Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Sailing toward carbon zero?

Taking stock of maritime transportation's climate impact

October 2021
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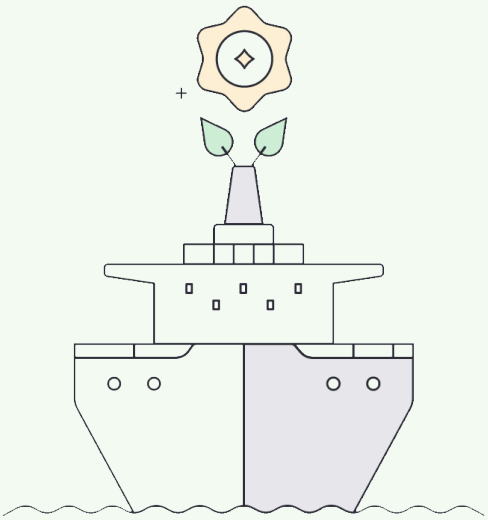

A three-part series[1] explores maritime transportation's decarbonization journey and complements the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping's forthcoming Industry Transition Strategy report

The first installment tracks the industry's climate impact based on current trends.

1 The Center would like to thank McKinsey & Company, as knowledge partner to the Center, for its analytical and editorial contributions to this series of articles.

Introduction

On the surface, the global shipping industry's environmental impact gives little cause for alarm. After all, despite accounting for around 80 percent of global transportation measured by volume, the sector is responsible for only 10 percent of transport emissions—and 3 percent of total greenhouse gas emissions. Compared to other forms of freight transport, shipping is the most efficient in terms of amount of emissions.

However, dig a little deeper and a more unsettling picture emerges. Even when taking planned decarbonization efforts into consideration, the continuous growth of world trade may drive a corresponding rise in emissions from shipping between now and 2050. The industry consumed about 300 million tons of fossil fuel in 2018 and, as the world's appetite for traded products grows, shipping volumes are expected to climb by around 1.3 percent on average every year between now and the middle of the century. Other roadblocks on the path to zero-carbon shipping include carriers' preference for cheaper fossil fuels and that improvements in ship efficiency alone are insufficient to offset emissions caused by demand growth.

The global shipping industry needs to do more to contribute to international efforts to curb the worst effects of climate change, which will require limiting the rise in global temperatures to be in line with the Paris Climate Accords. To chart feasible pathways toward carbon zero for the shipping industry, the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping was established to build consensus amongst leaders across the maritime ecosystem on the most viable pathways to zero.

A new model to navigate the path to zero

The shipping industry does not lack good ideas for how to decarbonize. The challenge is creating clarity among a large array of ideas and solutions—in terms of both decarbonization impact and economic implications—for a global and diverse industry.

That is why the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping developed the NavigaTE[2] model in order to help maritime stakeholders understand the most plausible pathways for the industry's decarbonization. The model analyzes the total cost of ownership for different ship-efficiency technologies and alternative fuels, based on industry inputs and cost forecasts from the Center's partners, as well as the impact of different customer, financial-sector, and regulatory interventions. The perspectives shared in this series of articles and the forthcoming Industry Transition Strategy report are based on insights from the NavigaTE model.

To complement the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping's first Industry Transition Strategy report, which will be released in October, the Center is rolling out a series of three articles that will make the case for why industry players should be doing more, lay out some of the complexities in the industry's path to carbon zero, and tease out some of the practical strategies that decision makers can consider.

In this first installment, we take stock of the global shipping industry's decarbonization efforts, presenting our best view of what will happen by 2050 if the industry keeps on its current path. We identify the industry's main drivers of CO_2 emissions, arguing that planned decarbonization efforts may not be sufficient to offset the growth in underlying demand. If industry players don't act decisively to cut their emissions now by rethinking how business is done and innovate lower carbon solutions, then they may soon find the decline needed to reach carbon zero by 2050 too steep to undertake. Furthermore, with other stakeholders such as regulators, investors, and customers scrutinizing the sustainability of how products are made and transported, clamors for more sustainable shipping will only grow louder.

