

ACCELERATING DECARBONISATION IN SHIPPING: A NO REGRETS APPROACH USING WIND POWER.

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Wind is free, clean, abundantly and exclusively available to ships equipped to harness it. It decouples ship owner/operators from volatile land based commodity fuel supply, critical in an energy-constrained future – and, most importantly, has the capacity to drive emissions out of the shipping sector immediately

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Introduction

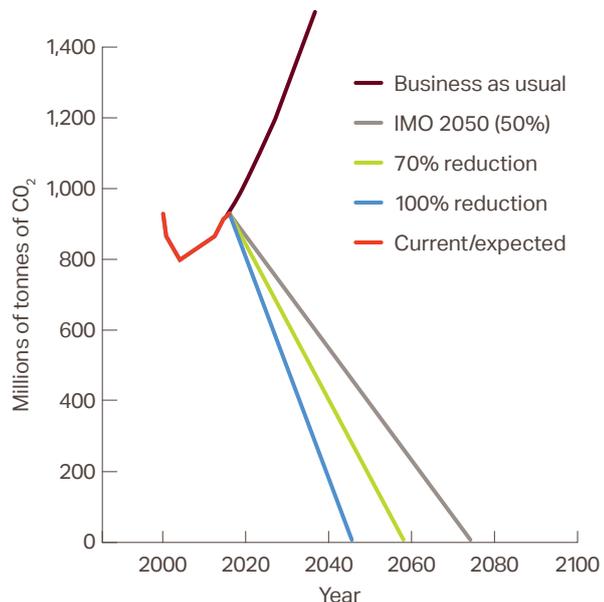
This short technical policy paper from the Institution of Mechanical Engineers provides an introduction to the propulsion solutions available to shipping that will enable rapid decarbonisation. This includes the use of wind as the primary energy, hybrid wind and/or fossil/alternative fuels and the potential for biofuels, hydrogen and ammonia as drop-in replacements for bunker fuel. The Institution of Mechanical Engineers promotes a complete move away from using fossil fuels for use in transport or any part of our energy system in the future. In the interim however we must use solutions that provide the biggest and fastest reductions in emissions that affect our climate and air quality.

This report aims to demonstrate how by changing the propulsion systems used in shipping we can move more rapidly towards 'net zero', a target put forward by the Committee on Climate Change and ratified into law in 2019^[1], and simultaneously reduce ocean pollution. The overall goal is to use our existing and emerging technologies and to be active in reducing the immediate impact our global supply chains have on the planet. Today shipping is responsible for between 2–3% of global emissions^[2] and is not required to be included in a nation's emissions monitoring, developed nations will be responsible for a larger proportion of the emissions from global shipping in a similar way to aviation. Countries with more money ship more goods.

As an international business, shipping has not received the type of attention other sectors have and it does not have a UK national regulatory framework that can be used to reduce emissions. This is compounded by existing failings from the industry, in November 2020 the International Maritime Organisation brokered an agreement with the majority of countries, including the UK, that would allow shipping to continue polluting unabated to 2030^[4].

In addition to the lack of action around shipping, we have seen a slowing of overall CO₂ emissions reduction recently with the UK reducing by just 2% in 2018 and indeed global emissions increasing by 0.6% in 2019. We did see an initial sharp drop in emissions in 2020, however this is likely to be due to the global pandemic and unlikely to persist. A recent report from the Office for National Statistics, shows the UK to be the largest importer per capita of GHG emissions in the G7 from outsourced activities, such as manufacturing and food production^[5], these are all critical users of the shipping sector. This means that there is an imperative to act now and apply technologies that will reduce our impact on the environment and human health.

Figure 1: Global fleet targets and trajectories under IMO targets^[3]



Policy Background

Before addressing the technical possibilities for reducing emissions in shipping it is important to reflect on the policy background, why shipping has received minimal attention for emissions reduction and why the Institution of Mechanical Engineers believes that addressing this sector is critical to developing a clean global supply chain for the future. Every day we are reminded of the globalisation that has taken place over the past fifty years from the interconnectedness of our financial systems, the spread of new viruses and the unequal impact that climate change has, with some nations suffering more from the effects of extreme weather. This has led in 2019 and 2020 to greater public awareness of the need to act now to reduce the environmental impact of our lifestyles on other nations and the planet.^[6]

Increasingly, albeit slowly, other sectors where the UK has a recognised responsibility are beginning to reduce their emissions, electricity is a good example, and we are now addressing passenger vehicles with renewed vigour with a target to phase out the sale of new petrol and diesel vehicles by 2030 under the new 10-Point Climate Plan^[7]. This means that sectors where less attention is paid will begin to increase their contribution to global emissions. Shipping and aviation combined this could become as high as 40% by 2050^[8] with shipping's contributions dependent on the technological and demand changes made between now and 2050.

This technical policy paper aims to identify some solutions for the shipping sector that will provide both, rapid decarbonisation while maintaining the opportunity to seek a completely new system in the future.



Shipping Hierarchy

MORE SUSTAINABLE	
Priority 1 Minimise demand	Manage the reasons why shipping is needed on such a large scale, what goods and services can be obtained with reduced need for shipping.
Priority 2 Optimise system efficiency	Increase all efficiency modes for shipping, this means route optimisation and connectivity through autonomy, increased capacity and slowing the ships down to reduce fuel use.
Priority 3 Implement existing technologies for emission reduction	After optimisation there is need to implement existing technologies that can rapidly reduce emissions, this can include wind and hybrid systems.
Priority 4 Plan for implementation of new technologies for emission reduction	Following implementation of existing technologies plan for new ships to be built and retrofitted with emerging technologies such as in-board hydrogen systems and digital fuel autonomy.
Priority 5 Continue with business as usual	This is an unsustainable solution that will result in shipping being responsible for potentially 20% of global emissions by 2050.
LESS SUSTAINABLE	

Bunker Fuels

Bunker fuel is a generic description for any fuel poured into a ship's bunker. It is usually the residual oil that is left over once the more valuable lighter hydrocarbons, such as gasoline and diesel which have been extracted from crude oil during the refining process. It is used to power the engines of large cargo ships.

