for 80-90% of marine incidents. Rudder positioning efficiencies and the reduction in crew facilities result in fuel savings of 1-3% and 6%, respectively. The latest developments include semi-autonomous navigation and docking.

Blockchains reduce paperwork footprint, saving costs

  Blockchain technologies allow the digitisation of procedures to reduce emissions as a result of greater supply chain visibility, data sharing and reduced paperwork. Additionally, significant cost reductions can be observed.

Smart ports reduce GHGs

  The development of smart ports is helping reduce congestion and waiting time for ships, effectively reducing emissions both around ports and overall GHGs. Challenges remain in investment costs and cyber security, however, improving efficiency and emission reductions via digital technologies can help the industry achieve results over the decades to 2050.

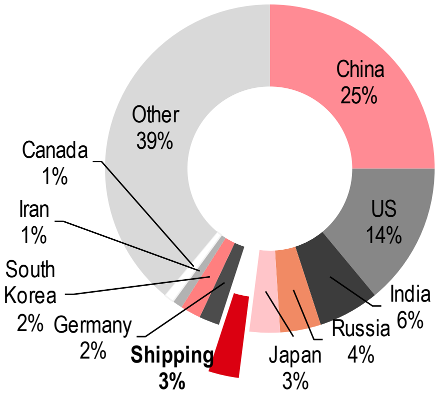
For a list of corporate participants of the decarbonising marine theme, please contact your HSBC representative or email AskResearch@hsbc.com for more information.

Marine emissions overview

Shipping produces 2.5% of global GHG emissions

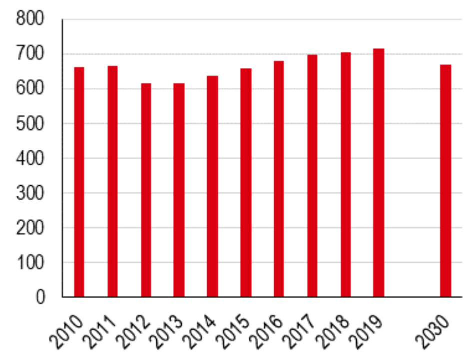
Shipping is the most prominent transporter of goods globally, with 80-90% of global goods transported by sea. The shipping industry produces 2.5% of global GHG emissions and if international shipping were to be considered as a country, only 5 countries produced more CO_2 emissions in 2015: China (25%), US (14%), India (6%), Russia (4%) and Japan (3%). See Chart 11.

Chart 11. Only five countries emit more CO_2 than international shipping (country-wise % of global CO_2 and shipping CO_2)



Source: ICCT (2015)

Chart 12. CO_2 emissions from international shipping rose between 2012 and 2018 ($MtCO_2$)



Source: IEA (2019), SDS scenario for 2030

As well as GHG emissions including CO_2 and NO_X, harmful pollutants such as SO_X, which contributes to acid rain, and particulate matter (PM) which has adverse human health effects, are produced by the marine industry. Definitions and impacts are summarised in Table 2.

Marine GHG emissions increased by 10% between 2012 and 2018

According to a report by the IMO in 2020, GHG emissions from shipping rose by 10% between 2012 and 2018, from 977 million tonnes to 1.076 million tonnes. Of particular concern is the high level of 'short-lived' pollutants such as black carbon and methane, which rose by 12% and 150%, respectively, over the same period. The significant rise in methane emissions is due to the increased use of liquefied natural gas (LNG), which reduces CO_2 and NO_X, emissions and produces no SO_X or PM emissions, however, emits high levels of methane compared to heavy fuel oil (HFO). The report found that under business-as-usual (BAU), GHG emissions could reach 50% above their 2018 level by 2050[2].

In 2015, 60,000 deaths were linked to PM emissions from shipping in ports

Not only is the motivation for decarbonisation due to the threat of climate change, the direct risk to human health stands as a present danger of high emissions. Research by the International Council on Clean Transportation (ICCT) found that 60,000 premature deaths were directly linked to PM pollution from shipping in 2015, which roughly equated to USD160 billion in health damages.

