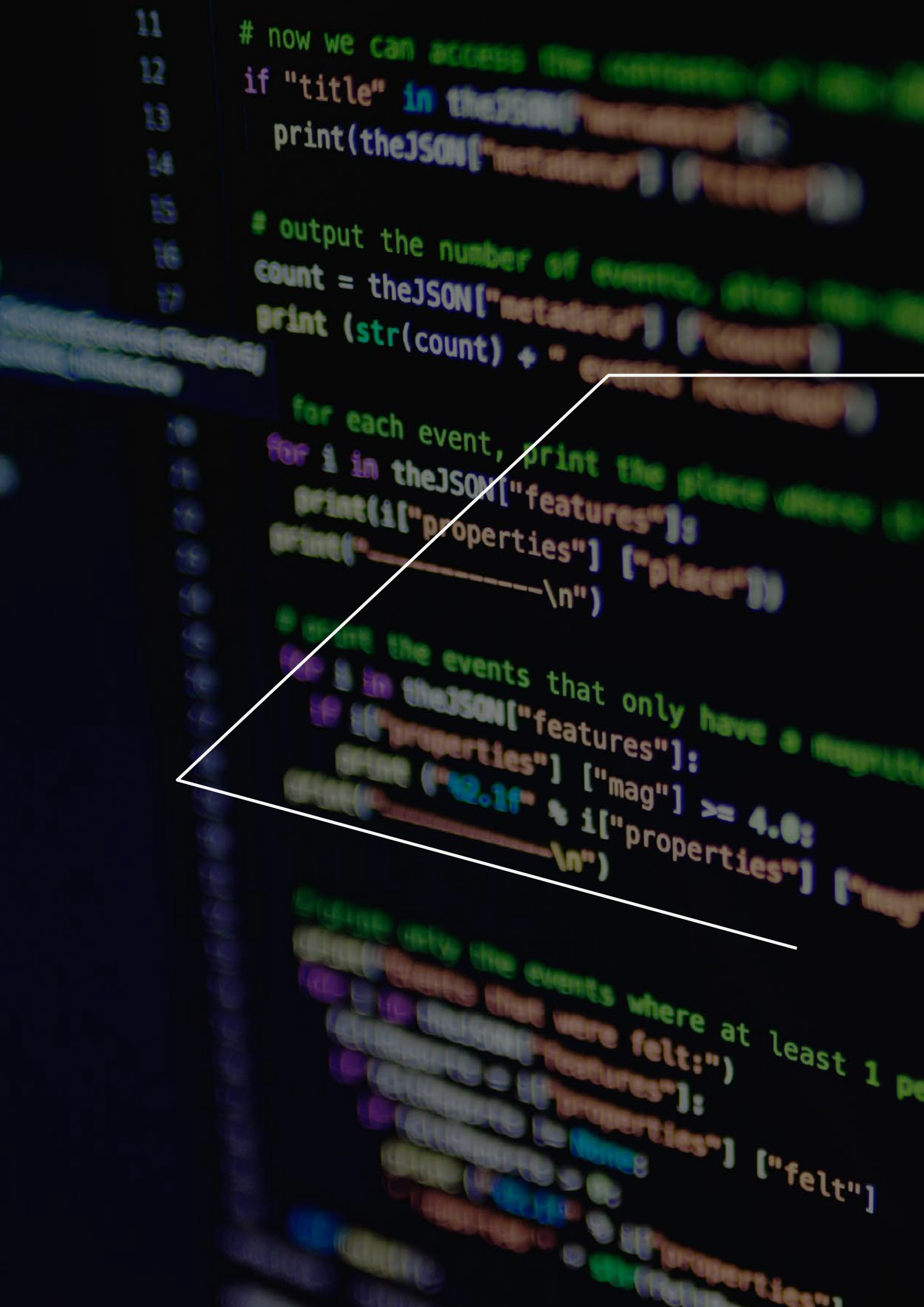
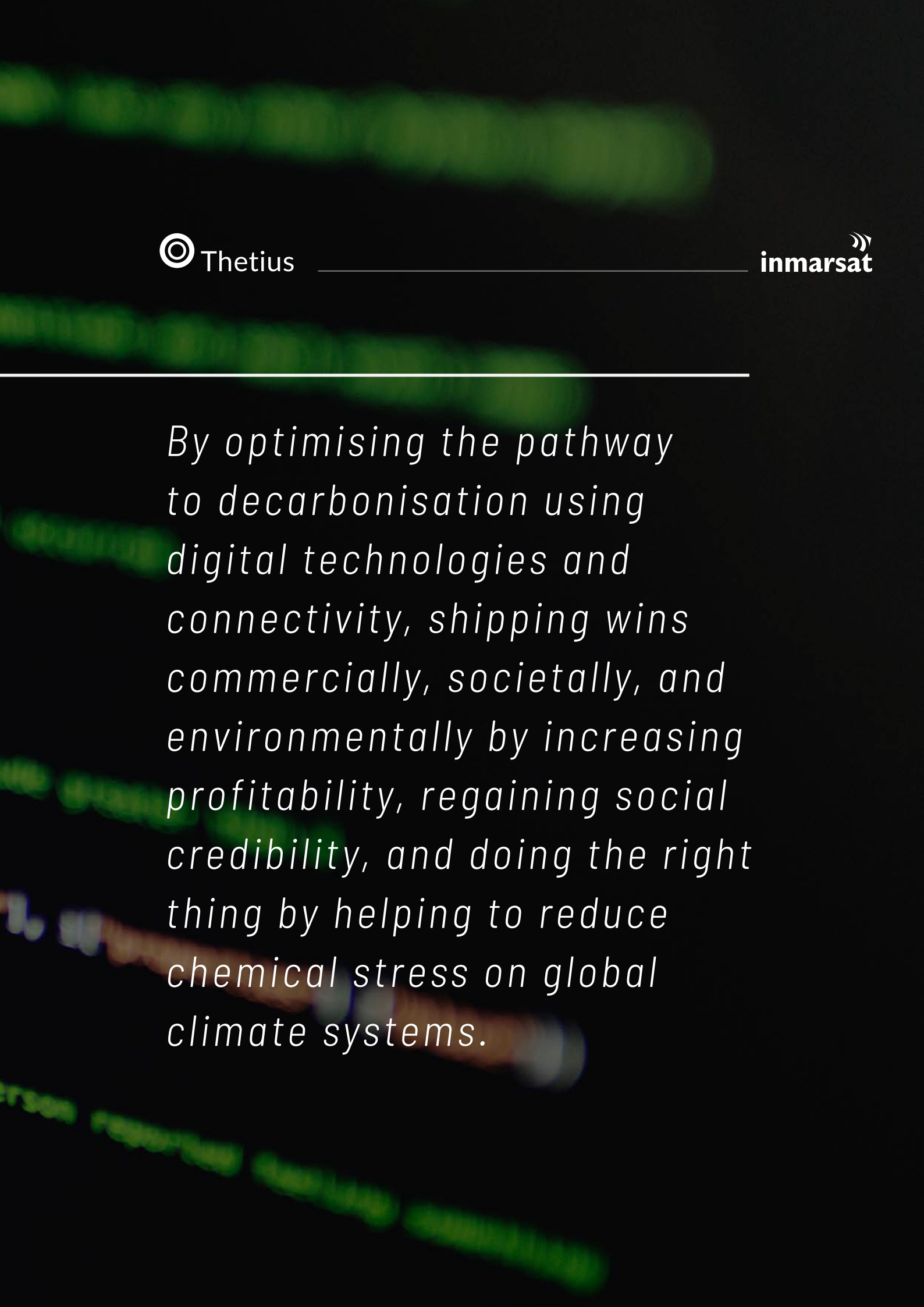

Thetius
inmarsat
THE OPTIMAL ROUTE
The Why and How of Digital Decarbonisation in Shipping
Matthew Kenney & Lauren Brunton
Foreword by: Ben Palmer, President, Inmarsat Maritime
inmarsat | Research Programme


11
12
13
14
15
16
17
now we can
if "title" in
print(
# output the
count = theJSON[
print (str(count) +
for each event,
for i in theJSON["features"]:
print(i["properties"] ["place"])
print("-----------\n")
# print the events that only have a
for i in theJSON["features"]:
if i["properties"] ["mag"] >= 4.0:
print ("%2.1f" % i["properties"] ["
print("-----------\n")
# print only the events where at least 1
print("The following were felt:")
for i in theJSON["features"]:
if i["properties"] ["felt"]



Thetius

inmarsat

By optimising the pathway to decarbonisation using digital technologies and connectivity, shipping wins commercially, societally, and environmentally by increasing profitability, regaining social credibility, and doing the right thing by helping to reduce chemical stress on global climate systems.

CONTENTS

FOREWORD

Digital transformation – but also collaboration – will be key to meeting the maritime industry's decarbonisation targets, says Ben Palmer, President, Inmarsat Maritime.

The International Maritime Organization's reduction targets for marine greenhouse gas emissions, set against a 2008 benchmark, are an ambitious but necessary response to shipping's growing environmental impact. With the IMO seeking a minimum reduction in marine GHG emissions of 50% by 2050, and a 70% reduction in the carbon intensity of emissions by the same year, the industry must act quickly and decisively to improve the sustainability of its operations.

However, there is no shortcut or silver bullet to achieving such objectives. Maritime decarbonisation will rely on changes in attitudes and behaviour; collaboration between governments and industry stakeholders; the introduction of – and widespread compliance with – further, shorter-term regulations; and the continued development and implementation of novel technologies and processes designed to deliver efficiency gains across all areas of vessel operations.

In the maritime sector specifically, it is essential that we listen to, understand and build on each other's views and recommendations as we seek the optimal route to decarbonisation.

According to Ricardo Energy and Environment, digitally-enabled optimisation strategies alone can yield up to a 38% reduction in maritime GHG emissions by 2050; evidence, if any were needed, that the paths to digital transformation and decarbonisation are tightly intertwined. In Inmarsat's experience, shipping companies fully appreciate the importance of performance analysis and digital solutions in achieving green operations: alongside crew welfare, environmental compliance is the major driver for the adoption of maritime connectivity services and the processes and applications they enable.

Against this background, and as the world's foremost provider of global, mobile satellite communications, Inmarsat is committed to supporting shipping's decarbonisation journey. Its industry-leading high-speed broadband service, Fleet Xpress, delivers the bandwidth necessary to collect, analyse and transfer significant volumes of vessel and machinery performance data – a series of processes that together facilitate decision-making for more efficient and environmentally friendly operations.

In addition, Fleet Connect, delivered through Fleet Xpress, allows Inmarsat's Certified Application Providers (CAPs) to deliver value-added services without interfering with general vessel operations or crew communications. Since several CAP solutions target emissions reduction by enabling efficiency gains in areas such as fuel consumption, weather routing and voyage planning, access to the Fleet Connect platform can help shipowners to enhance sustainability across their fleet.

Yet providing services and solutions that support maritime decarbonisation is only one example of Inmarsat's commitment to sustainability. With environmental leadership at the heart of its business strategy, the company is working hard to reduce the ecological impact of its own operations. For instance, Inmarsat recently collaborated with its partner Carbon Intelligence to quantify its Scope 3 emissions (those resulting from manufacturing), which were found to account for 97% of its environmental footprint. In response, Inmarsat has established a 90% reduction target – the most ambitious set by a satellite operator so far – which it aims to attain by embedding sustainability in its supplier selection process.

As this example demonstrates, leveraging partnerships and collaborating throughout the supply chain are crucial to achieving environmental sustainability. In the maritime sector specifically, it is essential that we listen to, understand and build on each other's views and recommendations as we seek the optimal route to decarbonisation. This report therefore reflects the voice of the industry and is driven by the urgent need for collaboration in protecting the future of shipping – and indeed the future of the entire planet.

Ben Palmer

President, Inmarsat Maritime

EXECUTIVE SUMMARY

In July 2011, the International Maritime Organization (IMO) made maritime history. For the first time since its inception, they announced the adoption of a set of mandatory measures for the reduction of greenhouse gas emissions from shipping. The transition from intergovernmental consultant to environmental regulator had begun.

40% of the technology companies operating in the maritime sector today have been founded since 2011 and most offer digital solutions that result in efficiency improvements.

In the 11 years since the launch of the GHG strategy, efforts to develop clean fuels have taken great strides. Parallel to this however, there has been an influx of digital innovations aimed at moving the needle quicker and more immediately. 40% of the technology companies operating in the maritime sector today have been founded since 2011 and most offer digital solutions that result in efficiency improvements. A litany of new regulations, initiatives, and market based measures have descended on shipping over the same period and today, the boards of shipping companies across the globe have moral, commercial, and legal obligations to take their GHG emissions seriously and put immediate steps in place to reduce the environmental impact of their ships.

Carriers that don't step up their efforts to invest in digital decarbonisation technology and embrace innovation, could find themselves redundant in the rapidly evolving ocean freight sector. The reasons for this are complex and are the result of change drivers emerging from multiple parts of the global supply chain from trade finance to the standards and regulatory framework. Despite this, some of the solutions are simple. As a starting point, here are three steps that all shipping companies can take immediately and with relatively modest investment:

- **KNOW YOUR NUMBERS.** Gather as much data from your ships and assets as possible and measure current performance against recognised benchmarks such as the EEXI and CII. Ideally, these measurements should be automated by working with an IoT platform to ensure that data is consistent, comprehensive, and comparable.
- **IMPLEMENT A DIGITAL DECARBONISATION STRATEGY.** Use the results from the measurements gathered to draw up a digital transformation roadmap, identify data silos and investigate how to liberate them, identify cargo blindspots and consider how to bring visibility to cargo owners, and build flexibility into your fleet renewal program that allows for an uncertain trajectory for global decarbonisation regulations.
- **PREPARE TO PARTICIPATE IN GREEN CORRIDOR SCHEMES.** These will be voluntary, but there is reason to believe that participating in them will bring commercial and competitive advantages which might prove very impactful over time.

While they should not be considered in competition with each other, digital decarbonisation tools offer impressive value for money when compared to measures based on clean energy.

While they should not be considered in competition with each other, digital decarbonisation tools offer impressive value for money when compared to measures based on clean energy. Of the estimated US $1.9tn it will cost to fully decarbonise shipping, 85-90% of that cost is in building the infrastructure to support future fuels. At a fraction of the cost, digital optimisation of conventional assets is still expected to achieve up to a 38% reduction in GHG emissions by 2050. That is 76% of the decarbonisation effort required by IMO targets[1] for perhaps 1/10th of the overall estimated cost. While it is clear from these numbers that alternative fuels infrastructure must continue to develop at pace, shipping can be making considerable progress in the meantime by embracing digital optimisation.

The finance industry has taken a proactive approach to encouraging immediate decarbonisation among their financed fleets. As sustainability NGO Ceres noted in an open letter to the US Securities and Exchange Commision (SEC) in 2021, *"Today's investors and lenders seek to track absolute GHG emissions to measure and hold companies accountable for promised reductions, in order to arrest both specific and systemic collapses in asset values and businesses."* Despite latest figures suggesting that only 47% of ships financed by Poseidon Principals signatories are 'aligned' with climate reduction targets, the scheme is only in its second year and already represents a portfolio worth US $185bn, or about 50% of the global ship finance portfolio.

1 The target is a 50% reduction in absolute CO_2 emissions by 2050

There is now a large community of digital innovators and service providers that are demonstrating real and immediate savings to GHG emissions while also delivering increased profitability.

It is a similar story for cargo owners. Discussing the changing demands with Michael Parker, Chairman of Global Shipping, Logistics and Offshore at Citibank in 2021, Wärtsilä's John Hartley, General Manager of Market Innovation, said, *"Ten years ago, all container carriers talked to a customer about was the price to move a TEU across the Atlantic or Pacific oceans. Now cargo owners say, 'if you don't come in with a very strong decarbonisation and ESG policy, you can't talk to us'."*

As a result, charterers formed voluntary measures of their own with initiatives like the Sea Cargo Charter and Cargo Owners for Zero Emissions Vessels (coZEV). Work is also underway by BIMCO to redesign standard charter party clauses to address the responsibility of shipping to reduce emissions and rebalance contracts to accommodate greener practices such as the 'just in time model'.

There is now a large community of digital innovators and service providers that are demonstrating real and immediate savings to GHG emissions while also delivering increased profitability. The link between wastage, environmental harm, and operating cost is obvious and emissions are being created unnecessarily across the ocean supply chain. Time wasted in port, or due to encounters with bad weather and foul currents, result in extra fuel being burned and avoidable emissions being released to the atmosphere. Eliminating these from the picture is a vital part of getting ocean freight to net zero on time.

Perhaps the most fruitful area for digital decarbonisation and certainly the most targeted by digital innovators, is the voyage phase when ships are at sea and their engines are at their most polluting. The market for digital ship operations and management technology is young and growing fast. Thetius data indicates that digital transformation in this area is currently an US $11bn industry with a compound annual growth rate of approximately 4.5%.

Voyage optimisation and fleet monitoring platforms are returning impressive results for their users. Solution provider Zero North revealed that its platform had prevented 218,000 tonnes of CO_2 from being released to the atmosphere throughout 2021, coinciding with a time when shipping's emissions as a whole increased by 4.9%. A few months prior, Cargill reported CO_2 reductions of up to 14.4% across its tanker fleet. In the same year, artificial intelligence capability from Deepsea Technologies produced a 12% reduction for capesize tanker operator Seanergy Maritime. Scaling these gains across the international shipping sector would make a significant contribution to realigning it with its 2030 carbon intensity and 2050 absolute carbon emissions targets.

18%

CO_2 emissions savings of 18% or more in some cases are being reported across early digital decarbonisation adopters, resulting in millions fewer tons of GHG being released.

CO2 emissions savings of 18% or more in some cases are being reported across early digital decarbonisation adopters, resulting in millions fewer tons of GHG being released using existing assets and conducting the same amount of work. But efficiency brings more than just better environmental outcomes, it has a positive effect on profitability too. Improvements in time charter equivalent earnings (TCE) correlate with savings in fuel and time - both on and off-hire. According to a study by Aalto University's School of Engineering, voyage profitability could be improved by up to 17.8% among mid-range tankers as a result of voyage optimisation alone[2] and some of the partner trials in this report demonstrated between 4 and 7% uplift in profits on the routes where digital optimisation was used. According to TechBinder founding partner Bram van den Boom, eliminating unplanned downtime using condition based monitoring can increase margins by as much as 50%.[3] As Wärtsilä once put it, *"If we can't do better with the existing fleet, how will shipping have sufficient money to earn the capital and justify the risks to build newer, more sophisticated, better-running ships in the future?"*

Digital and communications technologies are finding novel ways to make savings too. For example, by enabling regular doctor 'house calls' to be offered to ship's crew, digital technology is helping to improve the health and wellbeing of seafarers and negating the environmental impact of diverting ships to seek treatment for unwell crewmembers. As the idea develops, hundreds of thousands of nautical miles of diversions may be avoided each year, preventing thousands of tons of GHG in the process.

