GLOBAL MARITIME FORUM

INSIGHT BRIEF

The role of data in maximising operational efficiency in shipping

Global Maritime Forum Short Term Actions Taskforce

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How can data and digitalisation bring new insights to operational efficiency in shipping and help capitalise on the opportunity presented? This paper explored this key question as part of a series that examines the undervalued opportunity presented by operational efficiencies to reduce shipping emissions in the short term and pave the way for long-term decarbonisation solutions. The learnings presented here emerged from a series of meetings and workshops gathering perspectives from experts across the maritime value chain—shipowners, operators, charterers, ports, classification societies, and NGOs—as part of the Short Term Actions Taskforce. Other papers in the series provide an ***overview of the issue****, and dive deeper into the identified solutions and enablers: scaling up pilots, legal and contractual changes.*

1. Introduction: Why data matters

World trade is more than 30 times greater now than it was in 1950. And while there has been incredible innovation in the global transportation of goods, maritime trade is still at the beginning of its decarbonisation journey. Three types of operational optimisation—speed optimisation, capacity utilisation, and voyage optimisation—each provide between 10%-24% increase in operational efficiency.[1] If standardised environmental performance data were more accurate, greenhouse gas (GHG) emissions could guide operational decision making for ship owners. When more accurate data is made transparent and readily available, it can inform investment and operational decisions by charterers, and ports, as well as becoming a major criterion for industry decarbonisation targets, trade deals, and negotiations.

There is an adage in business: "What gets measured gets managed". This is especially true for strategic transformations like reducing emissions, for which measurable success criteria are essential. Measuring success means to create transparency and an understanding of reality at scale. This in turn is only possible if data is collected, analysed and interpreted at scale. Collecting data not only allows us to understand historic trends and slice-and-dice those into categories of interest, but it also unlocks predictive and prescriptive modelling with machine learning and AI. Such methodologies are critical to simulate future trends and apply mathematical optimisation to find the best business decisions to make that maximise success metrics.

The first step needs to be making it possible to measure every vessel's performance as frequently and accurately as possible. While there are ways of quantifying carbon intensity such as the Energy Efficiency Operational Indicator (EEOI), it is difficult to capture the full picture. The Carbon Intensity Indicator (CII) of the International Maritime Organisation (IMO) is a good example of this. While it introduces a global, easy-to-understand reference that brings much needed attention to operational efficiency in shipping, it has been met with criticism from many quarters for not including the actual cargo transported.

Furthermore, there are efficiency gains with regards to scaling that are not captured through the current indices: The same cargo will have a very different carbon footprint depending on whether it is transported by two smaller vessels or one large vessel. An additional discrepancy with the EEOI and CII efficiency measures is that they reward long haul shipments over short haul shipments, whereas short haul voyages have lower GHG emissions per tonne cargo moved than long hauls.

There could be around 10% of latent performance improvements[2] ready to be unlocked today through voyage optimisation. Given this context, and as the industry becomes more data-centric in general, there is a requirement for reliable, useful, and complete data to enable these optimisations to take place. In short, the industry has matured and data needs to as well. As the sector moves to rapid decarbonisation, the industry needs the right data to enable this transition.

2. Current requirements under IMO and EU regulation

For shipping to decarbonise, there is a need for reliable data that enables shipowners to monitor, verify, and report the emissions associated with their activities. Both the IMO and EU have mandatory schemes to collect data related to GHG emissions of the shipping sector for vessels with a gross tonnage (GT) above 5,000. The EU developed its own first step in a process to collect and analyse emissions data from ships ("EU MRV")[3] prior to an international agreement being reached by the IMO ("IMO DCS").[4] Both the EU MRV and IMO DCS data are collected after the end of the calendar year. Furthermore, the EU MRV data for a ship are published, but only at aggregated level. The IMO DSC is less transparent by only publishing aggregate data, and does not share ships' reported annual numbers in an attributable way.