Bunker fuel is classified as hazardous and very toxic to aquatic life, it is a persistent oil and likely to spread large distances. It is made from long hydrogen carbon chains and when burnt emits particulate matter, carbon dioxide and sulphur oxide as well as other emissions.

In 2018, 300 million tonnes of bunker fuel were used for ship bunkering. Shipping uses 6.1% of all global oil use^[9].

Emission Reduction: Existing Technologies

There are currently three ways that shipping can be rapidly decarbonised and build a foundation for developing the next wave of technologies that enable long term decarbonisation.

1. Wind Power

The use of wind as a primary source of propulsion for ships is not a new concept. 21st century wingsails retrofitted on to cargo ships that do not carry goods on the deck will allow for a significant decrease in emissions. This reduction is made by allowing the fixed sails to be used at sea and subsequently use less bunker fuel. A careful analysis of ship types working on suitable routes could allow for even greater reductions in emissions by optimising automated wingsails to harness maximum amount of wind.

A recent feasibility study supported by the Institution showed the potential for reducing emissions on a ship retrofitted with fixed sails could be as much as 30% given the right conditions^[10]. By ignoring the abundant, exclusive, and freely available wind potential at sea to decarbonise our shipping industry in the short term we will miss a pivotal opportunity to get in ahead of the curve immediately, driving down emissions from the sector giving time for the harder segments to adapt sectors in shipping to develop alternative more expensive zero emission fuels.

2. Slowing down

This is probably the shipping industry's most quoted solution to emissions reduction^[11], and it is true that like many forms of transport you can optimise your fuel use by slowing down. The flaw in this process, is that it does not address the need to move away from bunker fuel as an energy source for propulsion. The Institution of Mechanical Engineers firmly believes that ultimately, we should move away from the use of fossil fuels in all areas of our energy system.

Recommendations

3. Hybrid systems - combining the two

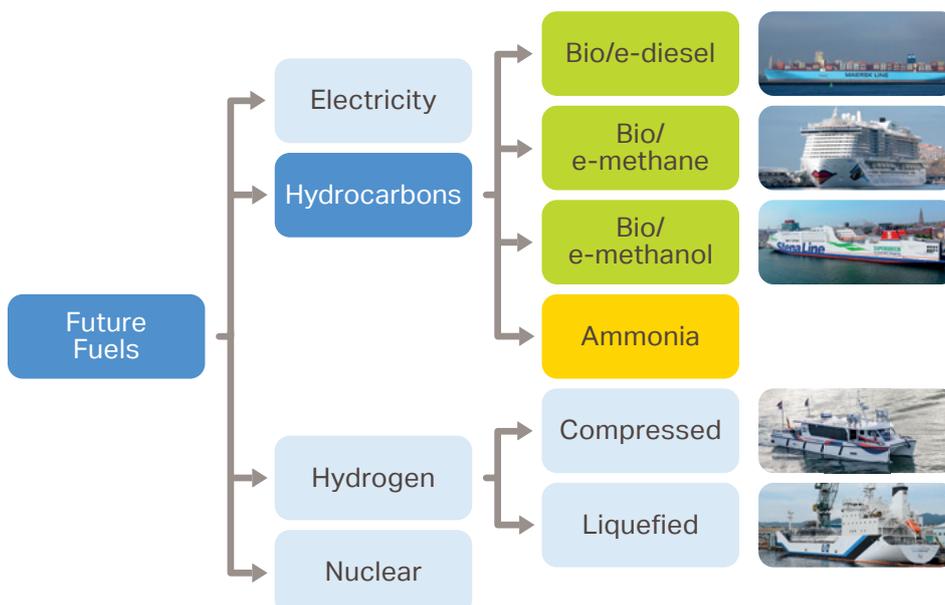
In the short-term, maximising our opportunity is key. By retrofitting fixed wind sails to cargo ships and slowing down we have the potential to reduce our emissions from shipping by up to 40% or more as technologies improve. The Institution strongly advocates the use of these techniques in the UK, beginning today to demonstrate our commitment to emissions reductions across our transport sectors.

In the future we will on/inboard new propulsion systems that on fully optimised ships enable fully autonomous fuel management. This could include wind, solar and hydrogen/biomethane as propulsion solutions as well as looking at wind and ammonia hybrid systems. We cannot wait for the silver bullet for shipping, but we can act now to increase renewables penetration in our energy systems.

The Institution of Mechanical Engineers recommends that:

1. The UK Governments support the development of a ship demonstrator using retrofitted wind sails. This will allow ship owners and users to understand how renewable wind can be used as primary propulsion on modern ships and could provide a compelling exhibition at COP26.
2. The UK shipping industry and users work with government on creative funding sources to build a '2050 now' ship that demonstrates how a fully autonomous fuel ship, that creates and manages its fuel could operate.
3. The International Maritime Organisation rethinks its recent low ambition announced in November 2020 to and seeks to aim for a substantial reduction closer to 70% to meet the requirements of the Paris Agreement.
4. The UK Government actively creates funding schemes to invest in technologies that will specifically decarbonise shipping and meet the urgent need to reduce our emissions at sea.

Figure 2: Potential for future fuels in shipping¹²



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- ¹² Ed Fort's (Lloyd's Register) presentation from "Decarbonising Shipping" presented at IMechE Low Carbon Transport: Engineering the Fuels of the Future in July 2019

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