CLIMATE ACTION IN SHIPPING

Progress towards Shipping's 2030 Breakthrough

2024 edition

GETTING TO ZERO COALITION
GLOBAL MARITIME FORUM

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RACE TO ZERO

2030
BREAKTHROUGHS

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This report is a joint effort between the UCL Energy Institute, Getting to Zero Coalition, and UN Climate Change High Level Champions.

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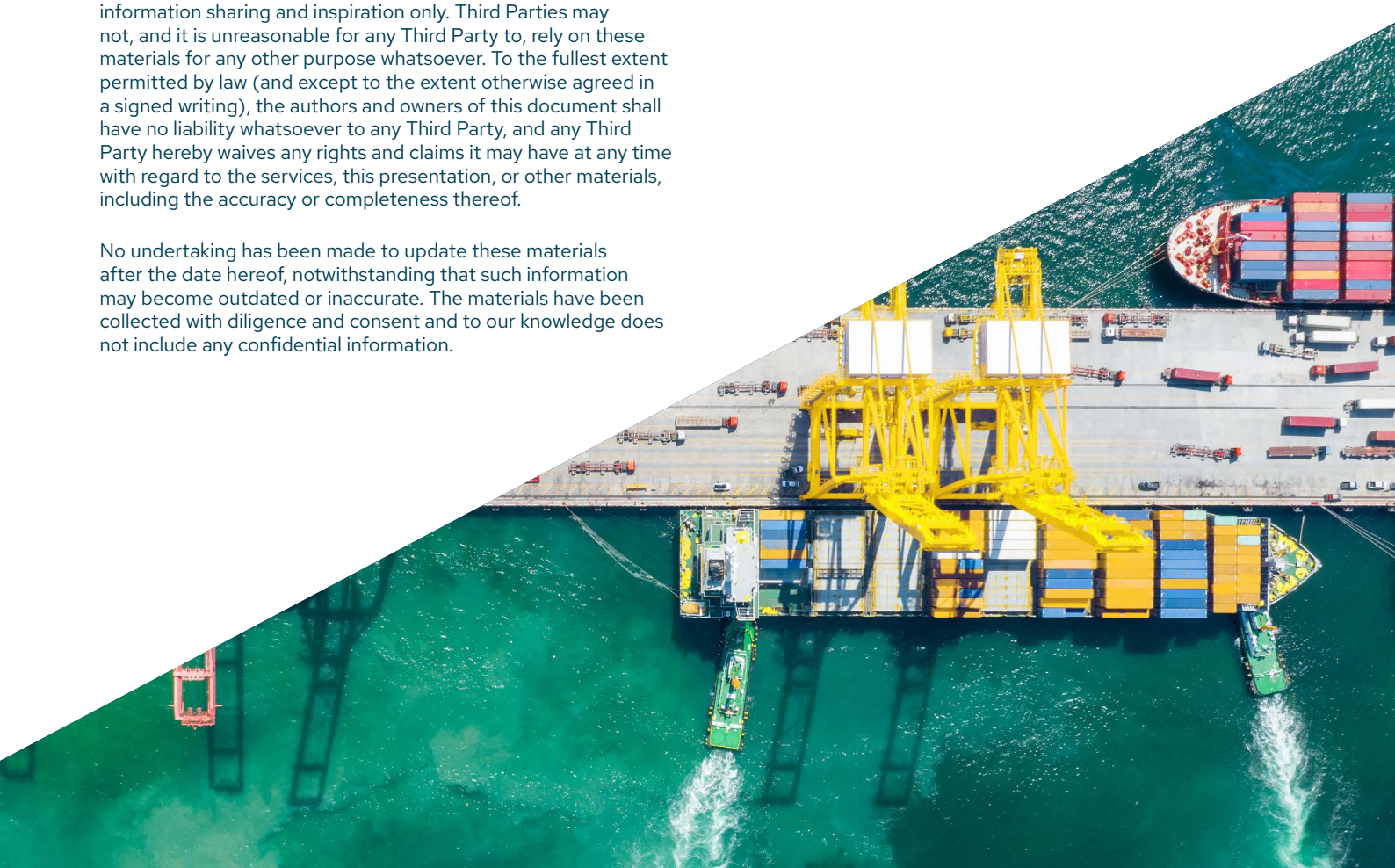