Data sharing in support of the EU Emissions Trading System (EU ETS) compliance is going to be critical. BIMCO has recognised this through its Emission Trading Scheme Allowance (ETSA) Clause,[5] shared earlier this year, which was designed to enable owners and charterers to co-operate on the timely sharing of data and information. This establishes charterers' responsibility to "provide and pay for" allowances corresponding to the ship's emissions during the time charter period. To enable this, charterers and owners must commit to timely data sharing practices, notably on verified fuel consumption data, to make provisions of allowances to surrender under the ETS. This will require a higher degree of cooperation, collaboration and transparency.

Reporting for the EU is required for voyages that carry passengers or cargo for commercial purposes to or from European ports – regardless of the flag they fly – and calls for data on actual cargo carried. In contrast, the IMO DCS requirements apply to all voyages, but only require reporting of deadweight or gross tonnage as a proxy for actual cargo carried. Each has different data checking, formatting and verification requirements, and timelines for compliance. To comply with the MRV and DCS reports, vessel owners have had to implement several processes and data quality standards. This requires a clear overview of all vessel data and an understanding of data reported.

Standardising data in order to comply with regulation is fairly straightforward. The real challenge now is to ensure that shipping companies can transform these requirements from an obligation into an opportunity. Shipowners and operators can go much further with the data they already collect for MRV and DCS reports by creating a new mindset that seeks out the value of that data, not only in terms of compliance but in potential financial and environmental benefits.

3. Barriers

a. Lack of standardised data collection

One of the reasons that operational inefficiencies persist in shipping is due to a lack of thorough measurement and up to date data and information related to vessel performance. Although the use of real-time sensors and flow metres is becoming increasingly common, there is no standard way of gathering data from vessels. There is one exception which is ISO 19030 which was launched in 2016 and outlines a method for measurement of changes in hull and propeller performance. It shows the way to calculate a set of four performance indicators for hull and propeller related maintenance.This standard allows the collection of metadata and specific performance data but is focussing on optimising technical performance. It has unfortunately not had a significant uptake in the industry.

Vessel noon reports are currently the universal source of information on ship performance despite their low frequency and reliance on human intervention. Most noon reports still depend on tank soundings which by nature carry high uncertainty. This is where things like flow metres would provide more frequent and accurate information. For the majority of vessels, noon reports provide a vital and regular indicator of vessel performance and environmental conditions. But because these reports are produced manually, often in accordance with individual company, charterparty or ship management guidelines, the diversity of their input and how information is recorded can vary widely. The way in which shipping companies currently gather data from ships via noon reports lacks the standardisation and sophistication levels that are required to match the data needs of the industry to optimise its voyage, vessel, and bunker operations, as well as minimise its GHG emissions. This creates the risk of information gaps and creates a requirement for significant manual intervention to cleanse the data input. Onboard validations can support better data from the source, but multiple stakeholders who are not used to sharing data such as fuel consumption with each other can be a key hindrance in decarbonisation success. In this situation, noon reports need to transform in line with how the rest of the industry's data landscape has matured.

While there is currently a drive on newer vessels to install advanced sensors that will gather and share data at higher frequencies, we cannot wait for this to become normal practice. Strong commitments will need to be made by the sector for this method of data gathering to become standard across the global fleet, rather than a preserve of some of the most advanced vessels. Some issues will need to be solved, including the fact that it can be difficult to keep sensors fully functioning and calibrated over time making it difficult, for the time being, to fully rely on sensor data.

b. Lack of trust

One consequence of inaccurate data or insufficient transparency of data is that it perpetuates a lack of trust between owners and charterers. Today's performance clauses within charterparties have built in split incentives for owners and charterers, leading to vessels running at inefficient speeds. Time charterers frequently bring claims against owners for underperformance, which often go hand in hand with legal claims for specific contractual disputes such as "overconsumption", when the vessel is using more fuel per day than specified in the charterparty. In time-charterparties it is not unusual for the eco speed and consumption warranty to be given "without guarantee", for which there will be no warranty and a performance claim will probably fail. Similarly, the general speed and consumption will usually be given on an "about" basis, commonly understood to be 0.5 knots and 5% bunker consumption.