By optimising the pathway to decarbonisation using digital technologies and connectivity, shipping wins commercially, societally, and environmentally by increasing profitability, regaining social credibility, and doing the right thing by helping to reduce chemical stress on global climate systems.

2 Ahokas, M.-M. (2019). Analysis of Voyage Optimization Benefits for Different Shipping Stakeholders. Aalto University School of Engineering. Retrieved from https://aaltodoc.aalto.fi

3 van den Boom, B. (2020, August 12). Big opportunity for maritime operations lay in grey data (sic). Retrieved from https://www.linkedin.com/pulse/big-opportunity-maritime-operations-lay-grey-data-bram-van-den-boom/

INTRODUCTION

Shipping is running behind decarbonisation targets and under exploiting opportunities to catch up. This is an own goal commercially and societally. New regulations and changes to the way cargo owners are selecting transport partners means that 'business as usual' is no longer an option.

Carriers that don't step up their efforts now to invest in digital decarbonisation technology and embrace innovation, could find themselves redundant in the rapidly evolving ocean freight markets.

Shipping lines that act decisively on digitalisation and decarbonisation will move ahead; and those that don't will be frozen out of preferential finance rates, valuable green incentive schemes, and business from the most lucrative charterers and cargo owners. Carriers that don't step up their efforts now to invest in digital decarbonisation technology and embrace innovation, could find themselves redundant in the rapidly evolving ocean freight markets.

Effectively, IMO targets give ship operators less than the lifespan of a current new build to implement ways to move more cargo with much less environmental impact. For operators that see the opportunity, cutting greenhouse gas (GHG) emissions in half by 2050 compared to a 2008 benchmark, will involve a mix of behavioural changes, fleet digitalisation, and a prolonged investment in clean propulsion.

Cargo owners closer to the heat of public opinion, such as big retail and consumer energy, want shipping to act quicker. More than 9 out of 10 fortune 500 companies now report on their environmental impact under the United Nations 'GHG Protocol'. In most cases, by far the largest group of emissions these companies report are 'scope 3' emissions; those resulting from their 'corporate value chain', including ocean transport.

Some of these companies are joining forces to increase pressure on the transport sector to decarbonise quicker. Other companies such as Walmart and Amazon, are big enough to exert pressure on their own. Companies with their finger on the pulse are desperate to pivot on green credentials in markets where consumer opinion matters. A recent survey of consumers carried out by logistics platform Sifted, found that 67% of respondents considered eco-friendly practices in their purchasing decisions and 91% want an 'eco-friendly shipping' option at checkout.[4]

Consumer opinion is a blunt instrument without choice. However, technology-driven innovation is starting to shift the

4 Sifted (2021), How Much do Shoppers Care about Eco-Friendly Shipping? Retrieved from https://sifted.com/guides/eco-friendly-consumer-report/

power dynamic. One example is global logistics giant DHL, who now offer their freight customers a number of 'GoGreen' solutions, including the option to ship with a greener ocean carrier, bagging the shipper a 5% reduction in their scope 3 carbon footprint at the click of a button.

The finance and insurance industries thrive on providing the capital and asset protection needed to build and operate effective supply chain infrastructure. But these industries are now interpreting poor environmental outcomes as credit risk and as a result decarbonisation is an increasingly common prerequisite to securing affordable ship finance. For example, in January 2022, tanker fleet owner/operator d'Amico Tankers secured their first sustainability-linked loan as part of a debt restructuring. The operator has refinanced three vessels with an ABN-AMRO credit facility that adjusts the rate of interest based on the decarbonisation performance of the vessels over the next 5-years. Explaining the reasons for choosing this type of finance mechanism, d'Amico's Chairman and CEO Paulo d'Amico said, *"Having such a modern fleet provides us access to more competitive financing terms since the largest banks financing the shipping sector are a signatory of the Poseidon Principles and have made commitments to reduce the CO_2 footprint of the vessels they finance"*

In the political sphere, activists have criticised global regulators for what they perceive as a slow response to climate change. But, geopolitics are impossible to ignore and getting global interests to agree is notoriously difficult. The latest attempt, the 2021 UN Climate Change Conference dubbed 'COP26', produced some forward motion for ship decarbonisation. 22 countries, including the US, UK, France, Germany, and Japan, signed the 'Clydebank declaration on green corridors'. Carriers that participate in the green corridor scheme are likely to enjoy reduced port fees, priority berthing, virtual queuing, and reduced carbon levies. The scheme is not just lip service either; the first six corridors will be established within two years.

Significantly reducing crude-derivative fuel oil emissions is highly problematic and developing processes, technology, and infrastructure to transition to clean alternatives is a highly complex task.

As time goes on, there are fewer possibilities for carriers to avoid decarbonisation. In fairness, the laws of physics provide no easy solutions for shipping. Significantly reducing crude-derivative fuel oil emissions is highly problematic and developing processes, technology, and infrastructure to transition to clean alternatives is a highly complex task. Moving tens- or hundreds of thousands of tons of ship and cargo across oceans safely and reliably requires enormous propulsion power reserves. To store the energy required to produce that power onboard, a ship requires stable, energy-dense fuels that are widely available and sufficiently standardised in quality and compatibility to be used by all ships in all parts of the world.

Introducing a new fuel type that needs new engine designs, new storage facilities, and new methods of bunkering, transport, and supply, requires the coming together of multiple disciplines, industries, and interest groups. Achieving this will take patient diplomacy and time; something the industry is short of if it is to achieve its goals. It will also take extreme levels of investment; estimated to run into the trillions of dollars.

17.8%

According to a study by Aalto University's School of Engineering, voyage profitability could be improved by up to 17.8% among mid-range tankers as a result of voyage optimisation alone.

Optimising conventional fossil fuel-burning vessels with digital technologies also results in considerable GHG reductions, but at a fraction of the cost. In fact, over 70% of the decarbonisation that shipping is required to complete by 2050, is achievable through digital transformation alone. Shipping can - and must - immediately reduce its impact on the environment while maintaining commercial outcomes so that it attracts the investment needed for a wholesale move to clean energy.

Digitalising conventional shipping is already improving the links between the ocean freight sector and wider supply chain, unlocking a wealth of opportunities for shipping to transport more, while burning less. Examples can be found across the sector: Improvements in voyage and weather routing are already reducing ton-mile emissions and preventing fuel wastage by enabling finer adjustments to cruising speeds; Port call optimisation is reducing inefficiency in cargo operations and doing its bit to facilitate a 'just in time' (JIT) supply chain. Enhanced connectivity is reducing transport emissions by facilitating remote survey, inspection, and even pilotage services, as well as building a key piece of infrastructure for digital transformation as a whole.

These advancements don't just enable better environmental outcomes, compliance with regulations, or alignment with customer needs either. Streamlining maritime operations also improves profitability by reducing or removing operating cost. According to a study by Aalto University's School of Engineering, voyage profitability could be improved by up to 17.8% among mid-range tankers as a result of voyage optimisation alone[5] and according to TechBinder founding partner Bram van den Boom, eliminating unplanned downtime using condition based monitoring can increase margins by as much as 50%.[6]

The next generation of energy sources and propulsion systems are making an impact where they can. Net zero inshore and coastal vessels are already in use. But where the challenge of decarbonisation remains extreme, such as the deep sea liner trades, digitalisation is the key which unlocks more immediate progress towards greener sea freight.

This report explores digital decarbonisation and examines the impact that digital technology is having on reducing GHG from shipping. It will also showcase some of the most successful examples of fuel saving and decarbonisation as a result of using digital technologies that are commercially available today.

The end goal for the ocean freight sector is still to move to cleaner fuels - the long term health of global climate systems depends on it. But without embracing digital optimisation, shipping will be missing a critical step towards efficiency and sustainability. Indeed, without digital transformation, some carriers may not survive long enough to take advantage of future fuel sources. In this report we examine why and deconstruct some of the most impactful strategies for decarbonising conventional ships using digital technology.

Before we dive deeper, let's start with three steps that all ship owners and operators could take today to kickstart their decarbonisation efforts.

5 Ibid 2

6 Riviera Maritime Media. (2021). Unlock unused data for 50% profit growth. Retrieved from https://www.rivieramm.com/editors-choice-brand/five-steps-to-unlocking-unused-data-for-50-profit-growth-60840

3 STEPS TO DIGITAL DECARBONISATION

Vessels that are assessed at 'E', or receive a 'D' rating for 3 consecutive years, will be required to submit a corrective action plan to their flag administration to demonstrate how the vessel will be improved to a C rating or above.

STEP 1 KNOW YOUR NUMBERS

The first step to aligning ship fleets with the IMO GHG reduction targets is to start measuring current performance. Not only will this provide a benchmark, but it will make knowing where and how to make improvements clearer.

Mandatory measures announced by the IMO in 2021, require all existing ships to have their design efficiency assessed against the Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Index (CII). In force from November this year, ships should expect to require EEXI and CII certification from January 2023 onwards. While the IMO has not yet published detailed guidance, ships will be given an energy efficiency rating of A, B, C, D, or E - where A is the best result. Vessels that are assessed at 'E', or receive a 'D' rating for 3 consecutive years, will be required to submit a corrective action plan to their flag administration to demonstrate how the vessel will be improved to a C rating or above.

These measures target design improvements (EEXI) and operational efficiency (CII) and while many of the measures in each category result in comparable reductions in emissions, operational efficiency measures generally offer significantly better cost-benefit scenarios. It is vital that ship owners accurately measure their performance against a range of metrics to understand the problems they have and the improvements their chosen strategies are making.

'Absolute' and 'intensity-level' metrics are useful calculations for comparing the operational efficiency of individual voyage routes, or ships within a fleet. Absolute emissions are important because the ultimate goal of the IMO is absolute reductions in GHG, intended to reduce chemical stresses on the natural environment. On the other hand, intensity-level metrics are useful when assessing like-for-like emissions, making intensity metrics more suited to assessing voyage performance.

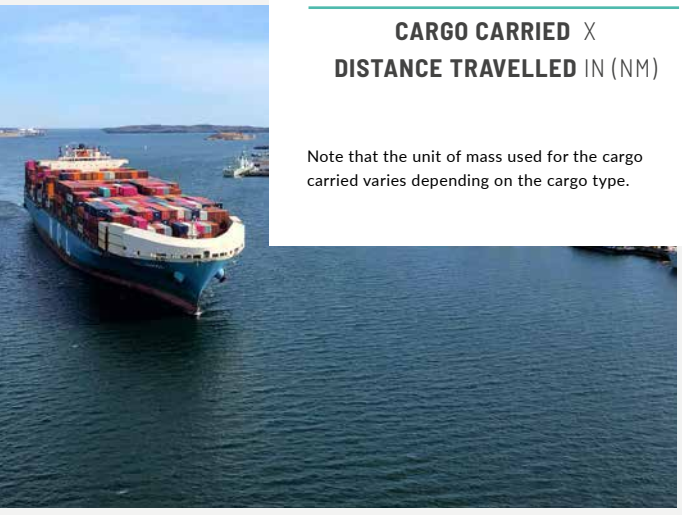
Carbon intensity is calculated by measuring the total emissions generated during a defined period of time (or amount of work done) in grams of CO_2 per ton-nautical mile (gCO_2/tnm). It's best measured using real-world operating conditions rather than a theoretical approach and employing algorithms such as the Energy Efficiency Operational Indicator (EEOI) is an effective way of calculating meaningful results.

Voluntary use of the EEOI algorithm is strongly recommended in the Ship Energy Efficiency Management Plan (SEEMP) framework, because it helps shift focus to existing ships' operating emissions, even when major design or propulsion modifications are not viable.

Calculating an EEOI is straightforward. The user needs to know four things: how much fuel has been consumed over the reporting period (FC), the CO_2 conversion factor for the fuel used (C_f), the mass of the cargo carried over the reporting period, and the distance travelled in nautical miles (NM). The formula looks like this:

$$\frac{\text{FUEL CONSUMED (FC)} \times \text{CORRECTION FACTOR (CF)}}{\text{CARGO CARRIED} \times \text{DISTANCE TRAVELLED IN (NM)}}$$

Note that the unit of mass used for the cargo carried varies depending on the cargo type.



The continuous monitoring of ship operations enabled by reliable IoT connectivity can provide real-time calculations of carbon intensity against the EEOI and other efficiency metrics.

AUTOMATED MEASUREMENT

Taking measurements and gathering data is both the prerequisite for an effective maritime digitalisation strategy and the first opportunity to implement one. The continuous monitoring of ship operations enabled by reliable IoT connectivity can provide real-time calculations of carbon intensity against the EEOI and other efficiency metrics. Automating the collection and sharing of data from ships makes this process more accurate and more efficient and there are several off-the-peg solutions that offer digitally enhanced data collection and analysis tools.

One example of a measurement platform comes from Iceland-based energy management solutions provider Marorka. They offer an onboard platform that gathers multi-source data from the vessel into a single data layer and makes the data available across the organisation via a cloud server. According to Marorka, their measurement solutions are installed aboard 600 vessels worldwide.[7]

7 Source: https://www.marorka.com/products/

STEP 2
IMPLEMENT A DIGITAL DECARBONISATION STRATEGY BASED ON THE RESULTS

Decarbonising ships is highly complex and difficult to manage alongside running a profitable fleet. Creating a workable plan will help technical managers measure the scale of the problem and spot opportunities to advance towards solutions. Here are some of the fundamental components of a good decarbonisation strategy:

Creating a workable plan will help technical managers measure the scale of the problem and spot opportunities to advance towards solutions.

- **DRAW UP A DIGITAL TRANSFORMATION ROADMAP.** Every mountain is conquered with the first step. For ship operators, developing a roadmap to success is the first step towards meeting new obligations and staying competitive. There are an array of options, opportunities, and risks that will impact each operator differently. Understanding regulations, measuring current performance and automating data collection, scanning the market for new digital tools, listening to customers, and quantifying the amount of funding required to progress are vital steps to producing a useful roadmap.

- **IDENTIFY DATA SILOS AND CONSIDER WHAT COULD BE ACHIEVED BY LIBERATING THEM.** 'Siloed' data is confined to a single system for the exclusive use of that system. One example might be enhancing the autonomy and efficiency of a fuel management system aboard a duel-fuel vessel. The concept of a micro cloud on ships involves a centralised, common-format data layer that is fed by multiple sensors and that is available to any application that requires data from it via an Application Programming Interface (API). Using this concept, the fuel management system in our example could prepare for and initiate more timely switches between fuel sources based on position, course, and speed information shared from the navigation suite on the bridge.

If other parts of the chain can see the whereabouts of cargo coming their way, they can produce better plans and make the handover process slicker.

- **IDENTIFY CARGO BLINDSPOTS AND CONSIDER HOW YOU CAN BRING MORE VISIBILITY TO YOUR CARGO OWNERS.** Increasingly, the global supply chain demands and expects end to end visibility. The biggest driver for this is the better coordination of the supply chain as a whole. If other parts of the chain can see the whereabouts of cargo coming their way, they can produce better plans and make the handover process slicker. Think of the supply chain as an olympic relay team and a piece of freight as the baton. Handing the baton to the next athlete in the chain requires both athletes to know where the other is and for them to communicate effectively on the lead up to the switch. Digital technologies are enabling a more end to end approach to freight logistics and the days of ships going off-grid for days or weeks at a time are numbered. The task is to deliver a piece of freight from a consignor to a consignee and all connecting parts now need to work as a team to make sure it is done in the most efficient manner. In this regard, shipping may begin to look more closely at the advanced interconnectedness and standardisation of the global air traffic management regime used in the aviation industry and begin drawing parallels with its current challenges.

- **BUILD AND BUY FLEXIBLY TO AVOID ASSET STRANDING.** The shipping industry is changing rapidly and the trajectory is difficult to determine with confidence. The metrics and algorithms used to measure and moderate GHG emissions are in flux from the international level downwards. The mechanisms used to benchmark ship emissions are also subject to alteration. Ship owners and operators should seek flexible asset configurations that allow them to adapt to the shifting sands of regulation and the undulating pressures from environmental, social, and corporate governance. Lastly, be mindful of the interoperability of IoT sensors and platforms by looking for common interfacing standards such as RS-232 or NMEA.

Ship owners and operators should seek flexible asset configurations that allow them to adapt to the shifting sands of regulation and the undulating pressures from environmental, social, and corporate governance.

Under the GHG protocol, scope 3 emissions are pressuring cargo owners to demand greener shipping.

STEP 3
PREPARE TO PARTICIPATE IN GREEN CORRIDOR SCHEMES

Shipping is no longer about ships, it's about cargo. Under the GHG protocol, scope 3 emissions are pressuring cargo owners to demand greener shipping. The Clydebank Declaration, announced at COP26 in 2021, introduced plans to convert major shipping lanes into 'green corridors'. The concept works by partnering two or more ports in a cooperation agreement and inviting ship operators to adhere to certain standards on data sharing, transparency, and digital decarbonisation in exchange for preferential benefits on the route. There will be a minimum of six green corridors established by 2025. While ships that do not meet the standards won't be excluded from navigating green corridors, ship finance is indirectly committed to supporting their use and carriers that don't secure access on may find themselves disadvantaged against competing services. For example, Danish Ship Finance, who have a US $5.76bn maritime loan book, have already made 20% of new loans sustainability-linked, which they say is rising to 30% by the end of this year. By 2025, new lending will only be available to clients who are engaged in a sustainable transition.

The concept works by partnering two or more ports in a cooperation agreement and inviting ship operators to adhere to certain standards on data sharing, transparency, and digital decarbonisation in exchange for preferential benefits on the route.

DEFINING DIGITAL DECARBONISATION AND THE PATHWAY TO 2050

The 11th July 2011 was an unstereotypical Monday in central London. Daybreak revealed a cloudless sky which outlined the gothic edifice of Westminster in a vivid sapphire blue. Bathed in the early sunlight, the earthy-brown of the River Thames churned passed in a cheerier sea-green shade and a gentle northerly breeze brought freshness to the air.

For the first time since its inception, the IMO was to adopt a set of mandatory measures for the reduction of greenhouse gas emissions from shipping.