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The UCL Energy Institute hosts a world-leading research group focused on the decarbonisation of the shipping sector. The research group's multi-disciplinary work leverages advanced data analytics, cutting-edge modelling, and rigorous research methods, providing crucial insights for decision-makers in both policy and industry. The group focuses on three core areas: analysing big data to understand the drivers of shipping emissions, developing models and frameworks to explore the path toward zero-emission shipping, and conducting social science research to examine the policy and commercial structures that enable the decarbonisation of the shipping sector.

Learn more at:
www.ucl.ac.uk/bartlett/energy/research/shipping

RACE TO ZERO
2030 BREAKTHROUGHS

Race to Zero is a global campaign rallying non-state actors – including companies, cities, regions, financial, educational, and healthcare institutions – to take rigorous and immediate action to halve global emissions by 2030 and deliver a healthier, fairer zero-carbon world. Race to Zero is led by the UN Climate Change High-Level Champions for COP28 and COP29 – H.E. Razan Al Mubarak and H.E Nigar Arpadari – to drive real world momentum and action.

Learn more at:
https://climatechampions.unfccc.int/

GETTING TO ZERO COALITION
GLOBAL MARITIME FORUM

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The Getting to Zero (GtZ) Coalition is a community of ambitious stakeholders from across the maritime, energy, infrastructure, and financial sectors, supported by key IGOs, knowledge partners, and other stakeholders committed to the decarbonization of international shipping, and endorsed by several governments.

The ambition of the Getting to Zero Coalition is to have commercially viable zero-emission vessels operating along deep-sea trade routes by 2030, supported by the necessary infrastructure for scalable net zero-carbon energy sources including their production, distribution, storage, and bunkering. The Coalition is managed by the Global Maritime Forum, who initially founded the Coalition together with the World Economic Forum and Friends of Ocean Action.

Learn more at:
www.globalmaritimeforum.org/getting-to-zero-coalition

Foreword

The shipping industry is responsible for about 80% of international trade, employs around two million seafarers, and is often heralded as providing one of the most efficient modes of transport.

The sector, however, is heavily reliant on highly polluting heavy fuel oil, accounts for about 3% of annual global greenhouse gas (GHG) emissions and if shipping were a country, its carbon footprint would be the sixth largest in the world.

The 2030 Breakthroughs goal for shipping is clear: the sector must achieve at least 5% zero-emission fuel in international shipping whilst aiming for 10%. Delivering this requires concerted action, at pace and scale.