In order to defend these claims, owners rely heavily on data collected by the master and the officers which is susceptible to subjectiveness and human error. Use of behavioural data to influence efficiency is covered in more detail below in Section 4.e, which also includes a case study.

c. Perceived confidentiality of data

The competitive nature of data is being used by many in the industry to keep data private. In the past, shipping companies have frequently claimed that it is not possible to share data on fuel consumption because doing so could endanger the sector's ability to compete. It has been used as an argument against the EU MRV regulation which requires ships calling on EU ports to submit the data that allows the calculation of the EEOI. For each individual ship, the EEOI has been made public since 2020[6] through a system administered by the European Maritime Safety Agency (EMSA) called Thetis-MRV. With such mandated transparency, the confidential nature of

data as an argument no longer holds any sense. Meanwhile, we are aware that the most competitive shipping firms are those that make their data public. We now know that there is still a problem with the accuracy of data, including that found in, for example, the noon reports and human errors frequently play a role in this.

d. Need for a multilateral approach

Data sharing will need to go beyond the transport piece of the value chain to include trading and commodity markets. Cross-industry collaboration will also be necessary to develop standardised data protocols, some of which are under development and are explored in a separate paper. More trust is a prerequisite for action across stakeholders, including better vessel data sharing and reporting across the industry from the shore to the sea and vice versa. Currently, with unknowns around who will pay for decarbonisation initiatives as well as misaligned incentives between owners and charterers, there is still a long way to go to build trust.

4. Enablers

We can expect new and data-driven business models, premiums for more efficient shipping companies, and globally scalable carbon trading standards. These will create a strong economic incentive for companies to be GHG efficient without setting the industry back.

From a consumer perspective, being able to access reliable data about the GHG emissions through the value chains of the products we buy could drive real change: if each one of us knew the carbon impact of everything we bought—from our clothes, to our car, to the food we eat—we could use that to inform our choices. Shareholder value, brand reputation, supply chain pressures, and bottom-line revenues would all be susceptible to these pressures.

For every single journey, charterers should be able to use the environmental performance as a factor in selecting the vessels moving their cargo. By using technology to proactively manage both the cargo leg and the ballast leg (the leg where the vessel is empty and is going to pick up the cargo), charterers can reduce their GHG footprint significantly. This can also help improve commercial terms in charterparties, planning smarter arrival time estimates, and predicting port congestion – bringing to life the "Virtual Just In Time" that has been in discussions for many years.

As mentioned earlier, greater trust is necessary for coordination and benefit sharing across stakeholders. This will be enabled in part by better vessel data being shared and reported across the industry. High-quality data can provide a link to voyage and vessel optimisations, but must go beyond what is provided by noon reports today. High-quality data is also key to enable more accurate fuel consumption models which can then be used to inform better decision-making within the shipping ecosystem, contributing to more sustainable, efficient, and profitable operations. Continuous monitoring systems with advanced sensors are another part of the solution, though uptake is currently low and most companies do not have the resources in place to manage and analyse the increased amount of data.

a. Data standardisation

On the path to decarbonisation, high-quality data is a prerequisite to voyage and vessel optimisations. The data that does exist has room for improvement in both quantity and quality, and with the new emissions regulations on their way, owners and operators will quickly realise that they may be missing the key information needed to report on emissions and fully optimise their vessel. This is further hindered by a lack of transparency between the contract parties.

To ensure vessel performance can be optimised, data input must be high-quality, standardised, interoperable. One challenge here is that owners, charterers and operators require their own custom reports with specific data for their segments and many have different field names and data formats. A first step towards improving the accuracy of vessel performance would be to improve data collection and reliability, for example using standardised data points, naming conventions, and definitions of terms for reports coming from vessels, enabled by more accurate software and models as well as continuous monitoring systems with advanced sensors.

Such data improvements will help the party collecting the data, but they can help charterparties on both sides if they are shared more transparently. Adoption of a standard holistic report from vessels could enable widespread collaboration and future data sharing that will enable the decarbonisation journey. This must go beyond what is provided by noon reports today, and data sharing can even be written into contracts.