Thus, coming together to make decisive shifts toward a more sustainable path is not only the socially responsible thing to do, but also an opportunity for this generation of maritime leaders to build a legacy of helping solve one of the world's most intractable problems.

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[2] NavigaTE refers to "Navigating decarbonization through Techno-Economic modelling".

solve one of the world's most intractable problems while supporting the ever-increasing flow of international trade.

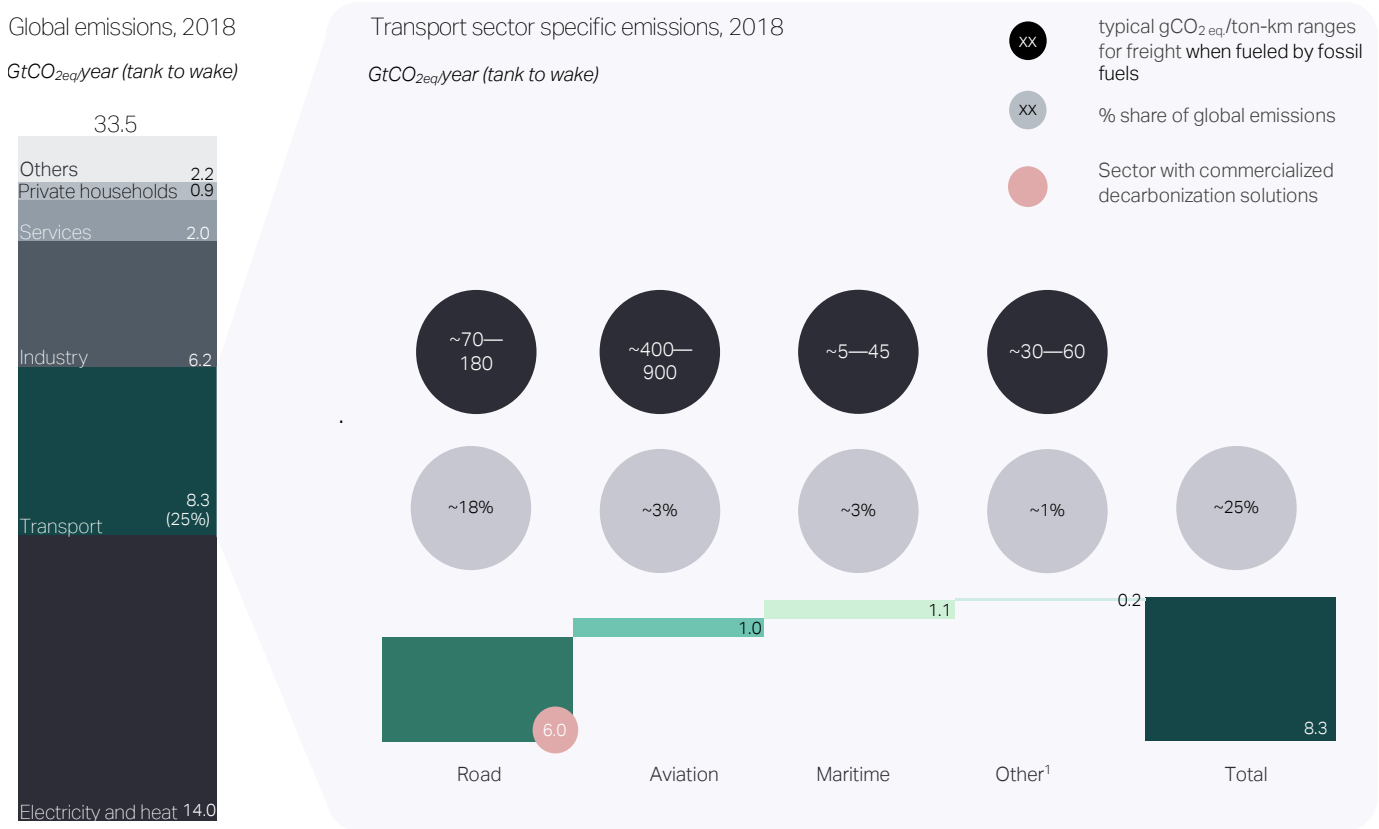
The shipping industry's carbon footprint

It wouldn't be an understatement to say that the global shipping industry is what makes international trade possible. The sector is responsible for nearly 80 percent of all goods transportation. Shipping remains by far the most energy-efficient form of freight transport, producing 20 to 25 grams of CO_2 per ton-kilometer, compared to up to 600 grams for aviation and between 50 and 150 grams for road-based transportation.