Table 2. Harmful impacts of emissions from shipping

Emission	Harmful impact
Carbon Dioxide (CO_2)	A greenhouse gas (GHG) which contributes to global warming, resulting in rising sea levels, extreme weather events and biodiversity depletion.
Sulphur Oxides (SO_X)	An air pollutant which is harmful to human health via respiratory complications, including lung disease, and premature deaths. Contributes to acid rain, which harms crops, forests and aquatic ecosystems.
Nitrogen Oxides (NO_X)	A GHG that additionally affects human health via respiratory complications, headaches and dizziness.
Particulate Matter (PM)	Contributes to acid rain and climate change, as well as being one of the main components of smog in cities, adversely impacting human health.
Black Carbon	A component of PM which has a climate warming impact. ICCT estimates 21% of CO_2-equivalent emissions from shipping is black carbon particles, the second biggest contributor to global warming after CO_2.
Methane (CH_4)	A GHG which is 84-86 times more potent than CO_2 in a 20-year period, and 25 times more potent in a 100-year period.

Source: HSBC

2 "Fourth IMO Greenhouse Gas Study", IMO, 2020

It's to be noted that not only GHG emissions damage environmental ecosystems. Our report *Paradise Lost?* (June 2020), highlighted the impact of ballast water and sewage discharge from shipping in the reduction of marine ecosystem diversity.

Tender controls in Norway disincentivising oil and gas use

Some countries are implementing emission controls to assist in the decarbonisation of the shipping industry. Norway has introduced standards for tenders of new vessels, the measuring of emissions to calculate a vessel's carbon footprint and emission taxes.

Marine vessel classifications and trends

Vessel landscape simplified

The heterogeneous nature of the transport sector presents challenges for potential alternative fuels for decarbonisation compared to power generation. Within shipping there is an additional level of complexity with the range of vessel types requiring specialised developments tailored to their size, voyage length and cargo.

For a list of Vessel types and details on average fleet age, please contact your HSBC representative or email AskResearch@hsbc.com for more information.

Since the Global Financial Crisis, cruise vessel orders have been increasing steadily, by an average of 29% a year (2010-2019). See Chart 15. Increasing levels of tourism drive concerns for marine ecosystems and pose a potential threat to water quality.

EU port calls by cruise vessels 90% lower than in 2019

EU cruise port calls were down 90% between June and September in 2020 when compared to the same period in 2019[3]. Cruise vessel orders have been particularly negatively impacted with a total of only 5 orders in 2020, totaling USD450 million[4]. This is a significant fall from the 40 vessels ordered in 2019, totaling USD19 billion.

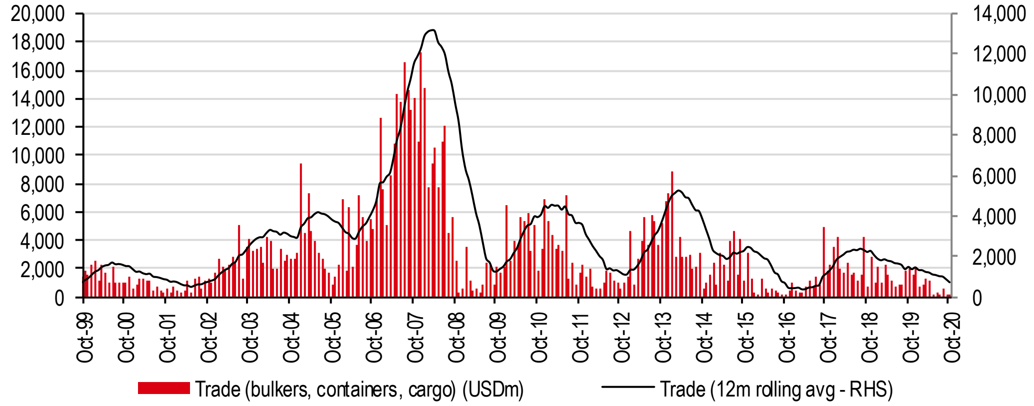
Unlike cruise vessels, trade vessel contracting hasn't been steadily increasing since the financial crisis but following a cyclical trend. Vessel orders peaked in December 2007 with a value of USD17 billion, and haven't reached this level since. See Chart 13. COVID-19 has also had a significant negative impact on trade vessel contracting, with bulkers, containers and cargo vessel order volumes falling by 53%, 62% and 60%, respectively, between January to October, when compared to the same period in 2019. However, there has been some recovery in 2020, particularly in containers.