Across the river on Albert Embankment, delegates from across the world gathered in the headquarters of the IMO, awaiting the opening of the 62nd Maritime Environmental Protection Committee (MEPC). The atmosphere in the plenary chamber was not out of the ordinary that day. As usual, senior officials of the secretariat presided from the centre, as nation state representatives gave prepared statements from the hemicycle. Sub-committees broke out into separate rooms and teams of translators busily relayed proceedings in native languages from darkened booths in the eves. For the most part, the business of bureaucracy went by with a sense of routine.

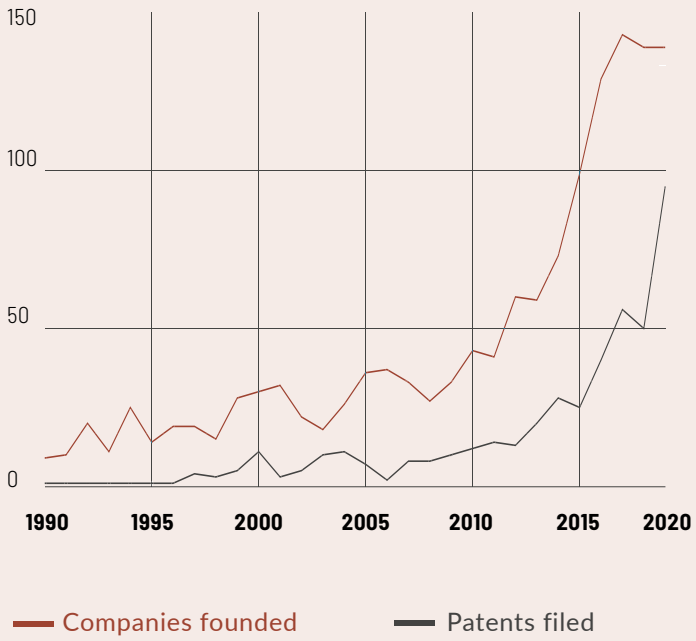
On that day however, delegates of the MEPC were to make maritime history: For the first time since its inception, the IMO was to adopt a set of mandatory measures for the reduction of greenhouse gas emissions from shipping. In the 11 years since publishing their first report on the subject, the IMO had not reached beyond commissioning feasibility studies and calling for more data. The transition from intergovernmental consultant to environmental regulator had begun.

Since the IMO GHG strategy launch in 2011, there has been an average 4.7-fold increase in the average number of startups entering maritime digital innovation year on year.

A NEW MARKETPLACE IS BORN

The tech and innovation industry responded to the IMO's GHG strategy at pace. Many startups, scaleups, and global enterprises saw an opportunity developing and were keen to join an emerging market. Digital solutions providers began launching in maritime as early as the mid-1990s, as computer technology opened new opportunities for digital processes. But the influx only really gathered pace once decarbonisation became a mandated aim. According to Thetius data, since the IMO GHG strategy launch in 2011, there has been a 4.7-fold increase in the average number of startups entering maritime digital innovation year on year. This has resulted in just under 40% of businesses operating in the vertical today having been founded since 2011. There has also been a 10-fold increase in patents filed over the same period.

NUMBER OF COMPANIES FOUNDED AND PATENTS FILED



Some of these new companies have seen opportunities to improve ship design. According to DNV, steps like improving hull form and underwater coatings, recovering waste heat, de-rating engine outputs, or implementing battery hybrid systems, can deliver efficiency savings of between 10 and 35% by 2050.[8] This approach is encouraged by IMO instruments like the Energy Efficiency Design Index (EEDI). This incentivises physical design improvements that result in decarbonisation and if EEDI works as it should, the road to decarbonised shipping will eventually result in alternative fuels and radical new ship designs.

However, the most impactful alternative fuels are still navigating earlier stages of development. This is largely because their use at scale requires alignment across multiple layers of science, technology, geopolitics, and economics. Unlike the shift from sail to coal, or coal to oil, shipping is unlikely to move homogeneously to a single new fuel this time.

8 DNV. (2021). Maritime Forecast to 2050 - Energy Transition Outlook 2021 (p. 30). Retrieved from https://eto.dnv.com/2021/maritime-forecast-2050/about

There are already vessels afloat powered by alternatives like methanol, ammonia, or renewable electricity and great strides have been made on a handful of alternative low-carbon fuel options. But these solutions are still some way from offering mature, proven, global scale, cost effective alternatives to fuel oils - especially in the trans-oceanic liner trades. Until 15,000+ containers can be transported across the world without fuel oil, calling at several ports, in several different countries, reliably, cost effectively, and with adequate refuelling options in scheduled and alternate ports; clean fuels do not yet represent a market-ready prospect.

Digital technologies can achieve 76% of the decarbonisation effort required by IMO targets for perhaps 1/10th of the overall estimated cost.

BANG FOR BUCK

Recent survey data shows that owners and charterers believe that voyage efficiency savings of 28% are possible,[9] but estimates suggest that optimisation-based emissions reduction strategies can result in up to 38% reduction in maritime GHG by 2050,[10] exceeding DNV's expectations for engineered design solutions.

A study commissioned by the World Economic Forum estimates that the cumulative capital investment needed to decarbonise the shipping industry is between US $ 1 - 1.9 trillion and alternative fuel supply infrastructure represents between 85% and 90% of that cost, meaning that digital technologies can achieve 76% of the decarbonisation effort required by IMO targets for perhaps 1/10th of the overall estimated cost.

With this level of cost effectiveness, it is reasonable to consider digital decarbonisation as a major step on the pathway to net zero shipping.

9 NAPA. (2020, February 14). Survey: Owners and charterers believe that voyage efficiency savings of 28% are possible . Retrieved from https://www.napa.fi/news/

10 Ricardo Energy & Environment (2022) Technological, Operational, and Energy Pathways for Maritime Transport to Reduce Emissions Towards 2050, issue 6, available at ogci.com

Far from being on its way to a 40% reduction, absolute CO2 emissions from shipping have increased approximately 16%.

This involves implementing digital technologies that enable the smarter and more efficient operation of conventional ships, for example weather routing, speed optimisation, predictive crew and equipment health management, continuous remote performance monitoring etc; unlocking significant efficiency gains and cost savings from existing fleets and those new builds most likely to be built with fuel oil engines over the coming decade.

The most obvious method of reducing harmful emissions from the burning of oil derivatives is to burn less of them while delivering the same amount of output. This is the essence of optimisation. It should be considered a prerequisite to shipping's transition to future fuels because in order to take advantage of the structural and technological developments in ship design and propulsion, shipping must maintain critical supply links, move the needle on climate alignment and remain commercially viable using its existing assets first.

WHAT INTERNATIONAL TARGETS MEAN IN PRACTICE

How well defined is this 'digital decarbonisation' phase? To answer that question, let's first consider how the global commercial ship fleet might change over the next 10 years. Remember, by 2030, the IMO has set the target of reducing CO_2 intensity from shipping by 40% over the 2008 benchmark. So, where is shipping on that journey today?

According to the IMO and other carbon tracking organisations, the answer is mixed. Far from being on its way to a 50% reduction by 2050, absolute CO_2 emissions from shipping have increased approximately 16%[11] and data from Marine Benchmark suggests that between 2011 and 2019, CO_2 emissions increased at an average rate of 2.1% year on year.[12] This appears to be largely as a result of a growing merchant fleet and the disproportionate rise in aggregate deadweight tonnage in the liner trades: Ships have grown in both number and size. However, this increase in deadweight tonnage has contributed to a positive impact on the carbon intensity of shipping, which is down 30% since 2008 according to the fourth IMO GHG study released in 2020.

11 A comparison of CO_2 emissions from the latest IMO greenhouse gas study suggests CO_2 emissions were 794m tons CO_2 in 2008 and 919m tons CO_2 in 2018. IMO (2020) Fourth Greenhouse Gas Study. Available at https://www.imo.org/en/OurWork/Environment/Pages/Fourth-IMO-Greenhouse-Gas-Study-2020.aspx

12 Marine Benchmark. (2020). Research Brief 11/2020 Maritime CO_2 Emissions. Retrieved from https://www.marinebenchmark.com/wp-content/uploads/2020/11/Marine-Benchmark-CO2.pdf

...in 2020 only 9.6% of the global merchant fleet was less than 4 years old, with 58.5% of the fleet very likely to be sent for recycling within 10 years.

It is difficult to predict how the global merchant fleet will grow and renew in the lead up to 2030 and beyond. The decision to scrap ships depends on a number of factors, not all of which are related to the age of the vessel. Freight rates, cargo demand, and scrap steel prices are heavily influential and are subjected to frequent fluctuations.

The current merchant fleet is ageing quite rapidly. Data from Equasis indicated that in 2020 only 9.6% of the global merchant fleet was less than 4 years old, with 58.5% of the fleet very likely to be sent for recycling within 10 years (being between 15 and 25 years old at the time of the report) and a further 10-20% potentially being recycled depending on market conditions.[13] However, according to UNCTAD, the same year saw three vessels built for every one scrapped (as measured in deadweight tons),[14] so the proportion of new builds is expected to rise over the next 5 years, prolonging the time horizon for replacing conventional ships with cleaner-fuelled versions.

Alternative fuels are making a gradual impact. Recent IHSMarkit data shows us that among the vessels being built in 2021, 88.16% were designed to use conventional fuel oil engines, compared with over 99% using conventional engines in the operational fleet that year.[15] This downward trajectory is an encouraging sign of things to come, but may not be representative of the overall rate or extent of change towards cleaner fuels. Around 80% of global merchant fleet CO_2 emissions come from the deep sea segment, which is dominated by large containerships, bulk carriers, and tankers. This group represents both the youngest average age of ships at 9.72 years and the highest proportion of heavy fuel oil (HFO) usage at just over 155m MT/year.[16] This means that the deep sea segment is highly likely to be the last to transition to cleaner fuels. Currently, only LNG and LPG are viable alternatives for deep sea shipping and the most successful transitions to these fuels have come from LPG and LNG carriers that can overcome the challenge of storing the fuel onboard by burning payload.

This suggests a prolonged transition to clean fuels which will make reaching the 2050 decarbonisation targets impossible to achieve without a concerted effort to optimiseconventional fleets. Here is why 'do nothing and wait' no longer exists for shipping.

REGULATIONS, STANDARDS, AND INITIATIVES - THE 'TOP-DOWN' AND 'BOTTOM UP' INFLUENCERS OF AN OPTIMISATION PHASE

Climate change mitigation is increasingly featured in global policy and regulation. The debate over whether human-made GHG emissions have a net detrimental impact on climate has reached a conclusion and courses of action towards reducing harmful emissions from human activity have been set.

Below, we take a whistle stop tour through five of the most influential policy-based initiatives that will catalyse the shipping industry into digital decarbonisation.

13 Equasis. (2020). The world fleet 2020. Retrieved from https://www.equasis.org/Fichiers/Statistique/MOA/Documents%20availables%20on%20statistics%20of%20Equasis/Equasis%20Statistics%20-%20The%20world%20fleet%202020.pdf

14 UNCTAD. (2021, November 18). Review of Maritime Transport 2021. Retrieved from https://unctad.org/system/files/official-document/rmt2021_en_0.pdf

15 DNV. (2021). Maritime Forecast to 2050 - Energy Transition Outlook 2021 (p. 30). Retrieved from https://eto.dnv.com/2021/maritime-forecast-2050/about

16 IMO (2020) Fourth IMO GHG Study, International, voyage-based allocation, HFO-equivalent fuel consumption 2018.

Inefficiencies can infiltrate the ocean freight sector even before cargo is loaded aboard a ship. In some cases, inefficiency is even encouraged by outdated clauses in charter party agreements.

START AT THE CHARTER PARTY

Inefficiencies can infiltrate the ocean freight sector even before cargo is loaded aboard a ship. In some cases, inefficiency is even encouraged by outdated clauses in charter party agreements.

When a charterer hires a vessel to undertake a voyage, the legal contract it creates is called a 'voyage charterparty'. These agreements are common in the bulk shipping sector, but are frequently used across the supply chain. The charterer pays 'freight' to have goods carried from the load port to the discharge port, and often this payment also includes the cost of delivering the vessel to the load port.

The freight payment will cover the voyage between the load and discharge ports, allowing for limited time for loading and discharge operations at either end - known as 'laytime'. If the agreed laytime is exceeded, the charterer has to pay damages to the shipowner for delaying the vessel longer than originally expected and this is known as demurrage. The demurrage rate will depend on the freight rates the vessel could attract at the time the charterparty was agreed.

Standard voyage charter contract clauses have traditionally been designed to protect the idea that voyages should be carried out as quickly as possible. Key terms require that the carrier undertakes the voyage at 'utmost despatch' and without 'deviation', meaning that the vessel must make best speed to the destination port without causing unnecessary delays. The result is that vessel operators are not just encouraged, but are legally obliged to sail at 'best speed' and arrive at the destination port at the earliest opportunity. It is very common to find that the discharge berth is not available when the vessel arrives because port operations traditionally operate on a first-come first-served basis. This requires that the vessel must go to anchor outside of the port to await an available berth at the terminal. Depending on the specific terms agreed in the charterparty, ships are often considered to be an 'arrived ship' when at anchor in a designated anchorage awaiting an available berth. This starts the clock on laytime, which often means that soon after dropping anchor, the vessel begins to earn demurrage from the charterer. This can be quite a favourable position for the ship owner. The vessel is largely safe, secure, and at rest, while still earning additional income. More recently, a mixture of high freight rates and unprecedented port congestion has created a lucrative demurrage business for ship owners, who in some cases have spent weeks at anchor awaiting an available berth. However, 2017 data from voyage optimisation specialists NAPA, suggests that this 'rush and wait' system wastes US $18bn worth of ship fuel each year on average and while it isn't clear how much of this is recovered via demurrage, it is clear that the practice is not conducive to favourable environmental outcomes.

The problem with all of this is that global Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Index (CII) regulations, schemes like the Poseidon Principles and Sea Cargo Charter, and the proliferation of JIT shipping and green corridor schemes, all require shipping to adjust voyage speeds to coincide with berth availability and ultimately avoid wasting fuel by sailing faster than is necessary.

Recognising this, BIMCO are prioritising revisions to their standard voyage charterparty clauses. BIMCO clauses are widely accepted as industry standard contract terms across the sea freight industry. Their new green clauses will set a new standard for charter party agreements that shift the focus away from 'utmost despatch' to allow shipping the contractual headroom to optimise voyage speeds in the interest of reducing carbon emissions and fulfilling its new obligations under EEXI and CII.

The first new clauses were issued in 2021 and are called the 'Just in time clauses for voyage charter parties'. Perhaps the most impactful change is found in clause (b) which states in part *'...the Charterers shall be entitled to request the Owners in writing to adjust the Vessel's speed to meet a specified time of arrival, or closest thereto, at a particular destination.'*

Demurrage is not eliminated by this clause. The standard contract still allows for the concept of laytime and demurrage, but states that laytime is calculated as the difference between the estimated time of arrival (ETA) and actual time of arrival (ATA). This allows carriers to claim demurrage while at sea, if the specified time of arrival given by the charterer is later than the owner's estimate which is likely to be based on a 'best speed' calculation. The charterer is motivated to request arrival times that are aligned with berth availability because slowing the vessel will reduce their scope 3 emissions, reduce or eliminate demurrage at anchor, and because the new clauses allow for the shipowners fuel savings to be credited against at-sea demurrage payments. Crucially, the new clauses make it clear that complying with specified arrival times by slowing the vessel down does not constitute a breach of the ship owner's obligation to make utmost despatch or deviation, freeing carriers from conditions that are at odds with the just in time concept.

Compliance with the new regime may mean that shipowners are at risk of being in breach of their obligations in performing the voyage under standard charter party terms.'

BIMCO has also announced a more comprehensive set of clauses that enable ship owners to exercise their obligations under EEXI and CII requirements. Work on these is still ongoing, expected for release in May 2022. According to BIMCO, *'The future regulatory framework is complex and challenging and may require shipowners to reduce engine power and speed to comply with the EEXI. The CII requirements may also see shipowners having to reduce cargo intake in addition to routing and slow speeding measures. Compliance with the new regime may mean that shipowners are at risk of being in breach of their obligations in performing the voyage under standard charter party terms.'*

Poseidon Principles

The Poseidon Principles is a voluntary ship finance charter which discloses the 'climate alignment' of the shipping portfolios of signatory financial institutions.[17] The principles are intended to encourage increased investment in greener ships by setting a baseline that aligns with the UN Paris Agreement to limit global warming to below 2 degrees celsius over pre-industrial levels .

Fleets that are financed by Poseidon lenders are required to report carbon intensity data to help the lender ascertain whether their portfolios fall in line with climate goals - i.e. reducing total annual emissions from shipping by at least 50% by 2050. The measurement used is called the Annual Efficiency Ratio (AER) which is reported in grams of CO_2 per deadweight ton-nautical mile (gCO_2/dwt-nm).

The principles are aimed primarily at financiers, lenders, and export credit agencies, with 29 major financial institutions currently signed up. The principles were extended in December 2021 to include the marine insurance industry. This creates a double-pronged approach because ships cannot sail uninsured and finance cannot be secured on uninsured ships.

In a 2021 open letter to the U.S. Securities and Exchange Commission (SEC), sustainability NGO Ceres noted how Poseidon supports the idea that, "Today's investors and lenders seek to track absolute GHG emissions to measure and hold companies accountable for promised reductions, in order to arrest both specific and systemic collapses in asset values and businesses."[18] The letter continues to describe how investors "...want honesty about how net zero commitments are being met." Ceres believes financial institutions and the banking sector, "seek this information both to protect the capital they have invested in individual companies as well as to protect their portfolios overall from the systemic risks of climate change."

> *The principles are intended to encourage increased investment in greener ships by setting a baseline for shipping that aligns with the UN Paris Agreement to limit global warming.*

Poseidon is gaining momentum. The existing signatories represent a bank loan portfolio to global shipping worth approximately US $185bn, equivalent to nearly 50% of the global ship finance portfolio.[19]

The four principles are:

- **AN ASSESSMENT OF CLIMATE ALIGNMENT.** This requires carbon intensity to be measured and assessed to ensure individual portfolios are on the correct trajectory in line with decarbonisation targets.
- **ACCOUNTABILITY.** The information used will be issued by classification societies or other IMO-recognised bodies to eliminate bias in the reporting.
- **ENFORCEMENT.** Covenant clauses are included in new business contracts that are designed to ensure the quality of the reporting information.
- **TRANSPARENCY.** Climate alignment scores for all signatories are shared publicly on an annual basis.