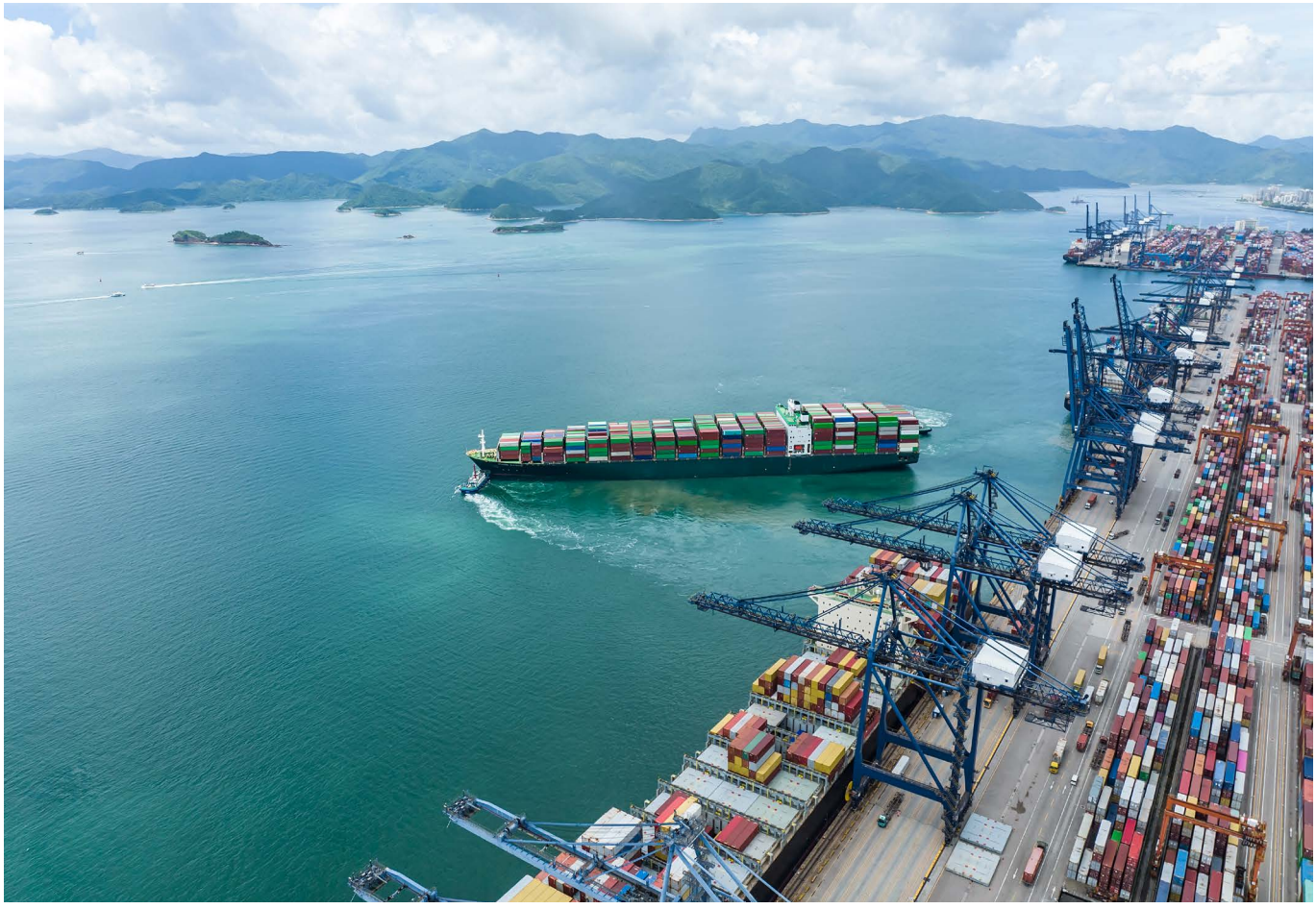
At COP28, over 30 business leaders from across the shipping sector committed to scaling up zero-emission fuels derived from renewable-based hydrogen, sending a clear signal.

As High-Level Champions, with our partners at the University College London and the Getting to Zero Coalition, we are delighted to build on this and share with you this report, the third in an annual series that assesses progress towards the maritime 2030 breakthrough goal and sets out a roadmap for action.

We are encouraged to see the progress made, but know we need to do much more and faster. While there have been some positive developments in the supply side and in policy, it is clear that the demand for zero-emission shipping is still lacking and finance is still being directed to conventional fossil-fueled shipping.

This report is a timely reminder of how the next 12 months are critical to build on the signals of change for all actors across the maritime ecosystem, and we hope that the findings provide both inspiration and challenge to act now to ensure a just transition in which workers and communities from all countries benefit and no one is left behind.

H.E. Razan Al Mubarak
UN Climate Change
High-Level Champion, COP28



All actors are lagging in achieving the 5-10% goal – rapid scale-up of demand for scalable zero-emission fuels must happen

The maritime shipping industry is a fundamental part of the global economy. The industry is responsible for about 80% of international trade, employs around two million seafarers, and generates 3% of global greenhouse gas (GHG) emissions. However, **reaching a future aligned with limiting anthropogenic climate change to (or below) 1.5°C will not be possible without maritime shipping playing its part**. To accomplish this, shipping will need to move away from highly polluting fossil-based fuels to those produced using renewable energy. Since its first iteration in 2022, this annual report has been tracking progress towards the uptake of such fuels.