Oil & Gas vessels

Oil & Gas (O&G) vessel contracting has, like trade vessels, not returned to the peak value of contracting pre-financial crisis (USD20.5 billion in March 2006). See Chart 14. Considering the impact of COVID-19 on O&G vessels separately, tankers, offshore and LNG/LPG vessel order volumes fell by 24%, 48% and 37%, respectively, between January to October, when compared to the corresponding period in 2019. LNG/LPG vessel orders have appeared to be on an upturn recently and have been recovering since their Q2 lows. However, in the long run we expect a glut in the global gas market as a storage surplus is experienced in Europe.

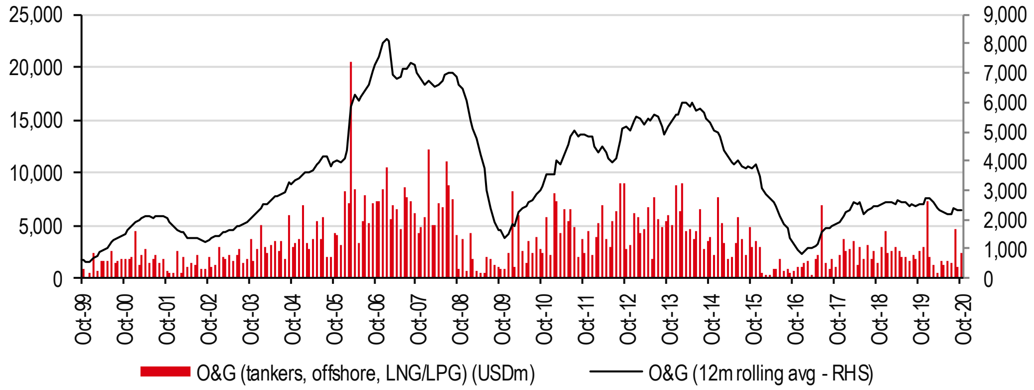
3 'COVID-19 - impact on shipping', EMSA, 25 September 2020
4 Clarksons data, 2020

Chart 13. Trade vessel order volumes (USDm) – Distinct cyclical trend, low order volumes in response to COVID-19



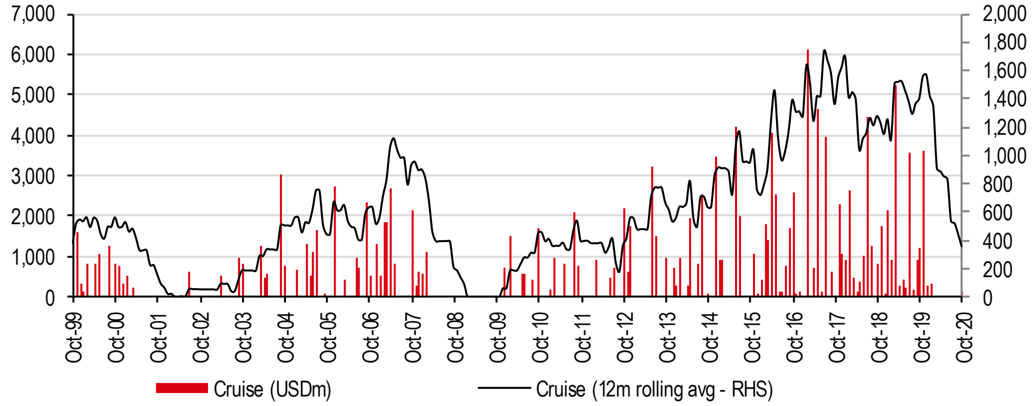
Source: Clarksons

Chart 14. Oil & Gas vessel order volumes (USDm) – Longer-cycle in comparison… LNG/LPG order volumes recovering