If we measure CO_2 emissions "from well to wake"—that is, emissions from crude-oil extraction, refining into fuel oil, and consumption in the vessel—the sector accounts for about 3 percent of total global emissions (Exhibit 1). While tank-to-wake is

Exhibit 1

The maritime share of 3% of global emissions risks growing as other sectors decarbonize if nothing is done



Source: IEA (2020, 2019), IMO 4th GHG Study (2020), IPCC. (2018), all data in tank-to-wake (TTW) emissions
1 Includes rail and non-specified transport

the commonly used term in the industry, a well-to-wake figure gives a fuller measure of the industry's carbon footprint.

Three segments—bulk carriers, tankers, and container ships—are responsible for around 65 percent of the shipping industry CO_2 output (Exhibit 2). While these three categories make up around 90 percent of shipping volumes and contribute the most in terms of absolute emission volumes, it's worth noting that these large ships tend to be more energy efficient and less carbon intensive than smaller vessels. Still, these segments remain a critical target when planning decarbonization pathways.

Strides have been made in shipping and the first vessels operating on zero-carbon fuels have been deployed. Technology and operating practices have led to improvements in energy efficiency. After decades of growing international trade, the 2008 global financial crisis triggered a reduction in trade growth, which resulted in a temporary shrinking of carbon emissions for about a year. After the recession, the industry managed to achieve substantial business growth while keeping emissions to a minimum through a variety of means. For example slow steaming—the practice of deliberately slowing down to reduce fuel consumption—helped reduce emission intensity per ton-mile by 13 percent between 2008 and 2012 and to an extent where the industry almost managed to decouple business growth and emissions for the decade between 2010 and 2020.