This report follows research from 2021 which showed that, by 2030, at least 5% of the annual total energy used by shipping needs to come from scalable zero-emission fuels (SZEF)[1] to ensure that such fuels break into the industry and scale to levels necessary to meet global climate goals[i]. In 2023, shipping's global governing body, the International Maritime Organization (IMO), adopted a revised GHG strategy with a similar – if not stronger – target for 2030. This strategy requires the industry to have at least 5%, but striving for 10%, zero and near-zero GHG emission fuels in use by 2030[2]. Five percent of energy through SZEF is estimated to be equivalent to 0.6 exa-joules (EJ), with overall energy demand for shipping in 2030 projected to be just over 12 EJ in 2030.

This report sets several key conditions for SZEF. These include the need for the fuels to be:

- Scalable, such that the 200-300 million tonnes (Mt) of oil equivalent of current annual consumption can be matched in the foreseeable future;
- Producible with GHG intensity reductions of 90-100% relative to incumbent fossil-based fuels on a full life cycle (well-to-wake) basis;
- Competitive in cost of production in the foreseeable future, assuming continued research and development and the adoption of viable policy support mechanisms.

This therefore excludes biofuels, less-polluting fossil fuels (including liquified natural gas (LNG)), blue fuels (i.e. those derived from fossil fuel sources, such as hydrogen produced from natural gas), or applications of carbon capture. Options that are not at a high technology readiness level and have significant barriers to adoption are also excluded.

Key developments in the last 12 months

This report reviews five system change levers and ascertains whether actions across these levers are aligned – or are aligning – with what would be necessary to meet the 5-10% SZEF goal for 2030. At a high level, these levers cover changes in technology, supply, finance, policy, demand, and civil society.

Over the past year, progress was seen in two of the five levers – policy and supply – which offers some cause for optimism:

- **Regulatory progress**: Following the adoption of the 2023 IMO GHG Strategy at the 80th convening of the Marine Environment Protection Committee (MEPC 80), work at the IMO has continued with negotiations for the adoption of mandatory mid-term regulatory measures for decarbonisation. It is hoped that by MEPC 82 in April 2025, a new set of regulatory measures will be adopted that should provide further signals to the industry for SZEF. The IMO developments can support SZEF adoption in the short to medium term and in the longer term. In the shorter term, the outcome of negotiations

1 Fuels which have net zero well-to-wake GHG emissions and have the potential to be produced at a competitive price compared to fossil fuels over a long period of time, whilst also having the potential to be produced at the volumes necessary to meet a significant amount of global maritime demand (I.e., in EJ of energy by the 2030s) (Smith et al., 2021).

2 For the purpose of this report "zero and near-zero GHG emission fuels" should be used to as equivalent to the definition of SZEF given in this report. In the main body of the report the 5% '2030 Breakthrough' target is referred as the '5%-10% goal' for the sake of brevity.

in relation to GHG pricing is likely to be one of the stronger SZEF signals, whereas in the long term, developments around an ambitious global fuel standard (GFS) could be more relevant. In both cases, uncertainties remain, with less certainty in achieving a strong enough GHG pricing mechanism to support SZEF adoption. In addition, as these measures are not expected to come into force before 2027, it remains to be seen how strong their impact will be by 2030. On a national level, hydrogen strategies have continued to be announced, but policy mechanisms could be strengthened to further support projects moving from announcements to development by strengthening subsidies and domestic demand for hydrogen-derived fuels.

- **Supply progress**: Green ammonia and e-methanol[3] production projects have continued to be announced. Under this report's medium growth scenario, the supply of both fuels is projected to be 50% higher in 2030 than it was just a year ago. This new projection of fuel supply would, in theory, be sufficient to meet the 5-10% SZEF goal by 2030. Many uncertainties remain, however, since this scenario assumes further development of both ammonia and methanol supply, continued announcements of new projects and development of announced projects, all of which are dependent on an ongoing business case, financial commitments, investment decisions, and viable demand signals.