Source: Clarksons

Chart 15. Cruise vessel order volumes (USDm) – Sharp fall in orders from recent 20-year high… signalling a downturn due to COVID-19



Source: Clarksons

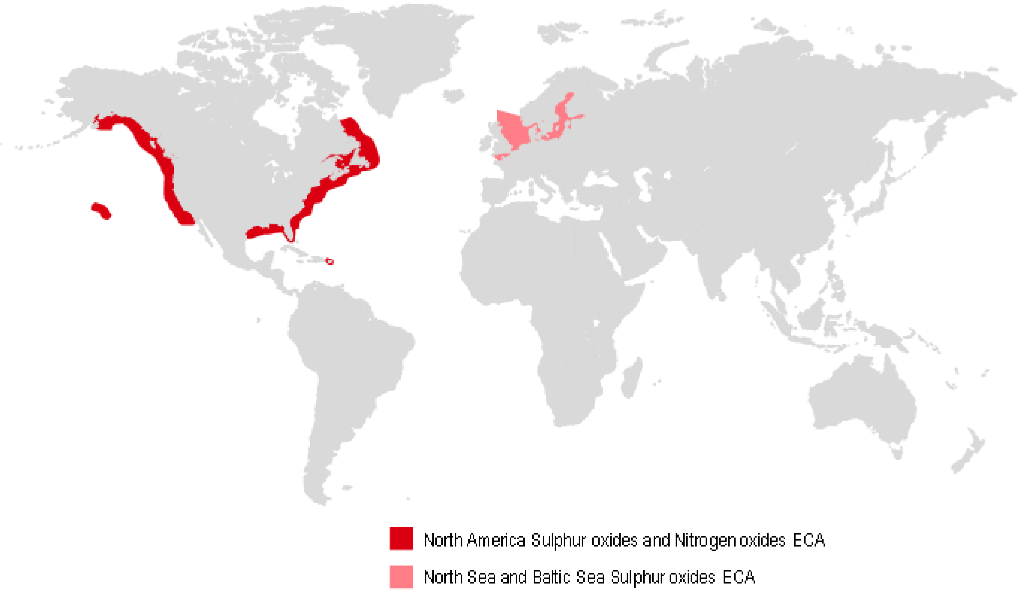
Marine policies

- Under BAU, emissions from shipping expected to be 250% higher than 2008 levels by 2050
- To prevent this, the IMO has implemented a target of 50% reduction in GHG emissions by 2050 and a sulphur cap reduction from 3.5% m/m to 0.5% m/m
- Efficiency policies - EEDI and SEEMP - apply to both new builds and existing fleet with the aim of reducing fuel consumption

Emissions reduction incentives include Singapore's Green Port Programme

The global scope of the shipping industry commands the role of non-state actors to set global safety and environmental standards for shipping. The IMO is a specialised agency of the UN which sets these regulations and targets. Flag and port states implement these on a national scale as well as their own standards and legislation.

Chart 16. Emission Control Areas (ECAs) map



Source: HSBC

It's the flag states who have regulatory control via laws and penalties for emissions and pollutions regulations as well as safety, living and working conditions for the industry. Aa a port state, Singapore has imposed penalties including 2 years in prison and fines of up to SGD10,000 for non-compliance with the IMO sulphur cap within its territorial waters. It's in the flag/port states' self-interest to enforce and support decarbonisation targets, not only due to the local environmental impacts, but for economic opportunities to benefit from the greater demand for sustainability and transparency of the shipping industry in recent decades.

Although shipping bunker fuel use is not covered within the Paris Agreement, the IMO has aligned to it by setting industry level targets to help play its part in the reduction of global emissions, for example by targeting a reduction in total shipping GHG emissions by 50% by 2050.

Additionally, the IMO has applied the UN Sustainable Development Goals to targets and regulations, the most prominent being Goal 13 - Climate Action. Goals 3, 7 and 14 are also particularly relevant to the industry, which are Good health, Affordable and clean energy, and Life below water, respectively.