17 Poseidon Principles (2021) Poseidon Principles- a global framework for responsible ship finance Retrieved from https://www.poseidonprinciples.org/finance/wp-content/uploads/2019/07/Poseidon_Principles.pdf

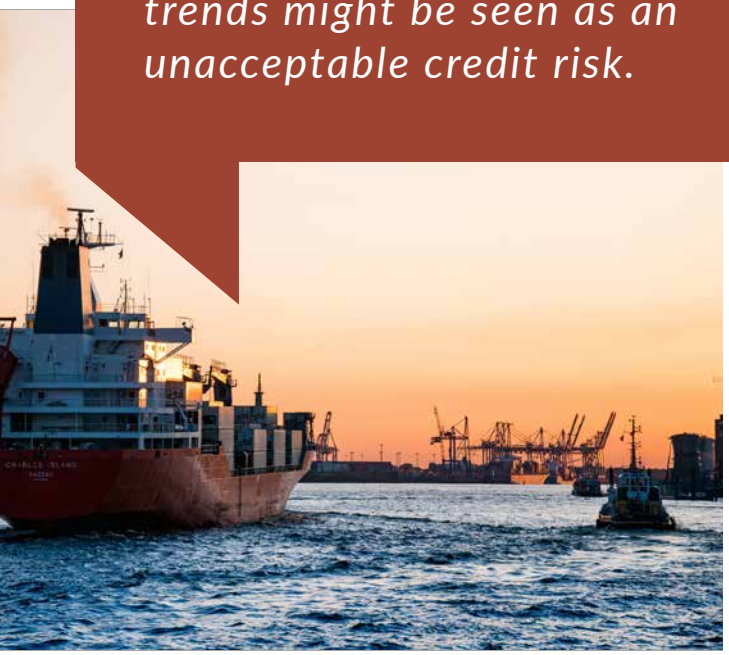
18 Public Input on Climate Change Disclosures, Lubber et alia, Ceres, 2021

19 Poseidon Principles (2021) Poseidon Principles for Financial Institutions Retrieved from https://www.poseidonprinciples.org/finance/about/

Promoting environmental stewardship through ship finance is intended to make a root and branch impact. The current signatories are responsible for nearly 50% of the global portfolio, however that still leaves an unsigned majority, predominantly consisting of financial institutions in the far East. Many believe that participation rates will grow to fill this gap. Commenting in 2019, maritime law firm Watson, Farley and Williams, who were involved in the development of Poseidon, believed that, *"owners of non-aligned ships might find the pool of possible financiers is reduced as signatories try to ensure that their portfolios consist of ships that do comply with GHG targets".*[20]

The role finance plays in the shipping industry is being redefined. Some see the supply of money as a potent instrument of change. Those operators who are not motivated to decarbonise may increasingly find their funding sources limited. While signatories to Poseidon are careful not to imply that funding will be refused on ships that might damage their climate alignment score, it is reasonable to assume that the rates offered will be higher than those offered on greener ships. As momentum gains in other areas, misalignment with decarbonisation trends might be seen as an unacceptable credit risk.

As momentum gains in other areas, misalignment with decarbonisation trends might be seen as an unacceptable credit risk.



Released in December 2021, the second annual Poseidon Principle Disclosure Report states that just under 48% of Poseidon financed fleets are aligned with the IMO's decarbonisation targets. However, the association running the initiative did point to some anomalies resulting from the COVID-19 pandemic which have distorted some of the alignment scores. This has resulted from a policy change at the IMO that includes distance travelled as a correction factor in absolute emissions reporting. This impacted the results for cruise ships who had itineraries curtailed or cancelled altogether during the pandemic.

The report also describes the way in which signatories are using the Poseidon framework as an opportunity for growth. The information generated in the reporting process is being used by signatories to create innovative finance products which steer portfolios by financing retrofits, modifications, or greener new builds leveraged through sustainability-linked loans.[21] It is also possible that the closer ship fleets come to alignment with IMO targets, the more signatories are likely to join Poseidon; creating a positive feedback loop that grows the initiative over time.

Poseidon provides a mechanism which protects ship financiers from environmental regulations developing faster than expected; something that risks stranding secured assets. Maritime legal experts Brodies LLP believe that as these risks are negated,

20 Watson Farley and Williams (2019) (The Poseidon Principles: Will they affect me? Retreived from https://www.wfw.com/articles/the-poseidon-princples-will-they-affect-me/

21 Poseidon Principles (2021) Annual Disclosure Report 2021 Retrieved from https://www.poseidonprinciples.org/finance/wp-content/uploads/2021/12/Poseidon-Principles-Annual-Disclosure-Report-2021.pdf

The SCC attempts to promote decarbonisation by setting an environmental benchmark for charterers and improving transparency on emissions reporting in the sector.

it is possible that signatory institutions could pass on ever greater discounts to ship owners in the future.[22] In addition, competitive tension amongst signatory banks looking to finance the most aligned fleets is creating something of a buyers market for more eco-friendly carriers.

There could be a risk that Poseidon creates a lucrative sub-prime finance market for more polluting fleets as a bi-product of its selectivity. While it is likely that some financiers will see an opportunity to back marginalised debtors, the combination of higher interest rates, lower freight rates, and higher costs as a result of not participating in things like green corridor schemes, will put a further squeeze on tight margins for more polluting carriers. Ship owners who are tempted to consider this an opportunity to do nothing risk committing to a strategy that becomes increasingly difficult and perhaps ultimately impossible to back out of further down the line, as competitive advantages compound in favour of greener competitors.

Sea Cargo Charter

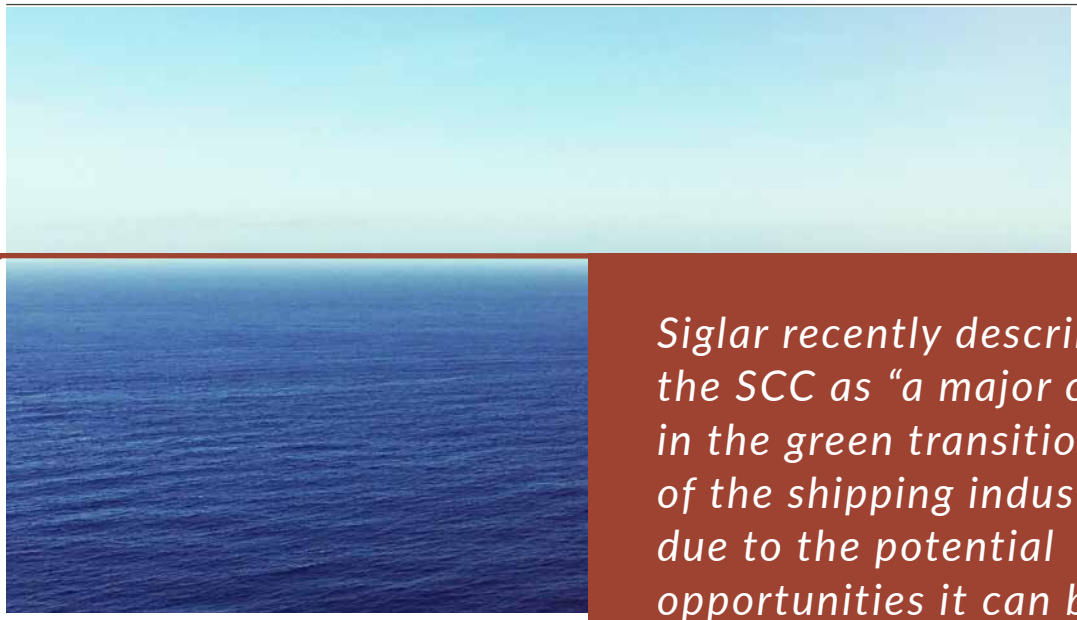
In many ways, the Sea Cargo Charter, or SCC, is a carbon copy of the Poseidon Principles. However, there are some key differences. Firstly, this initiative is aimed at cargo owners and charterers rather than financial institutions and currently it is only open to bulk cargo.

The SCC attempts to promote decarbonisation by setting an environmental benchmark for charterers and improving transparency on emissions reporting in the sector.

The principles match those in Poseidon - assessment, accountability, enforcement, and transparency, and similar to Poseidon, the SCC also has 29 signatories to date, including Chevron, Maersk Tankers, and Shell.

Another important distinction between the two frameworks is that they focus on subtly different measurements. Where Poseidon uses a carbon intensity metric called AER, which measures the grams of CO_2 emitted per vessel deadweight ton over one nautical mile, the Sea Cargo Charter uses the IMO's Energy Efficiency Operational Indicator (EEOI), which measures the grams of CO_2 emitted per ton of cargo carried per nautical mile.

22 The Poseidon Principles and their implications in Ship Finance, Brodies, 2020. Retrieved from: https://brodies.com/insights/banking-and-finance/the-poseidon-principles-and-their-implications-in-ship-finance



Siglar recently described the SCC as "a major catalyst in the green transition of the shipping industry due to the potential opportunities it can bring in emissions reductions"

What this means in principle is that, reported annually, Poseidon incentivises absolute improvements to ship efficiency, whereas the Sea Cargo Charter is measured on a voyage specific basis - discharge to discharge - encouraging charterers to maximise slot, pit, or tank utilisation and discouraging voyage legs in ballast conditions (i.e. with no payload onboard).

Sea freight data and insight provider Siglar recently described the SCC as *"a major catalyst in the green transition of the shipping industry due to the potential opportunities it can bring in emissions reductions"*.[23] It is possible that over time, the SCC will grow in scope and scale, or be replicated across other ship sectors. Many stakeholders agree that these initiatives have the potential to encourage companies to take responsibility and take leading roles in self-regulation.[24]

Bulk shipping has been largely immune from corporate social responsibility in the past. But as previously discussed, the reality is that having a transparent approach to the environmental, social, and governance aspects of business management (ESG), is becoming increasingly important to cargo owners, charterers, and financiers. Taking proactive approaches like joining the SCC sends a clear message that shipping has become more self aware and is willing to become more transparent.

The growing reality is an industry where carbon levies are common, financial backing options are limited and climate-aligned, and more stringent enforcement of efficiency measures consolidate meaningful change in order to meet industry wide regulatory requirements. What better way to manage change than to show regulators that an industry is capable of mature self-governance?

The SCC has been welcomed more cautiously by some industry bodies. BIMCO and the International Chamber of Shipping (ICS) have both publicly expressing reservations around the measurement formula chosen.[25] However, more ambitious targets are expected to be announced in the first half of 2022 and for now at least, it looks like the utilisation-based metric is here to stay.[26]

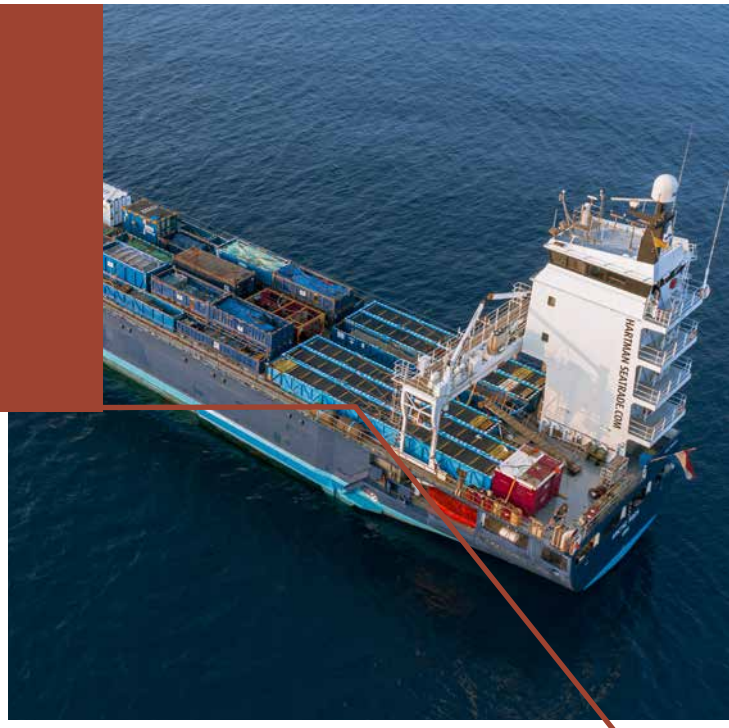
23 Siglar (2020) Siglar Carbon Reporting gets you fully aligned with the Sea Cargo Charter framework Retrieved from https://www.siglarcarbon.com/post/siglar-welcomes-the-sea-cargo-charter-framework

24 UK P&I Club (2021) The Sea Cargo Charter Retrieved from https://www.ukpandi.com/news-and-resources/articles/2021/the-sea-cargo-charter/

25 North of England P&I Club (2022) Charterers Tackle Carbon with the Sea Cargo Charter Retrieved from https://www.nepia.com/articles/charterers-tackle-carbon-with-the-sea-cargo-charter/

26 Logan (2021) Sea Cargo Charter expects to raise ambitions in first half of 2022 Retrieved from https://shippingwatch.com/regulation/article13156409.ece

The European Union (EU) is also encouraging a proportional shared responsibility for creating market conditions that are favourable to decarbonisation.



Global maritime carbon levies

In September 2021, the ICS presented the UN New York City Climate Week with an in-depth proposal for what would become the shipping industry's first global carbon levy. This submission called for an internationally accepted market-based measure (MBM) to accelerate the uptake and deployment of zero carbon fuels.[27] Targeted at globally trading vessels exceeding 5,000 gross tons, ship owners would be required to contribute towards an IMO climate fund for each ton of CO_2 emitted by their vessels. This climate fund is intended to be used for further development of alternative fuel technologies and bunkering infrastructure.

This mandatory global MBM is not the only proposal to have been presented as a call to action within the industry in this way. Operators such as Maersk Tankers have themselves been calling for a levy of $150 per ton of CO_2 emitted in the form of a carbon tax.[28] Others, including Trafigura, one of the largest ship charterers, have proposed levies of $250-$300 per ton of emitted CO_2 to be enforced. While these companies will have one eye towards maximising green market differentiators and further marginalising more polluting carriers, it is clear that these types of levy have the potential to spread the cost of funding the research and development required for shipping to make a mass-market move towards clean energy. According to a 2022 report by UMAS on behalf of the Getting to Zero Coalition, a carbon price of US $173/ton CO_2 would fund a 50% reduction in CO_2 by 2050, but interestingly, a 10% price rise to US $191/ton would be sufficient to fund a full 100% decarbonisation effort.[29]

The European Union (EU) is also encouraging a proportional shared responsibility for creating market conditions that are favourable to decarbonisation with their 'Fit for 55' package, which has included maritime emissions in the bloc's emissions trading scheme (ETS). The scheme, when enforced, will see ship owners regardless of the flag they fly, buy carbon allowances to cover all emissions during voyages in the EU.

27 International Chamber of Shipping (2021) International Chamber of Shipping sets out plans for global carbon levy to expedite industry decarbonisation Retrieved from https://www.ics-shipping.org/press-release/international-chamber-of-shipping-sets-out-plans-for-global-carbon-levy/

28 Bloomberg (2021) Maersk Seeks $150-a-Ton Carbon Tax on Shipping Fuel Retrieved from https://www.bloomberg.com/news/articles/2021-06-02/shipping-giant-maersk-seeks-150-a-ton-carbon-tax-on-ship-fuel

29 UMAS. (2022, January 18). Closing the Gap - An Overview of the Policy Options to Close the Competitiveness Gap and Enable and Equitable Zero-Emission Fuel Transition in Shipping. Retrieved from https://www.globalmaritimeforum.org/content/2021/12/Closing-the-Gap_Getting-to-Zero-Coalition-report.pdf

Sustainable Shipping Initiative (SSI)

According to the organisers, the SSI is a 'beyond compliance' scheme that is working to *'drive change through cross sectoral collaboration and a holistic approach to addressing the sustainability challenges faced by the shipping industry'*.[30]

In essence, members of the SSI set standards for themselves, with the overriding goal of representing industry thought leadership and proposing standards across their wider peer group. Among the 15 current members are Lloyds Register, Swire Shipping, and Wilhelmsen Ship Management to date.

To achieve their aims, the SSI has six vision areas; oceans, communities, people, transparency, finance, and energy. Each of these areas has defined objectives related to the UN Sustainable Development Goals (SDGs), and includes desired outcomes and milestones to measure progress with ambitions to reach beyond shipping across the entire supply chain.

Since its inception in 2010, the SSI has announced a range of outcomes, including the creation of the ship recycling transparency initiative which aims to encourage self regulation that improves ship recycling processes. Clean technology has been another working area for the SSI with work being completed that enables the widespread uptake of technologies. Interesting work is also ongoing within sustainable biofuels. The SSI are actively contributing to focus on facilitating an assurance process and common reference point for the industry around sustainability criteria for zero and low carbon fuels.[31]

COVID-19 exposed vulnerabilities in the global supply chain which are impossible to ignore.

REDESIGNING GLOBALISATION

COVID-19 exposed vulnerabilities in the global supply chain which are impossible to ignore. The pandemic's influence on economies around the world has exposed the short sightedness of ocean freight. It has highlighted the distances between producer and consumer; the disconnect between trade partners; and the knock on effects of lockdowns.[32]

Some of the bottlenecks and trade imbalances that resulted are still in evidence in 2022, as regional economic recovery and market corrections continue to cause port delays and inflated freight rates.

The stress testing that COVID-19 inflicted on the ocean freight sector has brought two precepts of trade and commerce into question. The first is the wisdom of a 'just in time' (JIT) supply chain, where raw materials and components are synchronised to arrive on assembly lines just as they are needed. The second and more expansive question concerns the wisdom of globalisation itself. At the height of the pandemic, some started questioning low inventory strategies that focussed on cost management over risk. The JIT model relies on a fully functioning transport sector and reliable communication between trade partners.