Case Study: Evidence of Challenges in Creating Standards

As part of a working group to create a noon report standard, ***ZeroNorth***, a member of the Short Term Actions Taskforce, has partnered with Energy LEAP, a member organisation for energy majors. The most prominent data format that comes from vessels today is noon reports, until high frequency data from sensors becomes readily available. In order to reach the industry's decarbonisation goals, it is important that reports from vessels contain the necessary data for today's regulatory and voluntary emissions reporting needs.

With no standard, benchmark, or easy way to compare emissions emitted between organisations, it is not possible to assess market implications of CO2 emissions, which will become critical as new regulations come into play with the carbon pricing mechanisms (e.g. EU ETS). A standard is urgently needed.

In the noon report standard working group, it was discovered that companies are finding that they do not have the right data at the end of the year to do emissions reporting, as it is not being collected on a daily basis throughout the year. Without the right data, it is therefore challenging to live up to the obligations of voluntary emissions reporting they have committed to, in particular with the Sea Cargo Charter for charterers who are not owners.

Learnings so far

- Energy LEAP, with its not-for-profit basis and broad reach across the physical oil trading industry, provided enough people in the room for the working group to create the standard for a particular segment – tankers, including LNG.
- It was critical to simplify the complexity in identifying the different emissions data points needed for each report.
- One blocker came from vessel report definitions for port reports, sea reports, noon reports, and a discrepancy in definition for when to start and stop emissions calculations. A workaround has been sorted, as well as the realisation that while reaching consensus is difficult, it does not require unanimous agreement.
- Also noted was that a naming convention and data format would be critical for the sharing of data and future industry collaboration needs.
- The first version will be a small part of what's needed for a full industry standard but is a good starting place for industry input and foundation for next steps.

In conclusion, it is imperative to solve the problem for organisations missing data for their emissions reporting. It is critical that noon reports contain the necessary data for today's regulatory and voluntary emissions reporting needs to reach the industry's decarbonisation goals. The main objective of the project is to create a noon report standard and achieve adoption by the industry.

b. Making use of optimisation software

Modern software and modelling can help speed, route, weather and bunkering optimisation. Routeing companies and service providers help ensure safety and cost efficiency using digital tools, for the benefit of both ship owners and time charter operators. Weather conditions are a critical influencing factor of a vessel's speed and fuel consumption and proper routeing using advanced satellite data and complex software can greatly affect the commercial result of the voyage. Modern vessels do not need to bunker at every port, and optimising when and where to bunker, which can be especially challenging in volatile market conditions.

Increasingly, such services are integrating machine learning and artificial intelligence into their calculations to deliver more accurate projections, especially those related to weather, which currently is reliable up to about two weeks ahead. More reliable vessel performance data and more accurate weather data can also enable more transparent tolerances in speed warranties in the charterparties between owners and charterers.

c. Use of continuous monitoring technologies

Onboard continuous monitoring systems using a range of sensors and technologies could improve on the results of optimisation services and operational efficiency more broadly. The primary targets of continuous monitoring are measurement of speed through water and fuel use. Precise measurements of actual speed through water are useful as input for vessel fuel optimisation and hull performance estimation. Electronic fuel monitoring systems can provide active insights to fuel use, which is a necessary step to increase performance optimisation. Together, such technologies can enable improvements in the application of vessel performance modelling and optimisation, enabling significant cost-efficiencies to vessels while making them more attractive for charterers.

Vessel speed is often measured by GPS, which provides a vessel's speed compared to fixed objects, but not compared to moving water with waves and currents. One project currently underway seeks to apply a new level of data accuracy in measuring the speed through water, with the hope of this technology enabling adjustments of performance clauses to reflect actual conditions. The new technology uses radar to accurately measure speed through water on a continuous basis together with environmental conditions, such as wind, waves and currents. With higher accuracy of speed measurement, it becomes possible to more accurately track fuel use and identify smaller efficiency gains. Accurate speed through water data is an important tool for controlling and optimising vessel fuel consumption, allowing shipowners and operators to optimise vessel performance and avoiding operation at sub-optimal speeds. Having a third-party operator collecting real-time speed through water data can help overcome issues of mistrust between owners and charterers.