- **Progress in pilots and demonstration projects**: The launch of the first dual-fuelled ammonia vessel, Fortescue's 'The Green Pioneer', was a notable event, as is the demonstration of methanol or ammonia bunkering facilities at some of the biggest shipping hubs like Antwerp, Rotterdam, and Singapore. Development of such resources could facilitate green corridor formation and provide a faster scale-up of demand on some key international shipping routes. The year also saw the conclusion of the Zero Emission Maritime Buyers Alliance (ZEMBA) first tender, with members signing bilateral contracts for the purchase of the environmental attributes associated with zero-emission freight services.

Changes on other levers have been less positive:

- **Demand for SZEF remains not on track**, due to orders and deliveries of conventional-fuel only vessels continuing at a rate that still significantly outpaces both the growth in SZEF-capable and SZEF-ready orders and deliveries as well as the rate of retirements (or conversions to SZEF capability) of conventional-fuel only vessels. Given the long lead times of demand scale-up, such as from ordering SZEF-capable tonnage to delivery, or even the ordering of SZEF-ready tonnage that will then require extra time for conversions to full SZEF use capability, this is an area of concern if these trends do not change in the coming few years. With the more positive signals seen on the supply side, the availability of more dual-fuel SZEF engine options in 2024 (for example for dual-fuel ammonia), the likelihood of further regulatory certainty, and with finance needing and looking for better options to move funding into, a faster rate of growth in SZEF tonnage could be expected soon. Indeed, the trend in the last two or so years suggests the growth in SZEF-capable tonnage orders is more exponential than linear.

- **Progress in finance is no longer on track with the 2030 goals**. There has been a slowdown in funding of SZEF-related activities and a slower-than-anticipated growth in the allocation of funding for SZEF-capable and SZEF-ready vessels. Additionally, more funding has been going towards conventional fossil-fuelled tonnage and there is a significant misalignment of existing shipping debt with the trajectories needed to meet the revised 2023 IMO GHG targets. Debt and financing will now need to accelerate at a faster rate into SZEF-enabling activities over a shorter period out to 2030.

Overall progress towards the 5-10% SZEF 2030 goal therefore remains only partially on track.

Current status of technology and supply

In terms of technology and supply of SZEF, progress remains partially on track. Technological developments have continued to progress, with cross-industry collaboration observed between an increasing number of companies and spread across a greater number of countries. There have been notable advances in the maturity of SZEF internal combustion, battery electric, and hydrogen fuel-cell propulsion systems, including the launch of the first dual-fuelled ammonia vessel and the availability of methanol and ammonia bunkering facilities at Antwerp, Rotterdam, and Singapore.

However, whether technological progress is scaling at a rate consistent with the 2030 breakthrough targets is less clear. Whilst at least 74 countries are now involved in the strategic planning of the green hydrogen sector, there is growing concern regarding the feasibility for governments to meet their stated green hydrogen ambitions. The International Energy Agency (IEA)'s hydrogen projects database is 50% larger than one year ago (38 Mt compared to 24 Mt), as is the projected 2030 supply of green ammonia and e-methanol under a

3 e-methanol refers to methanol produced from renewable sources.

'medium' growth scenario. **Similarly, green ammonia and e-methanol project announcements are also offering positive signals**, with current 'medium' supply scenarios based on announced project growth rates implying a 52% increase in e-methanol and a 62% increase in green ammonia availability by 2030 compared to the estimates given in 2023. The analysis results in an estimated 'medium' SZEF supply of 0.78 EJ by 2030. **However, substantial numbers of announced green hydrogen and SZEF production projects are struggling to pass a final investment decision**, and it remains unlikely that SZEF will be cost competitive with incumbent fossil-derived fuels by 2030 without significant policy intervention. **To put this in perspective, the 'low' 2030 scenario in this report, which takes a more conservative assessment of which projects are likely to be operational by 2030, results in a significantly lower supply of 0.26 EJ and is not sufficient to meet the 5-10% goal**.