30 Sustainable shipping initiative (2020) SSI Members – Sustainable Shipping Retrieved from https://www.sustainableshipping.org/ssi-members/

31 Sustainable shipping initiative (2020) Decarbonisation: Sustainability criteria for marine fuels Retrieved from https://www.sustainableshipping.org/our-work/current-work/sustainability-criteria-for-marine-fuels/

32 Thetius. (2021). A Changed World: The State of Digital Transformation in a Post COVID-19 Maritime Industry. Retrieved from https://thetius.com/changed-world/

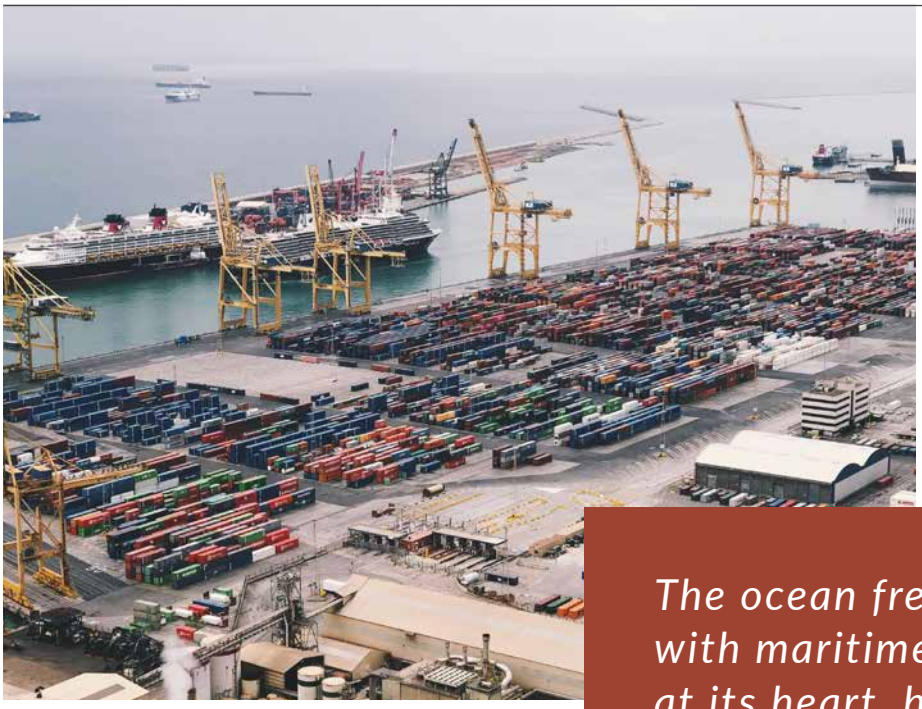
Any manufacturer that chooses to put an ocean between their supply and demand segments are cognisant of the added cost, risk, and complexity to their pipeline.

As carriers, logistics providers, and other key stakeholders in the supply chain began to close offices and operate reduced services, some manufacturers felt the heat almost immediately. For example, despite record demand for their cars, manufacturers including Ford, Toyota, and Jaguar Land Rover had to temporarily halt production due to a shortage of semiconductors. This resulted in considerable delays to customer orders and financial losses running to US $100bn in 2021.[33] The reasons for the shortage were complex, but the results fuelled rumours of an end to globalisation altogether, resulting in a rise in rhetoric around the so-called 'onshoring' of production and manufacturing activities back to their domestic markets. In their report on the semiconductor shortage, KPMG described a rising political pressure to re-orientate supply chains around domestic markets.[34]

While the notion of 'onshoring'' seems to offer a solution to weakness in the globalised supply chain model, it fails to address the reasons behind a globalised market in the first place. Manufacturers choose where to produce, distribute, and sell their products based on a complex network of considerations. In essence, any manufacturer that chooses to put an ocean between their supply and demand segments are cognisant of the added cost, risk, and complexity to their pipeline. These manufacturers source materials, production facilities, labour, and consumer markets in different parts of the world because they must; to access skills, materials, or infrastructure are not available in-country, or because it provides them with some other form of competitive advantage. A global market offers businesses options.

33 KPMG. (2021). Surviving the Silicon Storm - Why the automotive industry is the hardest hit and how automakers - and other chip buyers - can prepare for future semiconductor shortages. Retrieved from https://advisory.kpmg.us/articles/2021/surviving-silicon-storm.html

34 PWC Greece (2020), Press Release - The increasing importance of ESG factors in shipping finance. Retrieved from https://www.pwc.com/gr/en/media-centre/press-releases-2020.html



Digital ‘onshoring’

The focus for the globalised freight transport sector must be to address manufacturer concerns and help build resilience into the supply chain by assisting in a process of ‘digital onshoring’. Instead of pushing global industries towards isolationism and the closing of supply loops by repatriating manufacturing facilities and pivoting to domestic raw material supplies, the maritime transport sector has an opportunity to help manufacturers look to address their concerns digitally by introducing higher levels of transparency in freight.

Consider the drivers for onshoring: The simplification of logistics, easier forecasting and inventory management, a unified time zone across the business, more control over quality, and a reduction in transport related emissions. These aims can now be achieved in the global model by harnessing emerging digital technologies, delivered over robust connectivity networks.

Shipping must help their cargo owners confront current inadequacies in the global model. The technological evolution of globalised trade preserves the advantages of a more accessible and diverse marketplace, while also fostering closer cooperation between geopolitical regions. This is good for business, but good for international relations too. Choosing this over a regression towards more insular and nationalised economies is a vital step towards building a new age of globalised trade. Ship operators have to play an active role in bringing transoceanic ports ‘closer together’ by facilitating greater transparency, providing better data, and becoming more resilient to external threats through strategic automation and more digitally-enabled processes.

The ocean freight sector, with maritime transport at its heart, has never been more central to the successful evolution of globalised trade.

The ocean freight sector, with maritime transport at its heart, has never been more central to the successful evolution of globalised trade. Every ship operator has a role to play in ensuring that transport by sea is fit for purpose in a digitally-enabled, post COVID-19 international trading environment, by harnessing the technologies that are available today to help them and their trade partners de-isolate, derisk and decarbonise.

THE CHANGING COMPETITIVE LANDSCAPE

Consumer choice

Buying criteria in the freight markets is evolving and so too is the competitive landscape in shipping. Cargo owners have more to consider and need to demand more from their chosen carriers.

Discussing these changing demands with Michael Parker, Chairman of Global Shipping, Logistics and Offshore at Citibank in 2021, Wärtsilä's John Hartley, General Manager of Market Innovation, said, *"Ten years ago, all container carriers talked to a customer about was the price to move a TEU across the Atlantic or Pacific oceans. Now cargo owners say, 'if you don't come in with a very strong decarbonisation and ESG policy, you can't talk to us'."* He goes on to describe the digitalisation of existing ship fleets as a vital first step, saying, *"If we can't do better with the existing fleet, how will shipping have sufficient money to earn the capital and justify the risks to build newer, more sophisticated, better-running ships in the future?"*

"If we can't do better with the existing fleet, how will shipping have sufficient money to earn the capital and justify the risks to build newer, more sophisticated, better-running ships in the future?"

PWC believes that there is a strengthening bond between better ESG performance and shipping finance.

Financial change drivers

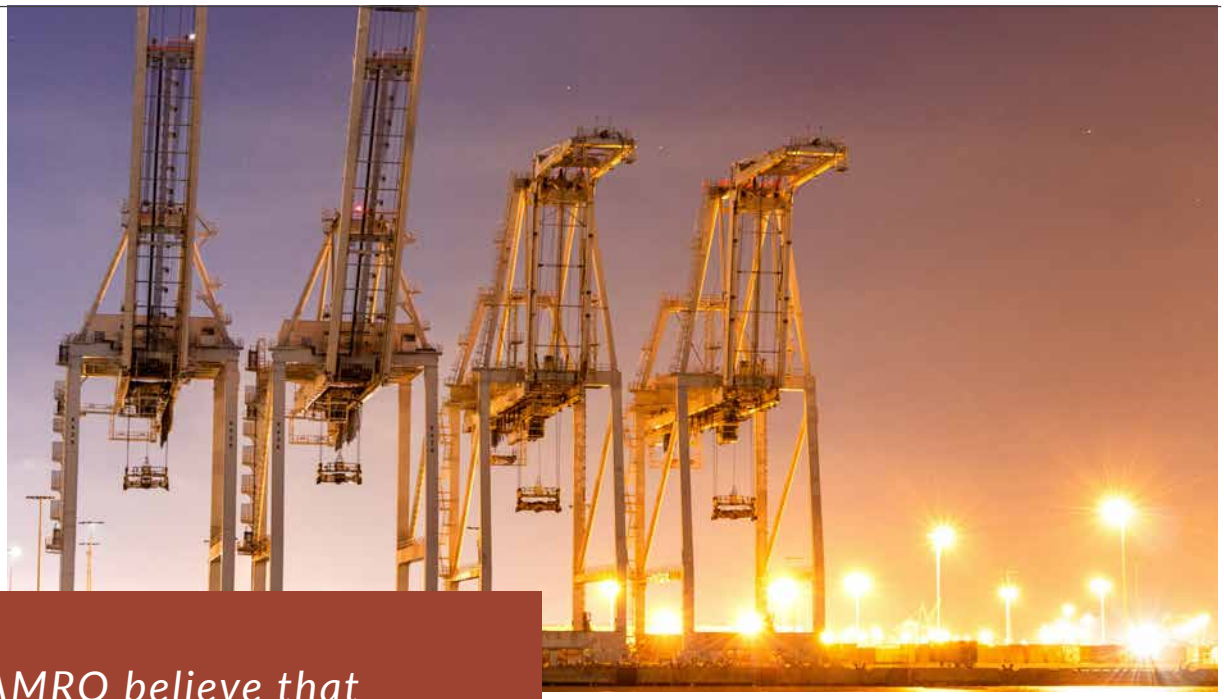
Buyer requirements are a keystone of trade and commerce, but market pressure is not the only influence on the freight market right now; pressure is mounting from the finance sector too.

Shipping requires high operating leverage, relying on borrowing to ride out trading patterns, cost price fluctuations, and changing economic conditions. But the supply of money is pivoting rapidly towards incentivising greener shipping.

Global professional services giant PWC believes that there is a strengthening bond between better ESG performance and shipping finance. In 2020, their Head of ESG and Maritime Sustainability, Dimitris Sakapis, said, *"Investors are now considering that ESG performance is highly correlated to creditor risk and they look to integrate ESG related risk factors into their investment processes."* [35]

By interpreting ESG performance as a measure of creditor risk, financial institutions are favouring operators who are making positive progress towards decarbonisation. The Poseidon Principles, discussed earlier in this report, are a clear example of pressure being exerted from the finance sector that is likely to have an impact on the competitive landscape in shipping.

35 Ibid



ABN-AMRO believe that transparency and reporting on sustainability is the first step towards sustainable shipping.

As a founding signatory to Poseidon, ABN-AMRO believe that transparency and reporting on sustainability is the first step towards sustainable shipping. They go further, stating that their role is now *"to decline funding for projects which fail to contribute to the greening of the shipping sector."*

ABN believes that achieving sustainability in shipping requires greater cooperation between cargo owners and ship operators, and supporting *"...innovations, technical adjustments, and operational improvements - all with an eye to their financial feasibility."*

Commenting on the process, ABN's Global Head of Transport and Logistics Clients, Joep Gorgels, said, *"Just getting rid of all the non-efficient vessels in one fell swoop would not only be a destruction of capital, but it would also be impossible from a practical perspective. The shift will take decades."*[36]

The world's largest shipping financier BNP Paribas also aims to *"align our ship finance portfolio to be environmentally responsible and to lead by example in the reduction of GHG emissions"*. The highly influential French banking group has a shipping portfolio in excess of US $17bn and reporting on its climate alignment annually will apply sustained pressure to work with their clients to make improvements.

The call to shipping is loud and clear: Fleets must digitally decarbonise and improve their compliance now with the shifting needs of their customers and the finance sector, or risk losing too much ground to competitors to even consider a 'future fuels' based decarbonisation program.

36 ABN-AMRO Bank. (2021, January 28). Poseidon Principles: helping ocean-going vessels become more sustainable. Retrieved from https://www.abnamro.com/en/news/poseidon-principles-helping-ocean-going-vessels-become-more-sustainable

TECHNOLOGY FOCUS
THE MOVERS AND SHAKERS OF DIGITAL DECARBONISATION

As we have seen, there are a number of key areas where digital technology can be applied in the ocean freight sector. Digital technologies bring about reduced emissions and improved efficiency by:

- **GATHERING AND ANALYSING NEW DATA** that can be used in real time, or quasi-real time, to inform decision making.
- **IMPROVING ON TRADITIONAL WAYS OF WORKING,** like switching to electronic bills of lading, using a port call optimisation platform during a busy port call, or performing remote class surveys.
- **AUTOMATING INEFFICIENT PROCESSES** and making calculations that are either too complex to do manually, or too time consuming to be used dynamically.

While nearly any process, document chain, or decision factor can be digitalised, here we will take a look at three of the most impactful areas for change - moving to **remote services** by connecting equipment and personnel over digital communications networks, **harmonising global trade** by making improvements at the interface between shipping, its customers and supply chain partners, and **optimising maritime operations** during at-sea phases. We then move to a final look at three examples of tangible decarbonisation outcomes in 'spotlight on success'.

Carriers frequently need to access third party services to keep their ships running reliably and within compliance requirements.

REMOTE FIRST

Figuratively and literally, shipping and ocean freight operations require the coordination of many moving parts. Carriers frequently need to access third party services to keep their ships running reliably and within compliance requirements. From flag or port state control surveys, to specialist machinery servicing, sensor calibrations, or software upgrades, the shipping industry has grown into a logistics-intensive operation.

Survey and inspection

In operation since 1760, leading classification society Lloyd's Register (LR) has been at the heart of many seismic events in global shipping. However, since deploying their first ship surveyor in 1812, the general method LR and all others have used to verify whether a vessel is built, maintained, and operated in accordance with legal or commercial requirements, has involved the physical deployment of people and equipment to board the ship at a suitable port of call. As the demands on fleet schedules increased and air travel became more cost effective, surveyors found themselves travelling further and further afield to carry out their duties.

But the COVID-19 pandemic changed this overnight. International borders across the globe were closed to foreign travellers and thousands of airliners were grounded indefinitely. Even domestically, surveyors were unable to board visiting vessels due to the significant risk of opening up new infection pathways and maritime authorities across the world were forced to act quickly to develop new ways of surveying that would allow them to maintain their obligations to control and enforcement, while eliminating physical human contact from the system.

LR had made tentative steps into remote surveying prior to the COVID-19 outbreak, but the pandemic significantly increased the roll out rate for their remote surveying capability. In March 2020 alone, the number of complex surveys Lloyd's conducted remotely increased by 25% and despite the gradual easing of COVID restrictions across the globe, LR have continued to grow the offering via the *LR Remote* app. Today, they estimate that about 6,000 of the 30,000 surveys LR conducts annually are completed without any physical attendance on the vessel.[37]

Enhanced connectivity is also opening up better ways of delivering mission critical services to ships at sea.

Software, servicing, and repair

Similar advancements in communications technology are making an impact in engine and machinery maintenance. There are a large number of maintenance tasks on ships that require skills or equipment supplied by OEMs or specialist service providers. Sensor calibration, software updates, or condition-based maintenance are all examples of preventive or corrective maintenance that routinely require sending specially skilled or equipped personnel out to a vessel. But improvements in digital communications networks allied with the greater interconnectedness of equipment via what is commonly called the 'internet of things' means that physical interventions are increasingly not required.

Power and automation provider ABB offer one of many examples of OEMs and service providers moving to a remote first platform of support. Developed in partnership with Microsoft, their *ABB Ability* system connects the user fleet to eight 'collaborative operations centres' around the world to provide 24-hour remote diagnostics, servicing, and engineering support. High sample-rate sensors attached to ABB equipment on the vessel are connected to cloud servers that allow ABB support engineers to remotely access, analyse, and in some cases repair faults remotely.

37 Lloyd's Register. (2021). Remote and Present - Remote Surveys Brochure. Retrieved from https://indico.riteh.hr/event/2/attachments/52/126/LR_Remote_Surveys.pdf

While there may still be questions to answer on how to maintain the quality of training or integrity of oral exams over a remote connection, there is little doubt that the cost savings and energy efficiency gains on offer could be significant if used on a global scale.

Interestingly, ABB applied a version of the *Ability* system to their own factory in Frosinone Italy, which resulted in a 30% reduction in energy consumption by connecting and analysing 120 electrical distribution points around the factory and identifying wastage.[38]

Enhanced connectivity is also opening up better ways of delivering mission critical services to ships at sea. The recent partnership between Inmarsat and OneOcean is delivering a powerful new way of delivering navigation and compliance capability to bridge teams by providing a secure dedicated data link between ship and shore. Harnessing Inmarsat's high speed Fleet Connect dedicated bandwidth service, OneOcean's voyage planning and compliance software makes ship navigation management easier, safer, and more efficient. But the partnership highlights benefits from high speed global satellite data links beyond those of the software itself. The system delivers, installs, and maintains the software remotely, avoiding the need for software engineers to visit the vessel. This enhances the environmental benefits further as well as heightening cyber security due to the dedicated data pathway the system uses - it can neither access the other communications networks on the ship, or be accessed by them.[39]

Training and certification

Emissions generated as a result of facilitating crew changes are to some degree unavoidable. But the education, certification, and examination of ship's crew is a fruitful area for digitally-enabled decarbonisation and cost saving. Many courses and exams can be adapted to remote delivery, potentially saving considerable amounts of GHG emissions by avoiding physical travel and unlocking cost savings for both shipping companies and education or exam providers.

During the COVID-19 pandemic, the UK Maritime and Coastguard Agency (MCA) began offering remote oral exams for officer candidates, which have so far remained available during the reopening phase. The environmental advantages of seafarers not needing to travel potentially long distance to attend an oral exam in person are obvious, but seafarer trade union Nautilus also point out that conducting oral exams online provides a 'golden opportunity' for greater transparency and accountability among examiners to demonstrate the objectivity of their pass or fail decisions. While there may still be questions to answer on how to maintain the quality of training or integrity of oral exams over a remote connection, there is little doubt that the cost savings and energy efficiency gains on offer could be significant if used on a global scale.

38 ABB. (2020, October 28). Sustainability plan pays off for ABB factory with 30% energy savings. Retrieved from https://new.abb.com/news/detail/69624/sustainability-plan-pays-off-for-abb-factory-with-30-energy-savings?_ga=2.81855633.620499537.1648137092-751634969.1648137092

39 OneOcean. (2021, April 14). Inmarsat and OneOcean partner to deliver pioneering digital solutions for navigation and compliance. Retrieved from https://www.oneocean.com/news/inmarsat-and-oneocean-partner-to-deliver-pioneering-digital-solutions-for-navigation-and-compliance/

Health and welfare

Better connectivity at sea enables major benefits to crew welfare also. Vessels that carry more than 100 passengers and crew are required to have a medical doctor onboard. However, in cargo shipping, the number of crew onboard rarely exceeds 25 and access to medical care aboard is limited to emergency first aid provision. But developments in satellite connectivity are enabling a new paradigm in healthcare services for seafarers.