While the argument for sensors and onboard monitoring technologies seems simple, there are several drawbacks. Such technologies can be costly to install and difficult to maintain. In addition, the cost of fuel monitoring systems may be borne by the owner, while the charterer may see the benefit. Prices are coming down, but fully equipping a vessel for continuous monitoring is still quite an investment, and it is important that the data produced is actually analysed and used for operational decision making. Ensuring that the benefits of such systems can be shared across charterparties will be critical to broader uptake.

d. Use of behavioural data

A new use of data targeting human behaviours that affect operational efficiencies to reduce fuel usage is showing promise. This type of solution can target and improve a range of behaviours, including trim and draft optimisation, speed optimisation, port turnaround time, autopilot improvement, and route optimisation. At sea, crews are constantly making decisions with multiple priorities and endless factors and nuances to consider. Each of these decisions has enormous potential consequences for safety of life, pollution and massive amounts of fuel. Connecting ship to shore through technology-enabled information sharing can help a ship's master to make more informed decisions regarding the vessel's speed and take action to maximise efficiency in line with environmental and commercial goals.

A study undertaken as part of the Clean Maritime Call, a Maritime Research and Innovation UK (MarRI-UK) initiative supported by the UK Department for Transport (DfT), revealed that there is a clear difference in efficiency practices between individual captains and chief engineers, offering savings potential of at least 12% from behavioural changes alone.

Case Study: Behavioural nudges can save millions in fuel costs

Signol, a member of the Short Term Actions Taskforce, partnered with ***Bernhard Schulte Shipmanagement*** Deutschland (BSMD) on a four-month pilot to reduce carbon emissions on board its managed ships through behavioural change alone. The partnership saw 30 masters and chief engineers across 23 BSMD-managed vessels receive personal targets and achievements via the Signol app and direct emails, nudging participants toward fuel-efficient behaviours and letting them review their voyages. Captains and chief engineers were measured on key metrics around auxiliary engine usage, main engine fuel consumption, and cylinder oil consumption. The final raw dataset contained 25,000 reports spanning 13 months, gathered from 'noon reports' filed by participating ships.

The results are profound for the maritime industry, as the sector strives to go green in line with the International Maritime Organization's 2050 strategy. The results prove that behaviour change alone can lead to a material reduction in ships' energy demand and carbon emissions, whilst lowering operational costs.

- An industry-changing 13,900 metric tonnes of CO2 was saved over the four-month trial, equivalent to a $3.16 million fuel saving for BSMD's customers and charterers.
- Bunker fuel consumption was found to have been significantly reduced, with a 12% reduction in the participating ships over the course of the trial—approximately 4,000 metric tonnes.
- The consumption of marine diesel for auxiliary engines also fell by 122 metric tonnes—a saving of more than $150,000 and 400 metric tonnes of CO2.
- Running time for the auxiliary engines was reduced by 570 hours over the four-months of the trial, reducing BSMD's maintenance costs.
- Even taking into account practical influencers on operations, there was a clear and significant difference in how consistently highly skilled individual operators implemented fuel-saving best practices.

The method and results were reviewed by UMAS,[7] which undertakes research using models of the shipping system, shipping big data (including satellite Automatic Identification System data), and qualitative and social science analysis of the policy and commercial structure of the shipping system, and which is also a member of the Short Term Actions Taskforce. The UMAS review of the trials methodology and data concluded that the "results suggest a clear association of variation in DFOC (Difference in Fuel Oil Consumption) values with the nudging of captains" and an increase in efficiency of AEU (Auxiliary Engine Usage), and that "the main conclusions that nudging can have a significant effect on DFOC and AEU appear reasonable."

e. Energy management systems

One key challenge to data management is that neither standardised data collection protocols nor standardised performance evaluation and comparison have been made mandatory. The basis for a robust decarbonisation strategy is a strong tool (supported by company leaders) that allows one to manage the performance of a ship. The IMO is not providing this tool. A simple description of what the company plans to do as is currently mandated through the IMO SEEMP (Ship Energy Efficiency Management Plan) is not sufficient. ISO 50001 provides a framework for an "Energy Management System (EnMS)" through which each company can set and pursue its own goals for improving energy performance and is applicable to all kinds of companies across multiple industry sectors.[8]