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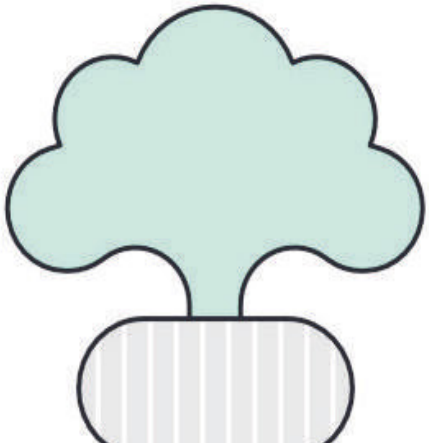
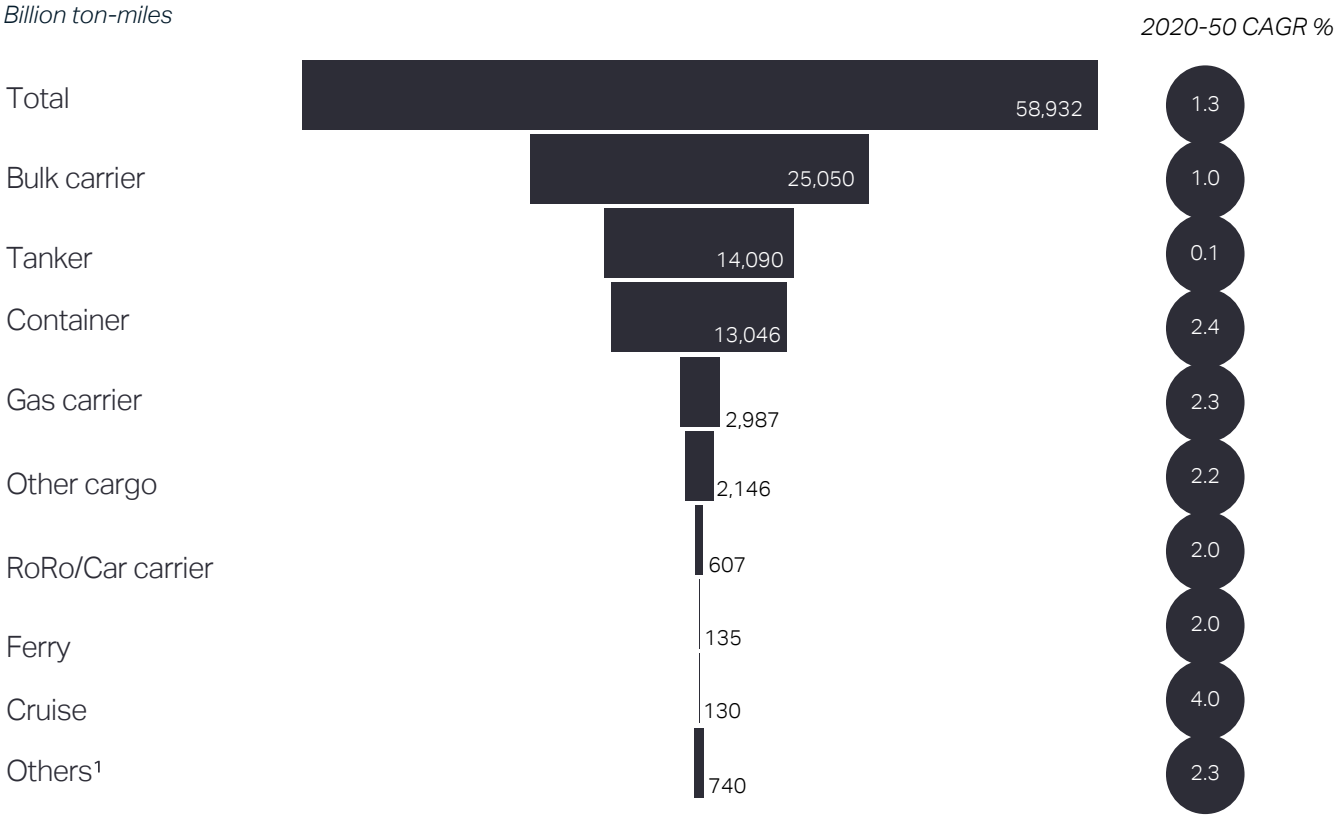