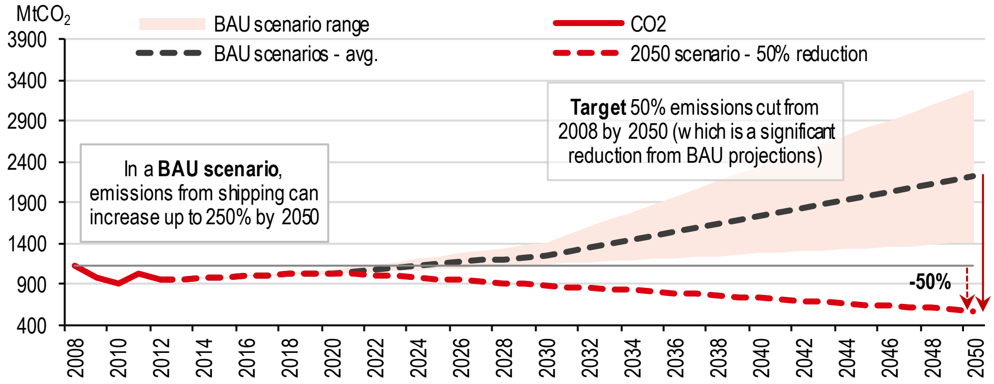
IMO 2050 targets

GHG emissions reduction by 50% by 2050 (from 2008 levels)

The IMO has set a target for the reduction of overall GHG emissions by 50% in 2050 from 2008 levels. This includes a 70% reduction in CO_2 emissions. A three-pronged-strategy has been developed to implement these targets with the following aims:

- Ship carbon intensity reductions via vessel efficiency gains
- International shipping carbon intensity reductions by at least 40% by 2030
- GHG emissions to reach peak levels as soon as possible to allow a decline, in line with the Paris Agreement

Chart 17. Under BAU, 2050 emissions projected increase to 250% higher than 2008 levels



Source: IMO, HSBC. Note: Solid red line = historical CO_2 emissions

For a list of New vessel efficiency frameworks as well as Issues with emission regulations today, and future scope, please contact your HSBC representative or email AskResearch@hsbc.com for more information.

Decarbonising marine propulsion fuels

- The marine sector is complex and varied with differing vessel needs so a number of propulsion fuels must be utilised to decarbonise
- Shorter-term, a combination of scrubbers, LNG/LPG, biofuels, batteries and other options are gaining traction
- In the longer run, zero emission fuels like green hydrogen and ammonia will be required but these require time and investment

Sailing towards zero emission fuels for marine

In this chapter we outline a number of short-, medium- and long-term technologies and how they are disrupting propulsion fuels for the marine industry today and in the future, helping hit targets for IMO 2020 and 2050.

Short/medium-term solutions comply with the IMO's sulphur cap

Scrubbers, LNG/LPG and biofuels provide effective short/medium-term solutions to reducing the emissions of the shipping industry due to compliance with the IMO's sulphur cap and forward-looking developments in infrastructure. The reason these solutions aren't considered long term is primarily due to the lack of compliance with the IMO's GHG emissions reduction target of 50% by 2050.

Downsides of short/medium-term solutions

The use of scrubbers produces environmentally harmful waste and can incentivise investment in higher sulphur fuel oil (HSFO). LNG emits 25% less CO_2 and 85% less NO_x than HSFO, and generates no sulphur or PM emissions, yet produces methane emissions which can actually increase GHG emissions in comparison to HSFO. Although biofuels are an effective medium-term solution with little infrastructure development required, there are issues of sustainability and meeting the shipping industry's fuel demand.

We also look at the medium/long-term technological solutions to decarbonising the industry, with alternatives that produce zero emissions, though much of these require significant investments in technology and infrastructure in order to become commercially viable.