Current status of demand

Progress needed or expected by 2024 to create sufficient demand for SZEF to meet 2025 or 2030 targets is still not on track. The share of SZEF-capable gross tonnage (GT) in the fleet remains very small. With more deliveries of SZEF-ready tonnage in 2023 compared to previous years, the combined SZEF-capable and SZEF-ready GT is now up to 0.44% of all total GT (up from 0.32% at the end of 2022). The significant change in the fuel make-up of the fleet that is needed has also, in part, been tempered by growth in deliveries of conventionally fuelled tonnage and the lack of retirement (or conversions) of existing conventionally fuelled vessels.

Taking the average growth rates over the last 5 years, including the orderbook, about 0.02-0.04 EJ of SZEF demand of the 0.1 EJ minimum needed in 2025 is anticipated (about 20-40 15,000 twenty-foot equivalent unit (TEU) containerships all running on methanol for a year). **Similarly, of the 0.6 EJ minimum needed in 2030, projections suggest that only 0.1-0.2 EJ worth of SZEF may be demanded. These are likely to improve over the coming years, with more fuel options becoming viable or accessible in 2024, and a more exponential growth rate seen in the last 2 years for SZEF-capable tonnage orders**. With a more non-linear trend in orders, increases in the share of the order book that is SZEF-capable each year could reach 50% by 2030. Using the median lead time from order to delivery of 2 years, an annual average for the size of the order book, and assuming no SZEF-ready (or non-SZEF ready) vessels are converted, **this approach suggests that about 0.43 to 0.52 EJ of SZEF demand could materialise by 2030 (of the 0.6 EJ needed)**.

As a share of the orderbook, SZEF-capable tonnage has gone from 3% at the end of 2022 to 6% at the end of 2023 (and stands at 9% for 2024 if the year is extrapolated using data up to August 2024). SZEF-ready tonnage as a share of the orderbook stands at 15.3% at the end of August 2024.

Current status of finance

Financial indicators for SZEF are not on track. Whilst transparency and willingness to disclose portfolios and alignment to emissions trajectories have grown, **those portfolios do not appear to be changing as rapidly as may be needed, especially if existing debt is measured against the IMO's 2023 GHG Strategy targets**. There have, however, been improvements on the alignment of shipping debt relative to the older targets from the 2018 IMO Strategy – aligned with a 50% reduction in tank-to-wake CO_2 emissions by 2050 – from being on average 6% off target to now being only 2% off target.

Assessed relative to the stricter trajectories in the IMO's new "minimum" and "striving" goals (in full well-to-wake CO_2 terms), shipping debt remains off track by 23% to the "minimum" and 28% off the "striving" goal. Whilst this increases pressure on finance to adapt towards SZEF, the current misalignment is not necessarily unexpected—especially given that more SZEF-aligned options to direct funds are only starting to materialise. As more and more such funding opportunities arise, alignment will likely correct.

Issuance of green bonds and loans that could potentially be attributed to shipping or shipping-related industries fell from $6 billion in 2021 to $4 bn in 2022 and $2.4 bn in 2023. Although it is generally unclear whether these bonds or loans are going towards SZEF-related activities, a downtick could be indicative of a reduced appetite for issuing such loans, a lack of opportunities for putting those loans into use, as well as hesitance due to policy uncertainties. Increases in public finance would then be a way to counter a reduction in private funding, but there has been only limited movement in new public financial commitments (up by 11% for funding direct maritime decarbonisation projects compared to 2023).

Current status of policy

Policy developments to facilitate SZEF uptake remain partially on track. The global policy landscape has continued on a positive trajectory already set **with the adoption of the 2023 IMO GHG Strategy**. Since the adoption of the 5-10% level of ambition for "zero or near-zero GHG emission technologies, fuels and/or energy sources," **work on mid-term measures at the IMO has continued at pace**. The

imminent development of a regulatory framework and indicative checkpoints puts n**ew pressure on the industry to continue working to scale up SZEF demand**. On a national level, progress has continued but more is needed in terms of developing concrete support mechanisms for **SZEF bunkering and vessel developments**. As the negotiations at the IMO continue during 2024 and 2025, it is important that the definitions used for the IMO's 2030 5-10% ambition for "zero and near-zero GHG emission fuels" be in line with the definition of SZEF given in this report.