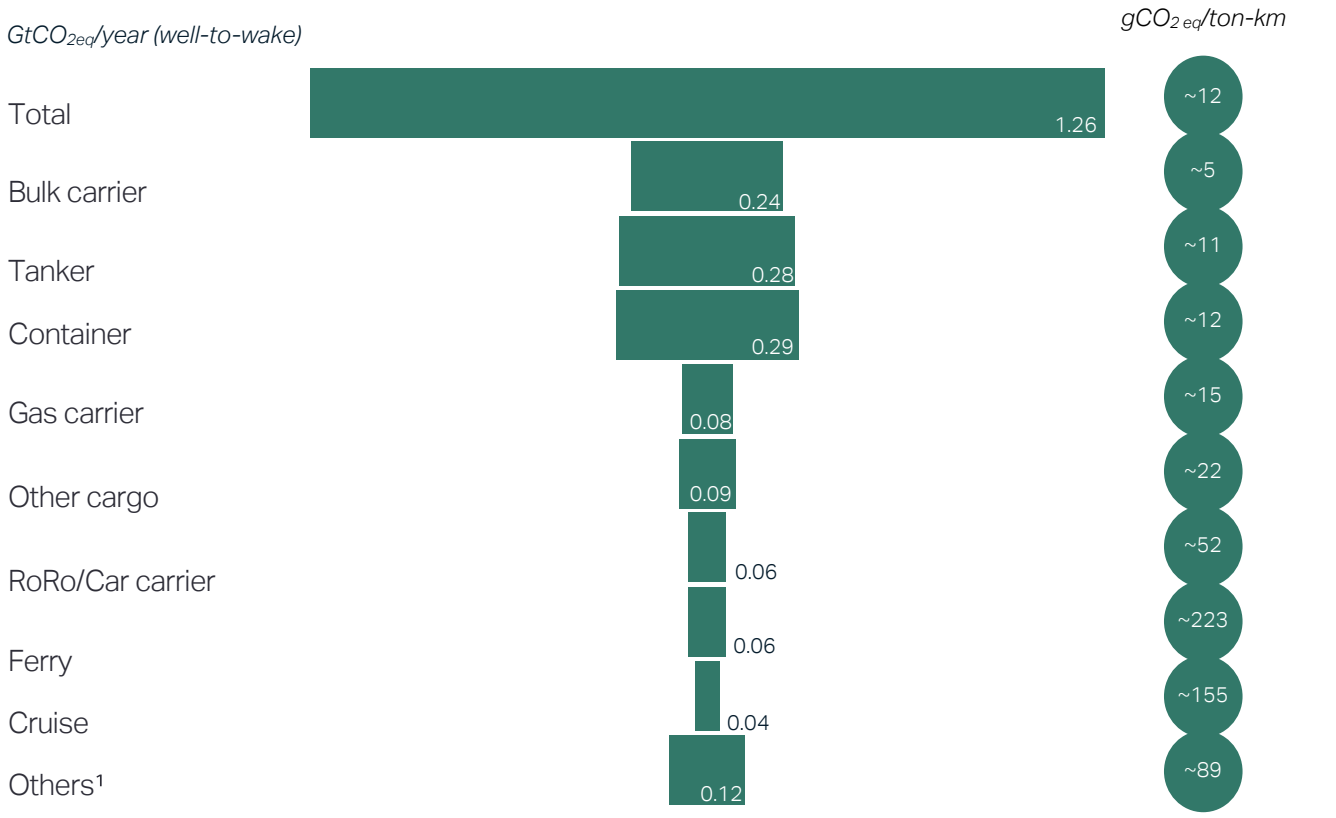
Exhibit 2

Three segments are responsible for most emissions and their volumes are expected to continue growing towards 2050

Industry volume distribution, 2020 and est. growth



Emissions and intensity, 2020



Source: IMO 4th GHG study, McKinsey. NavigaTE.
1 Others include offshore, tugs and non-specified ships

Obstacles in the pursuit of decarbonization

While progress has been made in the past decade, the path we're on may lead to more, not fewer, CO_2 emissions by 2050. Projecting forward the current policy landscape, likely rates of improvement in ship efficiency, and declining costs of alternative fuel technologies in recent years, we can expect the industry's CO_2 emissions to steadily climb by around 18 percent until 2050—a significant slowdown over recent years but still far away from carbon zero (Exhibit 3).

Sporadic shocks to international trade, such as the global financial recession of 2008 and the COVID-19 pandemic, are likely to be temporary and overall trade flows will continue to grow between now and 2050. Furthermore, there may be more environmentally conscious shippers aspiring to decarbonize, who may switch their preferred mode of delivery