Research featured in the British Medical Journal (BMJ) in 2021 found that the rate of disease-related incidents is about four times higher than injury-related incidents among a sample group of officers and crew on container ships.[40] According to Vikand, who provide medical services to about 120,000 seafarers worldwide, about 80% of illness-related deaths among seafarers are caused by chronic or long-term illnesses such as diabetes. Regular doctor 'house calls' are a powerful way of monitoring trends in crew health and welfare over time and provide a consistent method of administering preventative treatment and clinical management of long-term conditions. Delivering this type of enhanced service has direct benefits to 'human sustainability' including by increasing the health and wellbeing of crews at sea, but also results in less lost time incidents and vessel diversions, both of which have environmental impacts of their own. Studies conducted prior to the COVID-19 pandemic suggested that medical diversions and evacuations affects about 7% of the world's 1.5 million seafarers each year, costing the industry US $760m in diversions and evacuations. In one instance in March 2022, a 47,000 GT cargo vessel diverted over 500 nautical miles at best speed to get treatment for an unwell crew member.[41] While telemedicine services cannot prevent all diversions, an older study conducted by the US Center for Naval Analyses revealed that telemedicine services could prevent 155,000 nautical miles of diversions per year for the US Navy.[42]

Research featured in the British Medical Journal (BMJ) in 2021 found that the rate of disease-related incidents is about four times higher than injury-related incidents among a sample group of officers and crew on container ships

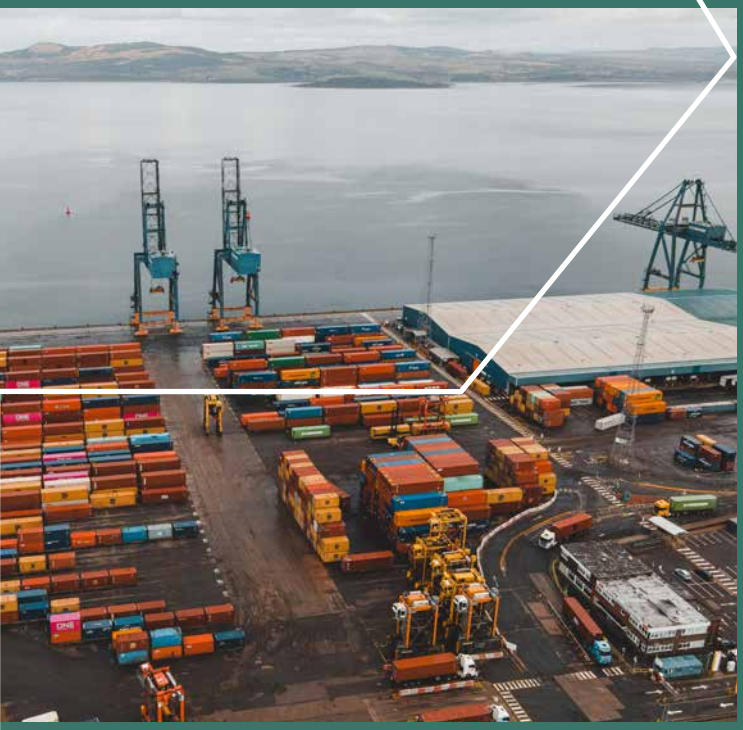
Remote pilotage

It is common in shipping for vessels to arrive at ports with hazardous approaches and complex marine traffic management schemes that are unfamiliar to the officers on the bridge. At the same time, each vessel will have handling characteristics that only the bridge team will be familiar with. It is usual practice to board a local marine pilot who has expert knowledge of the port layout and hazards to advise the bridge team on safe passage and work with the master and crew to ensure the vessel enters or exits the harbour safely. This involves a hazardous transfer at sea from a pilot boat to the ship, often via a rope ladder.

40 Sagaro GG, Dicanio M, Battineni G, et allncidence of occupational injuries and diseases among seafarers: a descriptive epidemiological study based on contacts from onboard ships to the Italian Telemedical Maritime Assistance Service in Rome, ItalyBMJ Open 2021;11:e044633. doi: 10.1136/bmjopen-2020-044633

41 The Royal Gazette (Bermuda). (2022, March 24). Ship diverts to Bermuda after senior officer has heart problem. Retrieved from https://www.royalgazette.com/general/news/article/20220323/ship-diverts-to-bermuda-after-senior-officer-has-heart-problem/

42 Center for Naval Analyses. (1997, September 1). A Cost-Benefit Analysis of Shipboard Telemedicine. Retrieved from https://apps.dtic.mil/sti/pdfs/ADA334780.pdf



Once aboard, the pilot will also have close contact with the ship's crew, an issue brought into sharp relief during the COVID-19 pandemic.

Some harbour authorities had already begun trialling remote pilotage services prior to 2020, including a major trial in Finland, where pilotage services provider Finnpilot teamed up with Wärtsilä Voyage Solutions to trial remote pilotage services based on their Pilot Pro navigation software. The trial highlighted advantages for pilot safety as well as indicating a 50% reduction in costs and the elimination of direct emissions by removing the need to physically transfer pilots offshore.[43]

Today, remote pilotage remains a serious conversation within the industry. While there are clear benefits in some aspects of safety, energy efficiency gains, and profitability for port operators, some are more nervous about the risks. As data is gathered from ports using remote services, confidence is likely to grow. Whether the savings fully compensate for the loss of comfort the physical presence of a pilot on the bridge might have, remains to be seen.

Inefficient processes and the lack of transparency and choice can result in considerable wasted effort.

HARMONISING GLOBAL TRADE

The term 'trade friction' neatly describes inefficiencies at the interface between the consumer market and the supply chain. From the moment a cargo owner initiates the freight of goods, to the moment the goods arrive at their destination, inefficient processes and the lack of transparency and choice can result in considerable wasted effort.

The concept of reducing this friction through digitalisation is not new. Much of the global supply chain already relies on electronic data interchange (EDI) protocols to convey information from link to link and this has been widespread since the 1990s. On average, moving one shipping container from door to door generates over 50 EDI messages, though depending on the region, carriers, and cargo type involved, some or all of these messages may be sent in other formats - including paper. What this illustrates is the complexity of communication in a typical cargo transaction. There is pricing, booking, transport, customs and excise formalities, port services, pilotage, stevedoring, ship navigation, trans modal exchange, transfer of ownership, and trade financing to consider and more. The volume of information required is vast and the timeliness of it is critical to the efficiency of the cargo transaction.

The reality is that all instances of inefficient data exchange, where required information is not available at the right time, is incomplete, or deviates from what is expected, result in an increase in carbon emissions across the supply chain.

43 Finnish Maritime Cluster. (2019). Finnpilot launches Pilot Online . Retrieved from https://fmc-yearbook.com/new-services-and-solutions/finnpilot-launches-pilot-online/

The reality is that all instances of inefficient data exchange, where required information is not available at the right time, is incomplete, or deviates from what is expected, result in an increase in carbon emissions across the supply chain.

If a bill of lading needs to be printed and couriered separately to the cargo itself, this will clearly increase the carbon footprint of the transaction overall. Assigning harbour tugs to connect to a departing vessel before cargo operations are complete results in the tugs idling for longer, increasing the associated emissions footprint etc.

One example of the impact that reducing trade friction can have is offered by fuel producer Neste, who utilises a 20-strong chartered fleet and procures over 1000 spot charters annually. In 2021, port congestion resulted in many of their chartered vessels spending upto 40% of their time waiting to load or discharge. The company implemented voyage optimisation software from NAPA which enabled the sharing of information between terminals, refineries, and the fleet, providing more efficient routing options and reducing the amount of idle time experienced. The first results came after a voyage by the MT Donia, a 5261 GT oil/chemical tanker from the ARA region in Northwest Europe to the company's refinery in Porvoo, Finland, where speed adjustment at the beginning of the voyage resulted in saving 30 tonnes of fuel.

Paperless trade

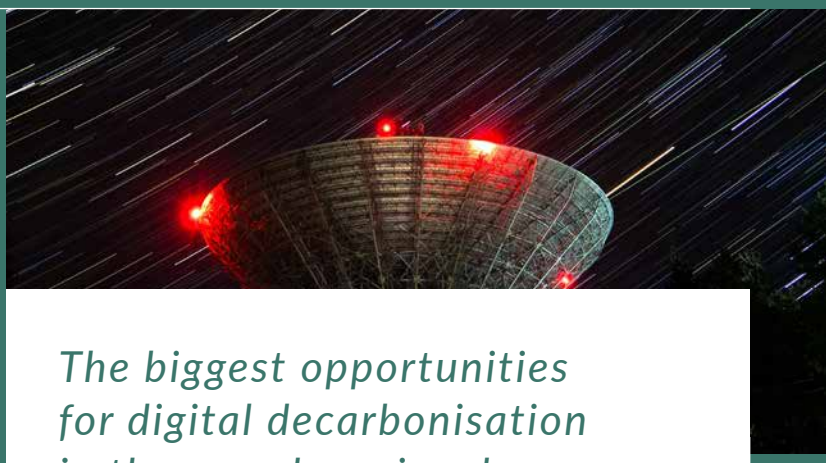
Digital technologies are beginning to have the required influence on attitudes and behaviours in the ocean freight industry. Electronic bills of lading are key documents in every cargo transaction, commonly serving three functions; as a receipt for the transfer of goods, as a contract of carriage, and as a document of title.

After sustained effort over a number of years, electronic bills of lading are slowly starting to infiltrate the market. The savings potential for them is significant, considering we are only talking about digitalising one document in a complex system. According to the Digital Container Shipping Association (DCSA), in 2020, ocean carriers issued 16 million original bills of lading, costing stakeholders a combined US $11 bn in the process.[44] Research from the UN Economic and Social Commission for Asia and the Pacific (ESCAP), suggests that fully digitalising regulatory trade practices such as the bill of lading could save between 32 and 86kg of CO_2 equivalents per end-to-end transaction. Scaling these savings to match trading volumes in Asia and the Pacific alone would imply savings of 13 million tons of CO_2, the equivalent to planting 439 million trees.[45]

44 DCSA. (2021, December 1). Spotlight on Going Digital - DCSA's Common Goal. Retrieved from https://dcsa.org/wp-content/uploads/2022/01/VoiceofIndependentDec21.pdf

45 ESCAP. (2021, November 3). Quantifying the environmental benefits from paperless trade facilitation. Retrieved from https://www.unescap.org/blog/quantifying-environmental-benefits-paperless-trade-facilitation

Standards are still under development for the widespread adoption of paperless trade, but some industry players have moved ahead and implemented it anyway. Ocean Network Express issued its first electronic bill of lading in 2020 for a shipment of synthetic rubber from Russia to China. Shortly after, the carrier extended the option to regional, and then global, customers via its 'ONE Ecommerce' platform. There are a number of similar examples across the maritime industry, but generally uptake remains low. The DCSA estimated that only 0.3% of transactions in 2020 used an electronic bill of lading.[46]



The biggest opportunities for digital decarbonisation in the sea phase involve processing large dynamic data sets to plan voyage routes.

Optimisation at sea

Perhaps the most fruitful area for digital decarbonisation and certainly the most targeted by digital innovators, is the voyage phase when ships are at sea and their engines are at their most polluting.

Conditions at sea can vary considerably and vessels must be capable of withstanding bad weather and sometimes violent sea states while keeping cargo and crew safe. This requires hull and propulsion system designs that offer power and stability in reserve and while naval architects and ship builders are well-practised at delivering safe ships, rough weather and sea conditions have a naturally adverse effect on energy efficiency.

The market for digital ship operations and management technology is young and growing fast. Thetius data indicates that digital transformation in this area is currently an US $11bn industry with a compound annual growth rate of approximately 4.5%. Of all of the decarbonisation markets tracked by Thetius, ship operations is the busiest with over 600 active organisations across the world. Most are startups which account for 29% of the market, followed by small and medium enterprise (SME) providers at 25%, closely trailed by large enterprises at 23%.

Voyage, weather, and route optimisation

The biggest opportunities for digital decarbonisation in the sea phase involve processing large dynamic data sets to plan voyage routes that avoid adverse weather, foul tidal and ocean currents, and costly diversions around hazards.This includes intelligent cargo planning that minimises route inefficiency and avoids backtracking or in-ballast voyage legs with no payload on board. Here we will take a look at some of the most interesting businesses and technologies offering efficiency solutions that target the at-sea phase of the ocean supply chain.

Tracing its origins to Maersk Tankers, Copenhagen-based platform developer ZeroNorth now offers digital optimisation solutions aimed at reducing GHG emissions across the tramp shipping sector. Their principal offering 'Optimise' is a piece of software that converts voyage data into actionable insights which they say translates into environmental and financial savings that benefit the industry and wider society. The system connects multiple data sources into a single interface which is analysed to produce recommendations for speed, route, and bunker optimisation.

46 Ibid 44

In March, ZeroNorth revealed that its platform had prevented 218,000 tonnes of CO_2 from being released to the atmosphere throughout 2021, coinciding with a time when shipping's emissions as a whole increased by 4.9%. They have also announced this year that their platform now includes an automated CII calculation. By combining a variety of vessel, market, bunker, and weather data with its algorithms, the ZeroNorth platform suggests a 'green route' that considers emissions and profitability in order to improve or maintain the vessel's CII ratings.

In 2020, ship operator Cargill reported achieving an overall reduction of 5% in CO_2 emissions per cargo ton-mile against a 2016 baseline, partly as a result of its partnership with ZeroNorth. However, type-specific reductions were even higher, with their larger panamax dry bulk ships having a 6.7% decrease and 14.4% across its tanker fleet, according to Cargill data.

One of the key reasons that technology is able to find these savings, where human counterparts have been unable, is down to complexity. To optimise a transoceanic multi-port voyage requires a detailed understanding of millions of data points and variables. Artificial Intelligence (AI) is a powerful tool for understanding large datasets and forumulating creative solutions to poorly-defined problems. Founded in 2017, Deepsea Technologies offers two AI-centric fleet and voyage optimisation tools named Cassandra and Pythia that help operators understand their fleet and asset performance, providing users with tailored routes, speed profiles, and trim policies relative to dynamic weather and sea conditions.

One of the key reasons that technology is able to find these savings where human counterparts have been unable is down to complexity. To optimise a transoceanic multi-port voyage requires a detailed understanding of millions of data points and variables.

In 2021, capesize tanker operator Seanergy Maritime Holdings announced that using the Pythia platform had achieved a reduction in fuel consumption of up to 12% across their fleet over a four month trial, with average fuel savings of 8% per vessel. Pythia uses AI performance models to analyse 19 different parameters, enabling it to determine optimum routes, speeds, and trims that are required to minimise fuel consumption along the route.

Weather conditions are particularly difficult to predict and quantify, and adverse weather is particularly costly to fuel consumption when encountered by a ship. There are many scenarios where deviating from the direct route in order to avoid bad weather will result in less fuel burned over the voyage. But determining when this will be the case and how the vessel ought to be diverted is notoriously complex for voyage planners and navigating officers. Weather is not the only reason for diverting from the direct route (known by navigators as the 'rhumb line') either. Hazards to navigation and channel blockages are a constant possibility, altering the safe routes available to transiting ships.

In 2018, route analysts from voyage services provider StormGeo advised on approximately 64,000 voyages across the world. With an average consumption of about 30 MT of fuel per day and average voyage time of 17.5 days, the total consumption for all of these voyages was estimated at around 33,750,000 MT. The company estimates that their weather routing service alone can result in a 3% reduction in consumption on average, saving over 1 million tons of fuel over the year, equivalent to the removal of 600,000 cars from the road.[47]

Optimising fuel management along different routes also plays a role in environmental outcomes and profitability. According to Storm Geo, in 2019 they routed a bulk carrier around the North Sea Emissions Control Zone (ECA). The route they suggested covered a slightly longer distance to the standard route, however analysts calculated that while the vessel would consume 37.52 MT more Intermediate Fuel Oil (IFO), the vessel would use 36.58 mt less of the more costly low-sulphur fuel oil. At a price differential of around $250 between the fuel grades at the time, the monetary savings ran to about $9,000.

By choosing to sail along the optimised route, Aurora Tankers halved the weather factor on the voyage from -1.56 to -0.76, minimising weather risk and saving valuable time.

In another example, StormGeo were able to save Aurora Tankers around 33 hours and $13,940 on one voyage. Route analysts closely evaluated the captain's intended route and recommended an alternative based on real-time weather forecasts, Emission Control Areas, known piracy areas, and client-instructed arrival times. While StormGeo's recommended route was nearly 400 NM longer than the captain's intended route, it was carefully designed to place the vessel to the south of heavier swells generated by northern Pacific Ocean storm centres, while positioning the ship in more favourable ocean currents.By choosing to sail along the optimised route, Aurora Tankers halved the weather factor on the voyage from -1.56 to -0.76, minimising weather risk and saving valuable time. The company saved approximately 41MT of fuel and reduced the voyage's CO_2 emissions by 123 MT; roughly equivalent to removing 26 cars from the road for an entire year.

47 How the Evolution of Weather Routing is Reducing Greenhouse Gas Emissions, Sheilds, Stormgeo, accessed 2022

SPOTLIGHTS ON SUCCESS

If there is still doubt in the minds of operators as to the importance of a digital decarbonisation strategy, in this section we take a closer look at examples of successful decarbonisation projects.

YXNEY MARITIME

Yxney Maritime is the software company behind Maress - a fleet performance optimization platform. Maress helps operators decarbonise their ship fleets by combining operational data sets from across their user's field of operations to produce insight on how to reduce fuel and emissions. By establishing baseline performance levels, decarbonising efforts can be visualised and assessed for effectiveness.

One of Yxney's clients, Solstad offshore, has been attempting to reduce their fleet emissions since 2009 when they announced their program 'Solstad Green Operations'. Partnering with Yxney to deploy Maress has resulted in an 18% fuel saving across their 147 vessel fleet. In addition, Solstad say their total operational footprint was reduced by almost 20,000 tons of C02 in 2018. Speaking of the partnership, Solstad Environmental Engineer Svein Erik Isaksen said, *"We needed a solution that performs effective energy management, without scaling up the administrative staff offshore. The solution has been to use Maress to change the way we communicate and to ensure that crews and support staff are pulling in the same direction."*

Capturing and distributing real-time operational data has also resulted in impressive results for Siem Offshore.