Medium/long-term – solar, wind, batteries, hydrogen and ammonia solutions – eventually zero emissions

Solar and wind assist in reducing fuel consumption of the vessel while also being a renewable source of energy. Batteries provide effective solutions for smaller vessels, improving emission levels for ports. Hydrogen and ammonia are considered long-term solutions, producing zero emissions if produced via renewable energy and being suitable for large vessels travelling long distances, so potentially could replace fossil fuels for the industry. The main challenge for the uptake of these fuels is infrastructure and investment. See Table 3 for disruptive propulsion fuels for decarbonisation of marine.

For a deep dive into the short, medium and long-term alternative fuel solutions for the shipping sector, please contact your HSBC representative or email AskResearch@hsbc.com for more information.

Table 3. Summary of alternative disruptive propulsion fuel technologies

	Scrubbers	LNG/LPG	Biofuels	Wind	Solar	Hydrogen	Ammonia	Batteries
Advantages	◆ Effective short-run solution to the IMO sulphur cap ◆ Allow continued use of the cheaper HSFO, benefiting from occasions of significant pricing spreads	◆ Reduces CO_2 (25% less) and NO_x (85% less) emissions ◆ Produces no sulphur or PM emissions – meets IMO sulphur cap ◆ Greenest currently viable option ◆ Cheaper than alternatives as price is linked to oil ◆ Infrastructure has potential to be utilised by non-fossil fuel alternatives; liquefied bio-methane (LBM) and liquefied synthetic methane (LSM)	◆ Can be blended with HFO ◆ Technologically ready for use ◆ Source of renewable energy with low emissions ◆ Meet short-term needs	◆ Renewable source of energy ◆ Unlimited supply ◆ Can be fitted to existing ships and new builds ◆ Can be designed to move or retract to allow for individual vessel needs e.g. loading ◆ Propulsion assistance creating fuel savings, resulting in decreased emissions	◆ Renewable source of energy ◆ Unlimited supply ◆ Costs are falling ◆ Power storage for use at night ◆ Effective for vessels with large surface area, e.g. bulk carriers ◆ Combined with additional efficiency measures has the potential for significant fuel consumption improvements	◆ Green hydrogen produces no CO_2 or harmful emissions if it's produced from renewables ◆ Colourless, odourless, light and non-toxic ◆ As renewable energy falls in price so does the cost of hydrogen ◆ Greater range of applicable vessels	◆ Higher energy density than alternatives ◆ Easier to store, transport and refuel than hydrogen ◆ Can be produced from renewable energy	◆ Suitable for smaller vessels with shorter voyages e.g. ferries ◆ Emission free – ideal for use near coastlines and passenger vessels
Disadvantages	◆ Expensive installation – less suitable for smaller vessels ◆ Reduced incentive to install if fuel pricing spreads are low ◆ Could lock in investments in fossil fuels ◆ Environmental concerns ◆ Risk of future regulations limiting use ◆ Not a long-run solution to decarbonising the industry	◆ Currently insufficient bunkering infrastructure ◆ Seasonally variable prices ◆ Methane slip from the supply chain and leakages from the combustion engine when it fails to burn, increasing emissions ◆ Retrofitting ships for LNG propulsion is expensive, and may not be commercially viable if the vessel is near scrapping age	◆ Increases the requirement for land to produce purpose-grown crops ◆ Can't meet high demand in the long run – hasn't got the capacity to be the main fuel source for shipping ◆ Comparably expensive ◆ Concerns with sustainability of feedstock	◆ Dependent on weather conditions and route ◆ Uses up deck space that would otherwise be used for cargo ◆ Significant installation, operating and maintenance costs	◆ Dependent on weather conditions and daylight hours ◆ Unlikely to be a significant source of efficiency improvements solely ◆ Uses up deck space that may otherwise be used for cargo	◆ Currently produced as grey hydrogen which relies on natural gas and coal ◆ Expensive relative to alternatives ◆ Lacking infrastructure ◆ Storage challenges ◆ Only 10% of hydrogen currently produced is merchant (produced for sale to another company)	◆ Has the potential to release NO_x due to high toxicity ◆ Currently produced using majority fossil fuels	◆ Power supply dependent on battery size ◆ Lower energy density than alternatives – 10% the density of liquid hydrogen ◆ Not suitable for large vessels without significant technological developments
Latest Developments	◆ Wärtsilä scrubber sales have fallen due to COVID-19 and narrowing fuel pricing spreads ◆ Maersk had nearly 100 vessels installed with scrubbers as of October 2020, which is around 30% of its fleet	◆ Carnival Corporation introduces North America's first LNG-powered cruise vessel into operation in April 2021 ◆ Brittany Ferries and Wärtsilä launching two LNG-powered ferries in 2022 and 2023	◆ Stena Bulk AB utilising used cooking oil biofuel by GoodFuels ◆ Volkswagen fuelling their vehicle transportation vessels with biofuels, reducing carbon emissions by 85%	◆ Wärtsilä and Anemoi development of rotor sails on dry and wet bulkers ◆ Norsepower develops first tilting rotor sail, estimated 25% CO_2 emission savings when two are retrofitted	◆ EnergySails by Eco Marine Power (EMP) combine both wind and solar technology, estimating fuel savings of 5-20%, with smaller vessels experiencing greater savings	◆ BeHydro engine by CMB, with the capability to reduce CO_2 emissions by 3,500 tonnes a year ◆ Ballard's FCwave module for passenger and car ferries, scaling up developments in collaboration with ABB and HDF	◆ ShipFC Project equipping Eidesvik's Viking Energy with ammonia fuel cells, ability to run for 3,000 hours annually on clean fuel	◆ Two 'super ferries' from P&O to operate in the English Chanel in 2023, cutting fuel consumption by 40% ◆ Largest fleet of electric ferries in India under construction, 78 100-passenger vessels