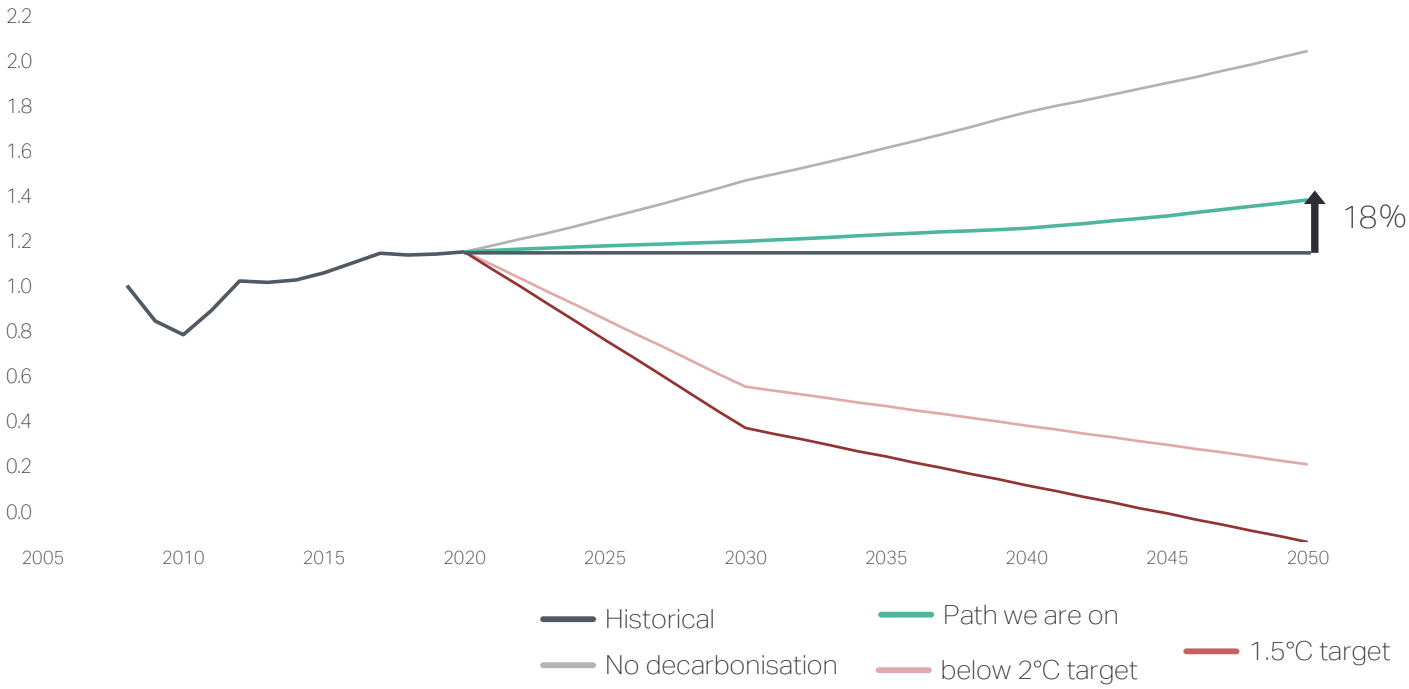
Exhibit 3

We are heading for an increase in emissions with current levels despite current industry-wide efforts

Current decarbonization efforts are outplayed by growing trade and large fuel price differences

WTW Maritime emission pathways[1]

$GtCO_{2eq}$/year



Sources: IMO, IPCC, IEA, Clarksons and NavigaTE

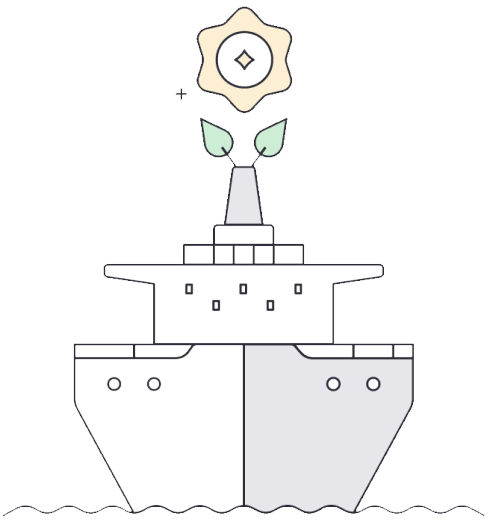
to seaborne from air freight. Continued trade growth will lead shipping volumes—especially for container freighters—to trend upwards by 1.3 percent annually, with emissions growing most significantly in the most dynamic trading regions in East Asia.

It is now clear that the current rate of adoption of cleaner fuel sources and more energy-efficient ship technologies may not be sufficient to offset the underlying demand growth. The global shipping industry needs to overcome a number of hurdles if it is to realize its ambitions of reaching carbon neutral by 2050.

High cost of zero-carbon alternatives

The needed large-scale transition towards net-zero will only be possible when the cost gap between fossil and zero-carbon fuel closes. Right now, fuel represents between 20 and 35 percent of the total annual cost of ownership for most vessels. Even though the production costs of cleaner zero-carbon alternatives are projected to decrease, they are currently higher than the prices of the commonly used fossil fuels.