18% SAVING

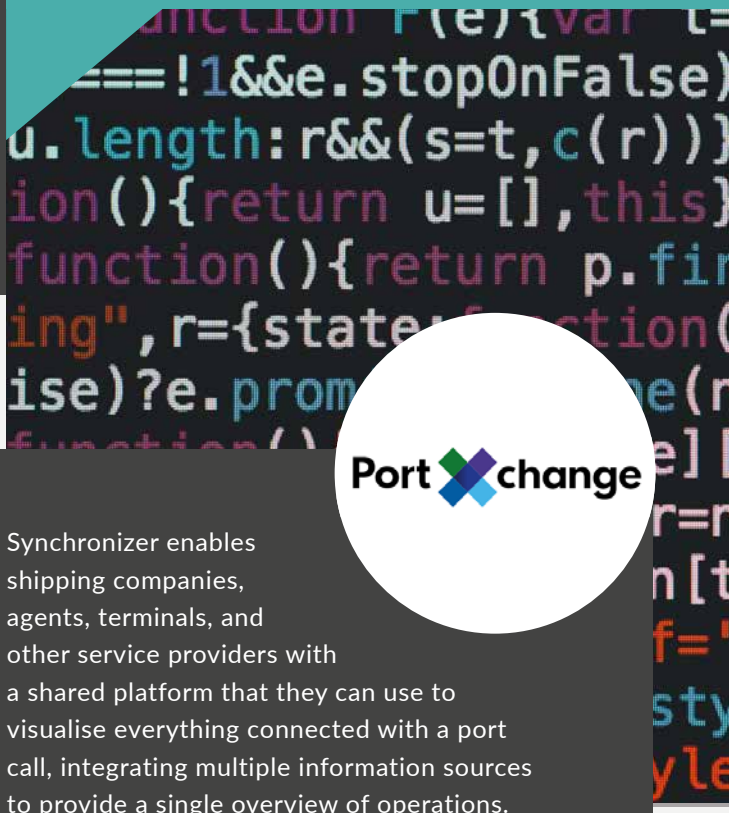
Partnering with Yxney to deploy Maress has resulted in an 18% fuel saving across Solstad Offshore's 147 vessel fleet.

They coupled Maress with ship performance monitoring hardware from Høglund to display real-time fuel consumption and efficiency data onboard its vessels. The technology has brought about swift cultural change in the company. Siem Operations Manager Jon August Houge said, *"It has triggered competition among the vessels. Each crew wants to be best in class when it comes to fuel efficiency. With real time input from sensors aboard the ship and theoretical calculation of fuel flow, the crews are able to optimise the operation of engines and power consumers."*

Results from a 30-day campaign in 2020 showed that the Siem fleet were able to save 442 tons of Marine Diesel Oil (MDO) and 231 tons of Liquified Natural Gas (LNG), achieve a 20.7% increase in efficiency, and prevent 30,870 kg of Nitrogen Oxide (NOX) and 2,130 tons of CO_2 emissions, saving US $344,733 in the process. According to Yxney, Maress-equipped vessels saved a combined 50,000 tons of CO_2 in 2020.

Yxney's cloud based software is beginning to gain momentum in the offshore services sector, with Equinor, DOF, Skansi Offshore, Tidewater, Eidesvik, and Aker BP all rolling out Maress across their fleets. Speaking of their success, Yxney CEO Simen Sanna commented, *"The energy transition has started. All stakeholders in the maritime industry are now looking for efficient ways of collaborating to meet 2030 and 2050 emissions targets."*

"The energy transition has started. All stakeholders in the maritime industry are now looking for efficient ways of collaborating to meet 2030 and 2050 emissions targets."



PORTXCHANGE

PortXChange was established in 2019 after spinning out of the Port of Rotterdam. The company offers two principal products - a port call optimization platform called Synchronizer and a fleet intelligence node called Shiptracker.

Synchronizer enables shipping companies, agents, terminals, and other service providers with a shared platform that they can use to visualise everything connected with a port call, integrating multiple information sources to provide a single overview of operations.

The platform is able to accept inbound information in a variety of formats, from Application Programming Interface (API) or Electronic Data Interchange (EDI) messages, to spreadsheet data, email information, and even website data scrapes. PortXchange also provides users with an outbound API that allows platform data to be integrated into proprietary systems. This is central to the company's ethos of democratising port call data for the good of all stakeholders involved in port operations.

Synchronizer enables shipping companies, agents, terminals, and other service providers with a shared platform that they can use to visualise everything connected with a port call.

Early trials of the Synchronizer platform at APM Terminals Rotterdam resulted in significant reductions in idle time prior to departure for Maersk container ships.

Once the ETA of a vessel is known, Synchronizer assigns the vessel a timeline, displaying all the events anticipated throughout the course of the port call. PortXChange does not handle cargo-specific information, but applies artificial intelligence to forecast future timings based on measured performance.

As their experience has grown, PortXchange has encouraged their prospective clients to bring in a business consultant when scoping and procuring digital platform solutions. The reason, they say, is that platforms like PortXChange offer more than just a tool. They challenge the very concept of port operations, and perform best when they are central to a more transformative process of change at the strategic, operational, and human level.

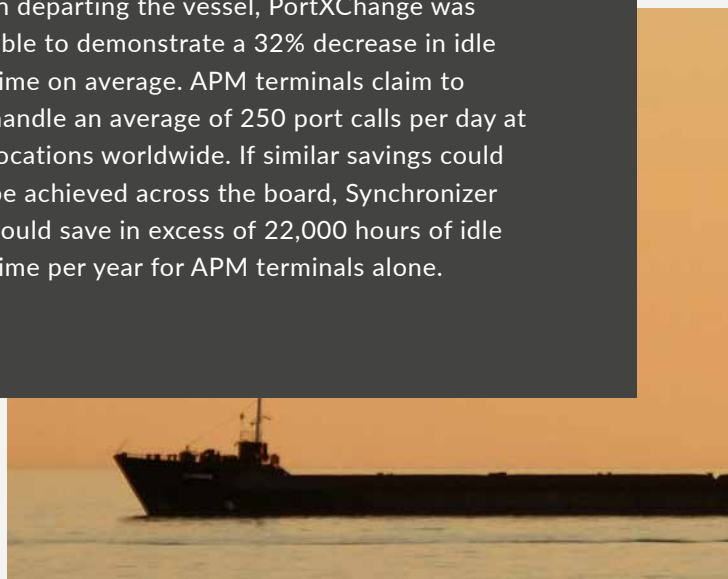
Speaking on the topic in 2021, then Director of Operations, Dita Bruijin said, *"It is vital that the digital platform matches the local reality at the port. It is important not to implement transformative technologies without also working with the port team to ensure there is alignment between the enhanced capabilities the platform delivers and what is being acted upon by port staff and operators."*

Synchronizer is now used by five major ports across the globe; Rotterdam, Mordijk, Felixstowe, Houston, and Algeciras. The first stage of onboarding involves detailed process mapping. The port's existing modes of operation are examined to fully understand where PortXchange can add the most value and ensure that there is sufficient scope for transformation within the operations teams.

Early trials of the Synchronizer platform at APM Terminals Rotterdam resulted in significant reductions in idle time prior to departure for Maersk container ships. Among 177 vessels measured, the average dwell time between the conclusion of cargo operations and the vessel departing the berth was 47 minutes. During this time, vessels will generally be ready for sea with their main engines idling. This has obvious environmental impacts and also delays inbound vessels, generally contributing to port congestion and a rise in unnecessary GHG emissions.

PortXChange was able to demonstrate a 32% decrease in idle time on average.

By increasing the amount of data shared among the different stakeholders involved in departing the vessel, PortXChange was able to demonstrate a 32% decrease in idle time on average. APM terminals claim to handle an average of 250 port calls per day at locations worldwide. If similar savings could be achieved across the board, Synchronizer could save in excess of 22,000 hours of idle time per year for APM terminals alone.



NAUTILUS LABS

Similar to Yxney, Nautilus Labs is a certified application provider for Inmarsat's IoT fleet data platform. The company builds software for ship owners and operators that informs decision making and visualises opportunities to improve vessel operations. Their strapline says they are 'Advancing the efficiency of ocean commerce through artificial intelligence', a claim that Nautilus can back up with numbers.

They offer voyage and power optimisation tools that use weather modelling and machine learning processes with vessel-specific data. This allows them to provide optimal shaft speed and optimal shaft power instructions. The company claims that, '*Nautilus optimised voyages see 5-7% of net profit increases and CO_2 savings of over 400 metric tonnes in one years operation*'.

The Nautilus solution claims to result in a 4-6% reduction in fuel consumption and 350 metric tonnes of CO_2 per vessel, per year on average. Their software is already used by several operators including Nordic Bulk, Teekay, Dorian LPG, TotalEnergies, and Eagle Bulk Shipping putting hundreds of vessels on to the platform.

The company claims that, 'Nautilus optimised voyages see 5-7% of net profit increases and C02 savings of over 400 metric tonnes in one years operation'.

The principle of their approach is granular data gathering and analysis. By aggregating data from many different sensors, a dynamic picture of vessel performance is calculated, making assumptions about fuel consumption, routing, speed, and hull form obsolete.

In an interview with Shipping Watch in March 2022, Nautilus Labs' CEO Matt Heider explained, "*There are opportunities that emerge over the course of long voyages to be dynamic and make adjustments, which can result in a substantial amount of CO_2 reductions and fuel savings if you capitalize on them.*"

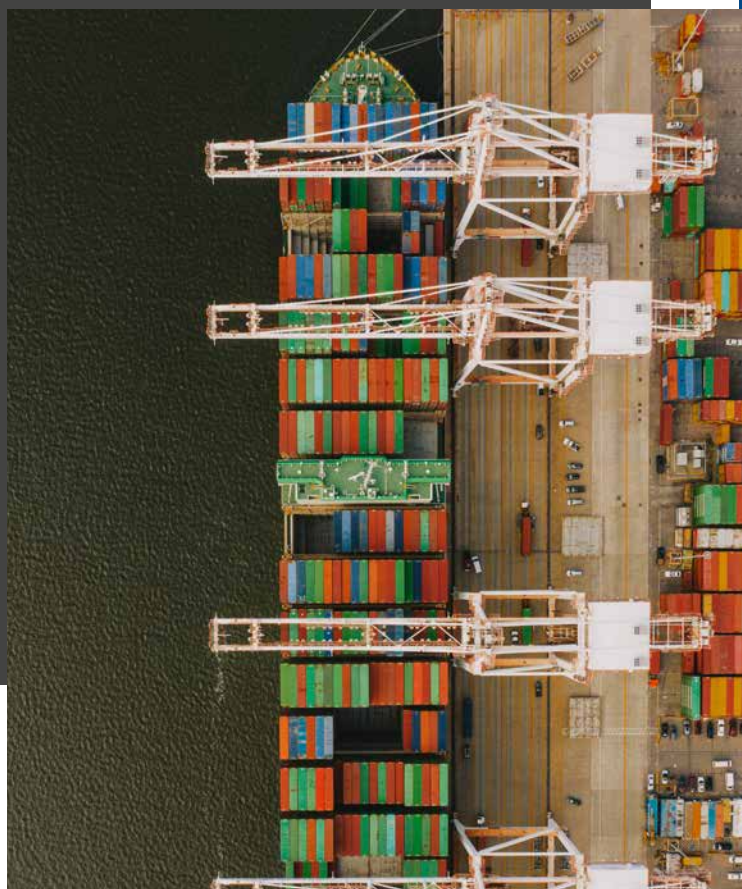
One of nautilus' more recent customers, Emirates Shipping Line, brought in Nautilus Labs' voyage optimisation in collaboration with the fleet owner Peter Döhle to improve collaboration and transparency across the charterparty and leverage more sophisticated data collection across the fleet. The system analyses a large number of data points to quantify vessel performance and make predictions that support planning and bridge decision making.

The Nautilus platform manifested a 30.5 MT fuel saving and 4% uplift in time charter equivalent (TCE) earnings (a measure of profitability) throughout the voyage. 95 MT of CO2 emission was avoided - the equivalent of taking 21 average family cars off the road for an entire year.

Masters across the fleet have access to a Nautilus Labs dashboard, enabling them to see their vessel's dynamic performance profile, empowering them to make adjustments that result in efficiency gains and increased profitability for the line. Johann Diercks, Director of Shipmanagement at Peter Döhle, said, *"Nautilus Platform supports us and our crews to meet the requirements of our customers to operate their vessels as cost and fuel efficient as possible and to reduce the emissions of our operated fleet."*

Another adopter of Nautilus software is Eastern Pacific Shipping (EPS). Their 150-strong fleet consists of a mix of tankers, bulk carriers, gas carriers, containerships, and pure car and truck carriers. EPS began their relationship with Nautilus in 2019, equipping six vessels, which has since been extended to the wider fleet. To illustrate the potential, Nautilus data was used by the bridge team on a tanker voyage from Scotland to Nigeria and onwards to Indonesia. Despite the ship needing to stop in South Africa for a medical emergency, the dynamic data feeds of the Nautilus platform manifested a 30.5 MT fuel saving and 4% uplift in time charter equivalent (TCE) earnings (a measure of profitability) throughout the voyage. 95 MT of CO_2 emission was avoided - the equivalent of taking 21 average family cars off the road for an entire year.

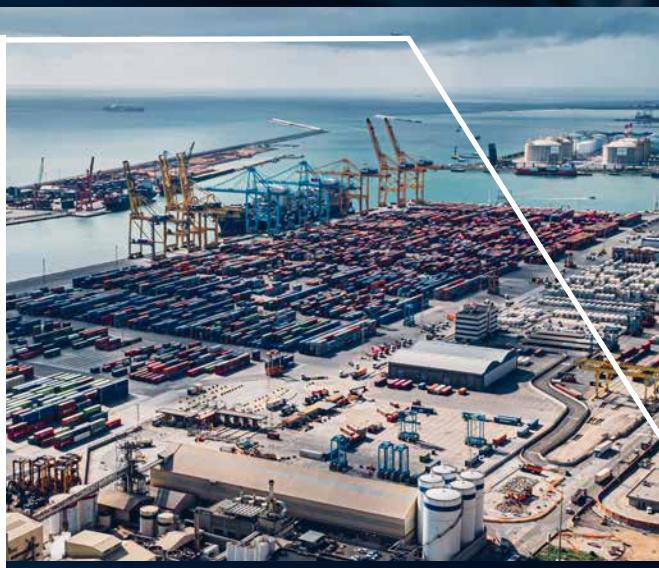
In March 2022, Nautilus Labs announced the successful closure of a sizable Series B funding round, securing a US $34m investment from Microsoft's M12 venture capital fund. With it, the company plans on developing new digital decarbonisation tools aimed at helping their clients find efficiency gains and reductions in GHG emissions. They also plan on opening a number of satellite offices at major hub ports around the world in addition to its four existing offices in New York, Singapore, Paris, and London, potentially in Copenhagen and Athens.



CONCLUSION

For shipping, there remain many obstacles to overcome on the pathway to net zero. Progress to date has been measurable, particularly in carbon intensity, but not yet impactful enough to make the goal of decarbonisation a certainty or to pin hopes of transformative progress on a single technology alone.

While it is true that the ultimate destination for a net-zero maritime sector is clean energy, the industry cannot watch and wait over the coming decades while technologies and infrastructure evolve to meet the demands of climate change.



Enabling digital technologies such as blockchain, AI and machine learning, IoT, and broadband, low latency satellite connectivity have progressed so rapidly that their impact on decarbonisation is not yet fully appreciated in some parts of the maritime sector. Digitalisation is often separated in the minds of shipowners. It is used for cost reduction, process automation, resilience to risks, or for improvements to safety. Decarbonisation on the other hand, is sometimes considered a problem for mechanical engineers and chemists, not software developers.

While it is true that the ultimate destination for a net-zero maritime sector is clean energy, the industry cannot watch and wait over the coming decades while technologies and infrastructure evolve to meet the demands of climate change. Instead, shipping must harness the readily-available power of digital technologies to decarbonise conventional ships today, optimising the pathway to 2050 and accelerating the rate of change required to achieve the targets set by the international community. Business as usual is no longer an option and digital technology holds the key to making up for lost ground and getting shipping back on track towards sustainability.

$11BN MARKET

Digital decarbonisation is a US $11bn market which is growing rapidly.

Digital decarbonisation is a US $11bn market which is growing rapidly. The impact that digital technologies can have on decarbonisation is significant. According to some analysts, optimising conventional ships with digital decision support alone can result in up to 38% reduction in GHG emissions by 2050 and at a fraction of the overall US $1.9tn capital expenditure required overall.

At present, shipping is behind the curve. Estimates vary, but absolute CO_2 emissions from shipping appear to have increased by around 16-18% since 2008. However, the international framework of legislation, regulations, and market based measures are beginning to turn the tide. Mandated reduction targets from the IMO, changes to counterproductive clauses in charter party agreements, coordinated pressure from the finance sector in the form of initiatives like the Poseidon Principles, and global maritime carbon levies are coalescing to force and facilitate change for the better.

At present, shipping is behind the curve - absolute CO2 emissions from shipping have increased by 16% since 2008.

Increasingly ingenious digital technologies, enabled by more powerful and more reliable communications networks, are moving the needle on decarbonisation for carriers who refuse to let the grass grow under their feet. Significant reductions are being found by moving operations such as pilotage, crew training and certification, equipment servicing, and diagnostics to ‘remote first’.

The shipping industry has a once in a lifetime opportunity to facilitate an evolutionary change to 'digital onshoring' for their customers, bringing the world closer together and delivering on a monumental decarbonisation effort that will impact the future for humanity.

Harmonising global trade and removing trade friction by moving paperless and sharing more information between trade partners, and optimising sea voyages with better bridge connectivity and enhanced weather and voyage routing, are producing up to 40% improvements in efficiency and up to 30% reductions in emissions. It all adds up.

This capability is there today and the ocean sector does not need to wait. The optimal route to decarbonised shipping is powered by digitalisation and the two go hand in glove. Innovators like Yxney Maritime, PortXChange, and Nautilus Labs, working with carriers big and small are showing what can be achieved today. Ignorance to ESG policies no longer satisfies global demand - cargo owners now need more help to reduce their scope 3 emissions and global regulators and the finance sector are aligned on providing measures to ensure they get it.

The shipping industry has a once in a lifetime opportunity to facilitate an evolutionary change to 'digital onshoring' for their customers, bringing the world closer together and delivering on a monumental decarbonisation effort that will impact the future for humanity. By optimising the pathway to decarbonisation using digital technologies and connectivity, shipping wins commercially, societally, and environmentally by increasing profitability, regaining social credibility, and doing the right thing by helping to reduce chemical stress on global climate systems.