Source: HSBC

Alternative decarbonisation technologies and strategies

- In addition to the rise of lower and zero carbon fuels, a suite of solutions is available to make the sector more fuel efficient
- Efficiency options from speed reduction, hull coating / cleaning, and air lubrication to weather routing can lower carbon-related emissions
- Digital technologies for smarter shipping such as autopilot and blockchain can also drive lower emissions through efficiency gains

Making marine smarter

Scope for significant fuel savings if multiple alternative strategies are adopted well before zero emission fuels

In the full note, the previous chapter highlighted how technologies like scrubbers and LNG are being used to lower the GHGs for the marine sector today, as well as how new disruptive propulsion fuels can send the marine sector sailing towards zero emissions, aiming to hit the IMO 2050 targets. This chapter in the unredacted version outlines the disruptive technologies and efficiency strategies which have the potential to enable significant reductions in the fuel consumption of vessels and, therefore, GHG emissions before the longer-term fuel technologies become a reality.

We estimate that, if multiple efficiency technology strategies are utilised, the potential for fuel savings could exceed 50%, which would not only be beneficial operationally in terms of costs, but also environmentally in terms of emissions.

Table 13 Efficiency technologies and strategies overview

Strategy	CO_2 and fuel use reduction	Cost (USD)	Promoted by EEDI?
Speed reductions	10-30%	No cost	Yes
Hull cleaning	1-10%	5,000-50,000	No
Hull coating	1-5%	30,000-500,000	No
Air lubrication	5-15%	2-3% of the new build cost	Yes
Weather routing	1-4%	15,000	No
Autopilot	1-3%	Assumption of technology already available	No

Source: ICCT (2013), GloMEEP (2020)

For a deep dive into the Alternative decarbonisation technologies and strategies for the shipping sector as well as top smart ports globally, please contact your HSBC representative or email AskResearch@hsbc.com for more information.