The existing infrastructure supporting these fuels is also very well established and transitioning to clean alternatives will incur additional costs for most companies—and their customers may not yet be willing to pay that cost. In the absence of effective and widespread regulatory requirements, we may well see a slow uptick of cleaner fuel sources between now and 2050.



Misaligned incentives for ship owners to invest in green technology

The adoption of other energy-efficiency levers has happened, but not as much as it could have, largely owing to the misalignment of incentives between owners and charterers. Whereas charterers often pay the fuel bill, the owner pays for the capital expenditure of the ship, which includes expensive fuel-saving devices. Ship owners often forgo installing the most efficient (and more expensive) technologies because they are not financially rewarded since they don't bear the burden of fuel costs, and because charter rates do not reflect the value of energy efficiency.

There are some signs that this may change, as ships with eco-designs can sometimes command higher charter rates, but, when the market is down, charterers may not be willing to pay the premium. A more enduring alignment of interests is necessary to persuade owners to start ordering more fuel- and emission-efficient ships, and optimize how they operate the ones they have from a emissions-efficient perspective.

Lack of consensus on a common road

There needs to be an industry-wide understanding, coordination, and agreement to scale up in a way that leads to genuine impact, especially in terms of the adoption of cleaner fuel alternatives. There's no agreement right now on which of the numerous potential decarbonization pathways to adopt. For instance, short-haul vessels may electrify or adopt hydrogen fuel, while decarbonizing deep-sea vessels may likely require green ammonia, methanol, or a different fuel with a high energy density. A "chicken and egg" problem prevails where shipping companies choose not to invest in cleaner ships for want of appropriate fuels, while clean-fuel providers choose not to invest in the provision of clean maritime fuels for want of sufficient demand. The development also suffers from the lack of global standards to define means and metrics. Meanwhile, negotiations at international organizations are plagued with both political and structural challenges and are focused primarily on reducing CO_2 intensity and not on absolute reductions.

Furthermore, if and when a specific solution is decided on, implementing it would come with its own set of challenges. The global shipping industry is a vast and diverse one, with different maturity levels across the entire value chain. Adopting a specific green technology may be a sound business decision for a big integrated ship owner and operator that is used to upgrading its fleet, but the same act could distress a smaller company financially.

The cost of doing nothing

Decarbonization has become an increasingly pressing issue for many other industries which are on their own journeys toward carbon neutrality. Depending on how successful other sectors of the economy are at reducing their environmental impact, shipping could account for between 5 and 8 percent of global CO_2 emissions by 2050, compared to 3 percent in 2019.

In addition to being the environmentally irresponsible thing to do, not acting decisively to move to a more sustainable path may result in shipping companies seeing their financing dry up as investors and banks deploy their capital to sectors with a smaller carbon footprint. As customers around the world become more sensitive to the environmental impact of their consumption patterns, they may demand that their governments legislate to pass more stringent sustainability requirements. Meanwhile, in the private sector there has been a growing trend among investors to make sustainability-related demands of the companies they invest in. Shipping companies that do not get ahead and proactively reduce their emissions stand to lose out. Public perception of the industry as a whole may also diminish.

Runaway climate change will likely result in extreme weather events, including severe conditions at sea that could result in more ship casualties. Rising sea levels also put port and terminal infrastructure at risk. Operators may find themselves having to spend more to adapt if we don't limit the rise in global temperatures to less than two degrees Celsius, which the Intergovernmental Panel on Climate Change says will help us avoid the worst effects of climate change.

Thus, a different path is required for the industry to thrive well into the 21st century and enable the global connectivity that has been the hallmark of growing the world economy for over a century.

But what will that take? In our next article, we identify the critical levers that make sense for the environment and the bottom line of industry players.

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About

Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping

The Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping is real climate action. It is a not-for-profit, independent research and development center creating an industry-wide transition strategy by providing overview of the technical solution space and the critical change levers.

With partners from leading organizations across the world, we will accelerate the development and implementation of new energy systems and technologies.

The Center was established in 2020 with a donation from the A.P. Moller Foundation.