EnMS is a series of processes that helps a company use data and information to maintain and improve their energy performance, while improving operational and energy efficiencies and reducing environmental impacts. The ISO 50001 framework provides a systematic approach to energy management within a company. A company that conforms to the standard can provide proof that they have implemented the international energy management systems and are committed to continual improvement in energy performance. ISO 50001 is based on a similar approach to that already employed in ISO 9001, ISO 14001 and IMO SEEMP. The challenge with this solution, however, is that it is perceived as onerous and burdensome. An informal poll of companies engaged in the Short Term Actions Taskforce found that those using ISO 50001 at a corporate level found the cost-benefit overwhelming, and none of the companies is using the standard specifically for shipping efficiency.

f. Transparency initiatives

There are several initiatives aiming at boosting transparency by increasing data sharing and creating accountability along the maritime supply chain. The Poseidon Principles are the first of three initiatives developed by the Global Maritime Forum with the shared aim to decarbonise shipping through four principles: assessment, accountability, enforcement, and transparency. During the very early stages of the Poseidon Principles, some charterers who were part of the drafting group voiced the need for a transparent process for reporting emissions related to chartering activities. This is how, following the example of the Poseidon Principles, the Sea Cargo Charter was launched in October 2020. The most recent initiative was launched in December 2021. The Poseidon Principles for Marine

Insurance gather a group of marine insurance institutions committed to aligning their portfolios with responsible environmental impacts.

The Poseidon Principles are a global framework for assessing and disclosing the climate alignment of financial institutions' shipping portfolios. They establish a common, global baseline to quantitatively assess and disclose whether financial institutions' lending portfolios are in line with adopted climate goals. Thus, they also serve as an important tool to support responsible decision-making.

The Sea Cargo Charter establishes a framework for assessing and disclosing the climate alignment of ship chartering activities around the globe. It sets a benchmark for what it means to be a responsible charterer in the maritime sector and provides actionable guidance on how to achieve this. Through this initiative, the accessibility and quality of data is expected to increase. The Sea Cargo Charter relies specifically on the EEOI as the carbon intensity metric, which produces the closest measure of the vessel's true carbon intensity in operation, to a high level of granularity. The EEOI uses the parameters of fuel consumption, the GHG emission factor for each fuel type, distance travelled while laden with transported cargo, and amount of cargo transported over a given voyage.The Poseidon Principles use the AER and can therefore rely on the IMO DCS to collect data, while the Sea Cargo Charter uses EEOI and thus has a different approach to source data.

g. The role of hydrographic data for ports

The hydrographic industry has a significant role to play in reducing CO2 emissions, especially as an enabler for smoother traffic in and around ports, where water depth and bathymetry can be constraints to vessel traffic, especially as vessel sizes continue to increase.[9]

Hydrography is a fundamental discipline for all sea-related activities, as it deals with the physics of the marine environment. With rising ocean temperatures, melting polar ice, and increasing storm severity, coastlines are shifting and hydrographic data is changing. This underscores the importance of the International Hydrographic Organization (IHO) in its efforts to mitigate and adapt to the effects of climate change and enhance hydrographic support for safe and efficient maritime navigation. Two crucial aspects in this regard are the development of autonomous shipping and the reduction of emissions, which are driving changes in hydrographic services. To address these new requirements, the IHO and its Member States are focusing on a range of hydrographic data products and services based on the Universal Hydrographic Data Model.

The adoption of the new S-100 standard from the IHO will support a spectrum of maritime data sources and combine these into advanced charts and bathymetry. When moving cargo in and out of demanding harbour environments, more accuracy and detail of depths, tides, and currents will enable access to ports and waiting areas with larger vessels, increasing efficiency. Offering greater operational insight, S-100 will enable a business benefit, as well as operational efficiencies producing lower emissions.