Table 4. Summary of alternative decarbonisation technologies

	Speed reductions	Hull cleaning	Hull coating	Air lubrication	Weather routing	JIT operations	Supply chains and 3D printing	Autopilot and Autonomous vessels	Block chain
Advantages	◆ Fuel consumption reduced ◆ Benefit marine and human health ◆ Cost savings ◆ Requires no investment ◆ Easily implemented with few challenges ◆ Reduces noise pollution	◆ Fuel consumption reduced ◆ Operational efficiency ◆ Cheaper way to adhere to IMO's efficiency strategies	◆ Fuel consumption reduced ◆ Operational efficiency ◆ Reduces the need for hull cleaning as often ◆ Protects the hull	◆ Fuel consumption reduced ◆ Reduces frictional resistance ◆ Reduces fouling	◆ Reduces fuel consumption due to avoidance of bad weather ◆ Improves safety of crew ◆ Reduces risk of damage to the vessel	◆ Reduces fuel consumption ◆ Avoids the need to anchor ◆ Improves local port emissions ◆ Reduces the risk of collisions ◆ Efficiency improvements ◆ Reduces ship's speed	◆ Long-run solution to decreasing distance travelled by vessels ◆ Reduces emissions ◆ Reduces need for spare parts/stock (3D) ◆ Reduces time waiting for components (3D) ◆ Reduces costs (3D)	◆ Efficiency gains ◆ Reduced human error ◆ Reduces operational costs ◆ Increased cargo capacity ◆ Reduction in emissions	◆ Reduced paperwork, which can account for 15-20% of voyage costs. ◆ Increased efficiency ◆ Supply chain visibility ◆ Reduced emissions with fuel savings
Disadvantages	◆ Contractual issues ◆ Potential revenue concerns ◆ Challenging to regulate ◆ Weather conditions sometimes require higher speeds	◆ Success depends upon level of foul and cleaning success ◆ Required often – every 4-12 weeks.	◆ Less fuel reduction potential than hull cleaning ◆ Need to be recoated every 12-18 months	◆ Mainly incorporated into new builds, rarely retrofitted ◆ Uses power from the ship to operate ◆ Success dependent on weather conditions such as surface pressure and waves	◆ Sometimes not contractually possible to change route ◆ Opportunity costs ◆ Investment in technology may be required	◆ Requires increased communication of requested time of arrival (RTA) ◆ Contractual issues	◆ Not a solution possible by the shipping industry currently ◆ Takes planning, funding and implementation ◆ Expensive to alter due to contractual issues ◆ Requires significant investment (3D)	◆ Cyber security threats ◆ Large investment required ◆ Regulatory challenges ◆ Legal and insurance challenges ◆ Unemployment increases	◆ Cyber security threats ◆ Privacy concerns ◆ Requires significant investment ◆ Systems can increase energy consumption
Latest Developments	◆ Ship companies supporting speed reductions to reduce emissions include Louis Dreyfus, Star Bulk and Navios	◆ ECOsubsea are a hull cleaning service provider with remotely operated vehicles (ROVs) that require 8-10 hours as a standard cleaning time and have already removed 50,000kg of fouling from over 1,000 vessels across Europe. ◆ The Baltic and International Maritime Council (BIMCO) are producing global hull cleaning guidelines	◆ Hempel, a Danish ship coatings company has applied its coating Hempguard X7 to over 2,000 vessels, and estimates to have reduced CO_2 emissions by 23.5 million tonnes since 2013	◆ Mitsubishi Air Lubrication System (MALS) was one of the first of these technologies to be developed; studies show fuel savings of 3-13% ◆ AIDA Cruises has implemented MALS on numerous vessels	◆ StormGeo, a Norwegian weather service provider, launched its s-Suite software in 2020, with voyage planning, weather reports and fleet performance management. Estimated CO_2 savings of 3 million tonnes a year	◆ Port of Rotterdam, Maersk and MSC have been conducting trials of JIT operations and have experienced fuel savings of 9%	◆ In, December 2020, Bureau Veritas (BV), 3D Metal Forge (3DMF) and PACC Offshore Services co-funded their project on additive manufacturing for marine. Aims include reducing replacement risks, reducing physical inventory and significant cost benefits	◆ Wärtsilä's SmartMove solutions has been installed on an American Steamship Company (ASC) vessel, allowing semi-autonomous navigation and docking on some of the most congested routes	◆ IBM and Maersk developed TradeLens in 2018, which aims to digitise global trade, significantly reducing the cost and complexity of trading. IBM estimates savings of USD38 billion annually for shipping carriers

Source: HSBC

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