BIBLIOGRAPHY

A

ABB. (2020, October 28). Sustainability plan pays off for ABB factory with 30% energy savings. Retrieved from https://new.abb.com/news/detail/69624/sustainability-plan-pays-off-for-abb-factory-with-30-energy-savings?_ga=2.81855633.620499537.1648137092-751634969.1648137092

ABN-AMRO Bank. (2021, January 28). Poseidon Principles: helping ocean-going vessels become more sustainable. Retrieved from https://www.abnamro.com/en/news/poseidon-principles-helping-ocean-going-vessels-become-more-sustainable

Ahokas, M.-M. (2019). Analysis of Voyage Optimization Benefits for Different Shipping Stakeholders. Aalto University School of Engineering. Retrieved from https://aaltodoc.aalto.fi/bitstream/handle/123456789/40795/master_Ahokas_Miika-Matti_2019.pdf?sequence=1&isAllowed=y

APM Terminals (2021, May 10). APM Terminals agrees divestment of APM Terminals Rotterdam to Hutchinson Ports. Retrieved from https://www.apmterminals.com/en/news/news-releases/2021/210510-rotterdam-divestment-hutchinsons

American Shipper. (2021, February 16). Shipping tech startups: 'Amazing' valuations, 'huge surge' in interest. Retrieved from https://www.freightwaves.com/news/ship-tech-startups-amazing-valuations-huge-surge-in-interest

B

BIMCO . (2021). Just in Time Arrival Clause for Voyage Charter Parties 2021. Retrieved from https://www.bimco.org/contracts-and-clauses/bimco-clauses/current/just-in-time-arrival-clause-for-voyage-charter-parties-2021

BIMCO. (2022). Upcoming Contracts and Clauses. Retrieved from https://www.bimco.org/Contracts-and-clauses/Upcoming-Contracts-and-Clauses

BIMCO. (2021, May 28). BIMCO tackles challenging carbon rules with new charter party clauses. Retrieved from https://www.bimco.org/news/priority-news/20210528-bimco-tackles-challenging-carbon-rules-with-new-charter-party-clauses

C

Campbell, Johnston, Clark.(2021). Slow Steaming: Bulk Ship Union SA v Clipper Bulk Shipping Ltd (The "Pearl C") [2012] 2 Lloyd's Rep. 533. Retrieved from https://cjcmarinelaw.com

CE Delft et al. (2019, July 1). Reducing the Maritime Sector's Contribution to CLimate Change and Air Pollution. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/816015/maritime-emission-reduction-options.pdf

Center for Naval Analyses. (1997, September 1). A Cost-Benefit Analysis of Shipboard Telemedicine. Retrieved from https://apps.dtic.mil/sti/pdfs/ADA334780.pdf

ClimateWorks Foundation. (2022, February 7). A Big First Step Toward Green Shipping Corridors . Retrieved from https://www.climateworks.org/blog/green-shipping-corridors/?utm_source=blog

Commission on the Future of Mobility. (2021, October 18). Comments of the Commission for the Future of Mobility. Retrieved from https://downloads.regulations.gov/DOT-OST-2021-0106-0345/attachment_1.pdf

D

Danish Ship Finance. (2021, November 1). Shipping Market Review - November 2021. Retrieved from https://www.shipfinance.dk/media/2159/shipping-market-review-november-2021.pdf

Danish Ship Finance. (2021). Sustainability Report 2021. Retrieved from https://www.skibskredit.dk/media/2194/sustainability-report-10.pdf

Danish Ship Finance. (n.d.). Fleet Statistics. Retrieved from https://www.shipfinance.dk/

DCSA. (2021, December 1). Spotlight on Going Digital - DCSA's Common Goal. Retrieved from https://dcsa.org/wp-content/uploads/2022/01/VoiceofIndependentDec21.pdf

DHL Global Forwarding (UK). (n.d.). Go-Green Solutions & Sustainable Freight Transportation. Retrieved from https://www.dhl.com/gb-en/home/our-divisions/global-forwarding/special-expertise/gogreen-solutions.html

DNV. (2021). Maritime Forecast to 2050 - Energy Transition Outlook 2021 (p. 30). Retrieved from https://eto.dnv.com/2021/maritime-forecast-2050/about

DNV. (2021). Alternative Fuels Insight Platform. Retrieved from Retrieved from https://dnv.com

DNV. (2021). Actionable Plans to Reduce Oil and Gas Emissions. Retrieved from https://www.dnv.com/Publications/actionable-plans-to-reduce-oil-and-gas-emissions-193854

E

European Union. (2021, June 3). 2021 EU BlueEconomy Report. Retrieved from https://op.europa.eu/en/publication-detail/-/publication/0b0c5b-fd-c737-11eb-a925-01aa75ed71a1

Equasis. (2020). The world fleet 2020. Retrieved from https://www.equasis.org/Fichiers/Statistique/MOA/Documents%20availables%20on%20statistics%20of%20Equasis/Equasis%20Statistics%20-%20The%20world%20fleet%202020.pdf

ESCAP. (2021, November 3). Quantifying the environmental benefits from paperless trade facilitation. Retrieved from https://www.unescap.org/blog/quantifying-environmental-benefits-paperless-trade-facilitation

F

Finnish Maritime Cluster. (2019). Finnpilot launches Pilot Online . Retrieved from https://fmc-yearbook.com/new-services-and-solutions/finnpilot-launches-pilot-online/

G

Global Maritime Forum. (2021, November 10). The Next Wave: Green Corridors. Retrieved from https://www.globalmaritimeforum.org/publications/the-next-wave-green-corridors

Greenhouse Gas Protocol. (n.d.). Corporate Value Chain (Scope 3) Standard | Greenhouse Gas Protocol. Retrieved from https://ghgprotocol.org/standards/scope-3-standard

H

Hasanspahić, N., Vujičić, S., Frančić, V., &; Čampara, L. (2021). The Role of Human Factors in Marine Accidents. J. Mar. Sci. Eng, 9(3), 261. Retrieved from https://www.mdpi.com/2077-1312/9/3/261/htm

Hellenic Shipping News Worldwide. (2022, March 3). Shipowners' muted enthusiasm for scrapping. Retrieved from https://www.hellenicshippingnews.com/shipowners-muted-enthusiasm-for-scrapping/

I

ICCT. (2018, April 1). The International Maritime Organization's Initial Greenhouse Gas Strategy. Retrieved from https://theicct.org/sites/default/files/publications/IMO_GHG_StrategyFInalPolicyUpdate042318.pdf

IMO. (2021). Fourth IMO GHG Study 2020 Executive Summary. Retrieved from https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Fourth%20IMO%20GHG%20Study%202020%20Executive-Summary.pdf

IMO. (2021). Fourth Greenhouse Gas Study 2020. Retrieved from https://www.imo.org/en/OurWork/Environment/Pages/Fourth-IMO-Greenhouse-Gas-Study-2020.aspx

IMO. (n.d.). Addressing climate change - a decade of action to cut GHG emissions from shipping. Retrieved from https://wwwcdn.imo.org/localresources/en/MediaCentre/Documents/Addressing%20climate%20change%20-%20a%20decade%20of%20action%20to%20cut%20GHG%20emissions%20from%20shipping_FINAL_%2814-07-21%29_Large.pdf

Inmarsat. (n.d.). Certified Application Providers. Retrieved from https://www.inmarsat.com/en/solutions-services/maritime/certified-application-providers.html

Intelligent Cargo Systems. (2021). Guide to Port Call Optimisation. Retrieved from https://intelligentcargosystems.com

Institute of Engineering and Technology (IET). (2022, February 2). Delivering Net Zero through Digital. Retrieved from https://www.policyconnect.org.uk/research/delivering-net-zero-through-digital

IRENA. (2021, October 1). A Pathway to Decarbonise the Shipping Sector by 2050. Retrieved from https://www.irena.org/publications/2021/Oct/A-Pathway-to-Decarbonise-the-Shipping-Sector-by-2050

BIBLIOGRAPHY

K

KPMG. (2021). Surviving the Silicon Storm - Why the automotive industry is the hardest hit and how automakers - and other chip buyers - can prepare for future semiconductor shortages. Retrieved from https://advisory.kpmg.us/articles/2021/surviving-silicon-storm.html

Kuehne+Nagel (2022, March 10). The Value of Visibility. Retrieved from https://home.kuehne-nagel.com/

Kuehne+Nagel. (n.d.). Sustainability in Sea Freight. Retrieved from https://home.kuehne-nagel.com/-/services/sea-freight/carbon-offset

L

Lloyd's List. (2021, December 2). The five steps to zero-carbon shipping . Retrieved from https://lloydslist.maritimeintelligence.informa.com/LL1139161/The-five-steps-to-zero-carbon-shipping

Lloyd's Register. (2011, July 11). IMO MEPC 62 Agenda Preview for Clients. Retrieved from https://www.cdinfo.lr.org/information/documents/imomarineservices2010/mepc%2062%20agenda%20preview%20external%20new%20format.pdf

Lloyd's Register. (2021). Remote and Present - Remote Surveys Brochure. Retrieved from https://indico.riteh.hr/event/2/attachments/52/126/LR_Remote_Surveys.pdf

London Economics et al. (2021, October 1). Consultancy Research into the UK Maritime Technology Sector. Retrieved from https://londoneconomics.co.uk/wp-content/uploads/2021/11/LE-DfT_SmartShipping-Final-Report.pdf

M

Maersk. (2022, February 9). Annual Report 2021. Retrieved from https://investor.maersk.com/news-releases/news-release-details/annual-report-2021

Marorka. (n.d.). Hardware and Software powering Energy Management. Retrieved from https://www.marorka.com/products/

Martek Marine. (2017, May 21). The stark reality of maritime health hazards . Retrieved from https://www.martek-marine.com/blog/the-stark-reality-of-maritime-health-hazards/

Marine Benchmark. (2020). Research Brief 11/2020 Maritime CO_2 Emissions. Retrieved from https://www.marinebenchmark.com/wp-content/uploads/2020/11/Marine-Benchmark-CO2.pdf

Marine Link. (2012, February 28). Hapag-Lloyd Containership Fleet Reduces CO_2 Emissions. Retrieved from https://www.marinelink.com/news/containership-hapaglloyd342722

Marine Link. (2021, October 28). Performance Intelligence: The Key To Decarbonizing. Retrieved from https://www.marinelink.com/news/performance-intelligence-key-491644

McKinsey & Company. (2021, April 12). How to decarbonize global shipping: An interview with Bo Cerup-Simonsen. Retrieved from https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/shipping-and-carbon-zero-an-interview-with-bo-cerup-simonsen

Metapack. (2021). Ecommerce Delivery Benchmark Report 2021. Retrieved from https://info.metapack.com/rs/700-ZMT-762/images/Ecommerce%20Delivery%20Benchmark%20Report%202021.pdf

N

NEPIA. (2021). Navigating Contractual and Charterparty Issues. Retrieved from https://www.nepia.com/publications/navigating-decarbonisation-contractual-and-charterparty-issues/

NAPA. (2017, May 29). Shipping businesses lose annually 18 billion USD due to "Rush to Wait" – NAPA. Retrieved from https://www.napa.fi/shipping-businesses-lose-annually-18-billion-usd-due-to-rush-to-wait/

NAPA. (2020, February 14). Survey: Owners and charterers believe that voyage efficiency savings of 28% are possible . Retrieved from https://www.napa.fi/news/survey-owners-and-charterers-believe-that-voyage-efficiency-savings-of-28-are-possible

Nautilus International. (2021, August 18). MCA deck oral exams – to fail or not to fail? Retrieved from https://www.nautilusint.org/en/news-insight/telegraph/mca-deck-oral-exams---to-fail-or-not-to-fail/

Norton Rose Fulbright. (2022, March 1). Decarbonising shipping: Where are we now? . Retrieved from https://www.nortonrosefulbright.com/en/knowledge/publications/399d88fa/decarbonising-shipping-where-are-we-now

O

Ocean Network Express. (2020, April 2). Press Release - ONE Issues its First Electronic BL and Selects essDOCS to Power its Global BL Digitization Initiative. Retrieved from https://www.one-line.com/en/news/one-issues-its-first-electronic-bl-and-selects-essdocs-power-its-global-bl-digitization

OGCI/Concawe. (2022, February 8). Technological, Operational and Energy Pathways for Maritime Transport to Reduce Emissions Towards 2050. Retrieved from https://ricardo.com/news-and-media/news-and-press/pathways-outlined-to-enable-shipping-sector-to-achieve-decarbonisation-goals

OneOcean. (2021, April 14). Inmarsat and OneOcean partner to deliver pioneering digital solutions for navigation and compliance. Retrieved from https://www.oneocean.com/news/inmarsat-and-oneocean-partner-to-deliver-pioneering-digital-solutions-for-navigation-and-compliance/

P

Port of Rotterdam. (2020, December 14). 8-9% Fuel savings in Just-In-Time arrival trial . Retrieved from https://www.portofrotterdam.com/en/news-and-press-releases/8-9-fuel-savings-just-time-arrival-trial

PortXChange. (2021, April 7). How JIT arrivals can reduce shipping emissions . Retrieved from https://port-xchange.com/blog/just-in-time-arrivals-cutting-emissions-today

Poseidon Principles. (2021, December 1). Poseidon Principles Annual Disclosure Report 2021. Retrieved from https://www.poseidonprinciples.org/finance/wp-content/uploads/2021/12/Poseidon-Principles-Annual-Disclosure-Report-2021.pdf

PWC. (n.d.). Momentum is gaining in linking the monitoring and reporting of ESG performance to shipping finance. Retrieved from https://www.pwc.com/gr/en/industries/linking-esg-and-shipping-industry.html

R

Ricardo Energy & Environment (2022) Technological, Operational, and Energy Pathways for Maritime Transport to Reduce Emissions Towards 2050, issue 6, available at https://ogci.com

Riviera Maritime Media. (2021). Unlock unused data for 50% profit growth. Retrieved from https://www.rivieramm.com/editors-choice-brand/five-steps-to-unlocking-unused-data-for-50-profit-growth-60840

S

Sagaro GG, Dicanio M, Battineni G, et allncidence of occupational injuries and diseases among seafarers: a descriptive epidemiological study based on contacts from onboard ships to the Italian Telemedical Maritime Assistance Service in Rome, ItalyBMJ Open 2021;11:e044633. doi: 10.1136/bmjopen-2020-044633

Sea Cargo Charter. (n.d.). Becoming a Signatory. Retrieved from https://www.seacargocharter.org/signatories/becoming-a-signatory/

Sea Cargo Charter. (2021, November 1). Aligning Global Shipping with Society's Goals. Retrieved from https://www.seacargocharter.org/wp-content/uploads/2021/12/SCC-Technical-Guidance-V1.3.pdf

Seatrade Maritime News. (2022, March 7). Technology driving maritime healthcare says Vikand. Retrieved from https://www.seatrade-maritime.com/ship-operations/technology-driving-maritime-healthcare-says-vikand

Securities and Exchange Commission (SEC). (2021, June 10). Ceres - Re: Public Input on Climate Change Disclosures. Retrieved from https://www.sec.gov/comments/climate-disclosure/cll12-245664.pdf

ShipBob. (2021, April 21). Eco-Friendly Shipping - Top Green Shipping Methods. Retrieved from https://www.shipbob.com/blog/eco-friendly-shipping/

Siem Offshore. (2020, December 14). Competition-driven fuel saving gave results. Retrieved from https://www.siemoffshore.com/news/competition-driven-fuel-saving-gave-results

S&P Global. (2022). Commodities 2022: EU on collision course with shipping over carbon market reforms. Retrieved from https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/energy-transition/122321-commodities-2022-eu-on-collision-course-with-shipping-over-carbon-market-reforms

BIBLIOGRAPHY

T

The Getting to Zero Coalition. (2021, November 1). The Next Wave - Green Corridors. Retrieved from https://www.energy-transitions.org/publications/the-next-wave/

The Manufacturer. (2022, February 22). Is onshoring the new offshoring? Retrieved from https://www.themanufacturer.com/articles/is-onshoring-the-new-offshoring/

The Royal Gazette (Bermuda). (2022, March 24). Ship diverts to Bermuda after senior officer has heart problem. Retrieved from https://www.royalgazette.com/general/news/article/20220323/ship-diverts-to-bermuda-after-senior-officer-has-heart-problem/

Thetius. (2021). A Changed World: The State of Digital Transformation in a Post COVID-19 Maritime Industry. Retrieved from https://thetius.com/changed-world/

U

UK Parliament. (2022). Postnote No. 665 International Shipping and Emissions. Retrieved from https://researchbriefings.files.parliament.uk/documents/POST-PN-0665/POST-PN-0665.pdf

UMAS. (2020). Aggregate Investment for the Decarbonisation of the Shipping Industry. Retrieved from https://www.globalmaritimeforum.org/content/2020/01/Aggregate-investment-for-the-decarbonisation-of-the-shipping-industry.pdf

UMAS. (2022, January 18). Closing the Gap - An Overview of the Policy Options to Close the Competitiveness Gap and Enable and Equitable Zero-Emission Fuel Transition in Shipping. Retrieved from https://www.globalmaritimeforum.org/content/2021/12/Closing-the-Gap_Getting-to-Zero-Coalition-report.pdf

UNFCC. (n.d.). COP 7 - Reports | . Retrieved from https://unfccc.int/process-and-meetings/conferences/past-conferences/marrakech-climate-change-conference-october-2001/cop-7/cop-7-reports

UNCTAD. (2021, November 18). Review of Maritime Transport 2021. Retrieved from https://unctad.org/system/files/official-document/rmt2021_en_0.pdf

UNCTAD. (2020, February 25). Decarbonizing maritime transport: Estimating fleet renewal trends based on ship scrapping patterns. Retrieved from https://unctad.org/news/decarbonizing-maritime-transport-estimating-fleet-renewal-trends-based-ship-scrapping-patterns

W

Wärtsilä. (2021, June 30). In Conversation on the Poseidon Principles. Retrieved from https://www.wartsila.com/insights/article/in-conversation-on-the-poseidon-principles

Wärtsilä. (2019, November 19). Pilotage Digitalisation. How Remote is the Remote Pilotage? Retrieved from https://www.wartsila.com/insights/article/pilotage-digitalisation-how-remote-is-the-remote-pilotage

West P&I. (2021). Defence Guides: Speed and Consumption Claims in a Nutshell. Retrieved from https://www.westpandi.com/getattachment/72c4277d-d592-47d5-bb3a-a68da7215f9a/defence-guide_speed_consumption_4pp_v2_lr.pdf

World Economic Forum. (2020, July 7). How does the shipping industry plan to decarbonize? Retrieved from https://www.weforum.org/agenda/2020/07/shipping-industry-plans-to-decarbonize/


Thetius
inmarsat
inmarsat
Research
Programme