5. Conclusions and recommendations

The broad availability of data in the 21st century is a major enabler of the transparency and trust required for the maximisation of operational efficiency in shipping. As shipping accelerates its transition to decarbonisation, data and standards will play a key role in benchmarking the efficiency of vessels and fleets. Regulation is pushing for increased data transparency, and reporting standards such as EEOI, once seen as containing confidential information on cargo loads, are now becoming mandated.

Leading companies are one step ahead of regulation, and we can see several industry best practices that should be more widely adopted:

- Adoption of a standard holistic report from vessels that could enable widespread collaboration and future data sharing that will enable the decarbonisation journey. Cross-industry collaboration will be necessary to develop standardised data protocols, some of which are under development;
- Support for more accurate data collection, including use of continuous monitoring technologies, fuel mass flow meters, and technologies for accurately tracking speed through water;
- Support more transparent data sharing practices with charterparties, including public reporting of EEOI data;
- Use of energy management systems, such as ISO 19030 on hull and propeller performance and ISO 50001 on energy management;
- Signing up to relevant transparency initiatives such as the Poseidon Principles, Poseidon Principles for Marine Insurance, and the Sea Cargo Charter.

Awareness of the carbon intensity of vessels on a continuous basis will be a prerequisite to optimising vessel performance and can be a lever to more efficient supply chains at a broader scale. The foundation for a robust company decarbonisation strategy will be leadership by top management supported by strong tools that allow the benchmarking of ship performance through robust data tracking from one year to the next. These are steps that can and should be taken now.

6. Resources

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Glossary

Annual Efficiency Ratio (AER): AER measures all the carbon emissions from all ballast and laden voyages, anchorage, port stays, all divided by the deadweight and distance sailed in a year (grams of CO2 per DWT mile). Based on these AER results, ships are grouped into different CII ratings.

Energy Efficiency Operational Indicator (EEOI): IMO developed EEOI in order to allow ships to monitor the carbon emissions of their shipping activities. The EEOI is the total carbon emissions in a given time period per unit of revenue ton-miles. Variations in the index are mainly caused by three factors: the technical efficiency of the ship, the amount of cargo transported per unit of time and variations in speed. However, as the EEOI is an aggregate number, it is difficult to identify the influence of these factors.

Carbon Intensity Indicator (CII): CII is a measure of how efficiently a ship transports goods or passengers and is given in grams of CO2 emitted per cargo-carrying capacity and nautical mile. The ship is then given an annual rating ranging from A to E, whereby the rating thresholds will become increasingly stringent towards 2030. The CII applies to all cargo, RoPax and cruise ships above 5,000 GT.

Energy Efficiency Design Index (EEDI): EEDI provides a specific figure for an individual ship design, expressed in grams of carbon dioxide (CO2) per ship's capacity-mile (the smaller the EEDI the more energy efficient ship design) and is calculated by a formula based on the technical design parameters for a given ship. EEDI is a one off calculation based on ships design specifications, hence a static measure not a dynamic one.

EU Emissions Trading Scheme (EU ETS): The EU ETS is an emission cap-and-trade system where a limited amount of emission allowances – the cap – is put on the market and can be traded. Under the EU ETS each company with ships trading in the EU/EEA is required to surrender emission allowances corresponding to a certain amount of its GHG emissions emitted over a calendar year starting with 2024.

EU Monitoring, Reporting and Verification (EU MRV): EU regulation on the monitoring, reporting, and verification of carbon dioxide (CO2) emissions from ships, which first entered into force on 1 July 2015.

IMO Data Collection System (IMO DCS): The IMO DCS, adopted in 2016, tracks vessel ƒ fuel consumption, consisting of requirements for ships to record and report their fuel oil consumption with a view to inform further IMO measures to reduce GHG emissions from ships.

Ship Energy Efficiency Management Plan (SEEMP): The Ship Energy Efficiency Management Plan (SEEMP) is a document that details measures set by shipping companies to improve the energy efficiency of each vessel on a long run. Described as an operational measure, the SEEMP is more a tool to estimate the current energy consumption of the vessel and lower it along with the GHG emissions.

Endnotes

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