Current status of civil society

Civil society progress remains partially on track. Blueprints, actions, and negotiations have taken place across multiple segments of the maritime industry to improve the visibility of issues such as the maritime sector's gender imbalance, lack of adequate seafarer training, and lack of multiple voices in the fuel transition discussion. These developments provide much room for optimism, as outlined in several projects by the Maritime Just Transition Task Force (MJTTF). It will be important to see how these initial positive steps translate into concrete actions leading to change. In other areas, such as the growth of non-state actor voices from small island developing states (SIDS) and least-developed countries (LDCs) in the maritime decarbonisation discussion, further progress is necessary.

Supply of scalable zero-emission fuels has continued to increase, and policy is in line, but industry support in terms of keeping demand alive is paramount

As the remaining time to reach the 2030 target declines, this new edition finds 13 items 'not on track', compared to eight in the previous years' assessment, and otherwise similar but critical actions remain partially on track. This leaves **an increasing amount of work to do in a decreasing amount of time**. The consequences of failure will be an increased probability of a disruptive and costly transition damaging the industry and by association trade.

One reason that the reducing time to correct being 'on track' causes serious concern is that lead times are long for many of the actions still needed (i.e. the timescales to finance and build ships and energy supply chain projects, the timescales for national policy to be entered into force). **Very little correction to the 2030 trajectory will be possible once we are in the late 2020s**. The next 12 months are critical for progressing the levers, reducing the risks of the shipping sector falling irreparably behind.

All actors are lagging. It's critical that a big-picture view of the transition is maintained and used to guide actions from here, as all parts of the value chain need to step up and see their interconnected opportunities and risks. This report is hopefully a wake-up call. **A strong IMO strategy is necessary but not sufficient alone. All the other actions are still needed and require constant attention and improvement if they are to be fulfilled.**

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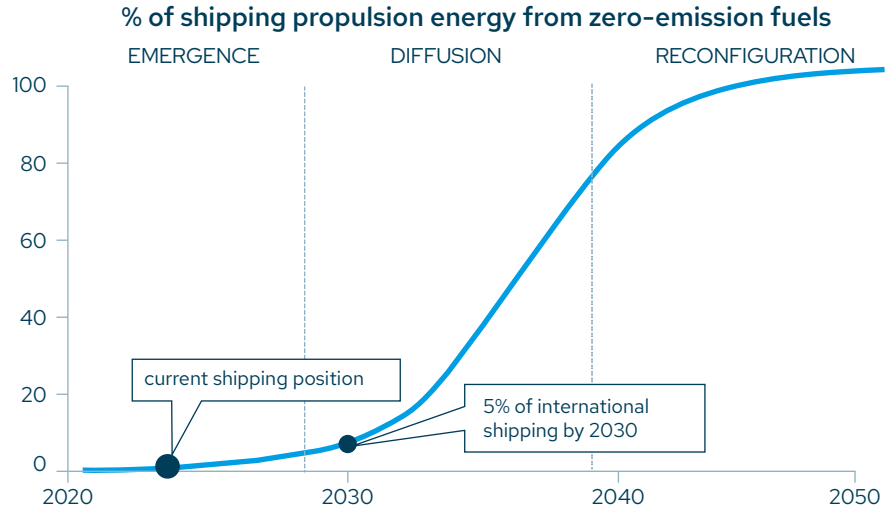
Introduction

Understating how shipping can decarbonise and what role scalable zero-emission fuels (SZEF) should play in this process is paramount to creating a future in which our main supply chains are decarbonised and the worst effects of anthropogenic climate change can be avoided.

Global trade is fundamentally dependent on shipping, employing over two million seafarers[ii] and accounting for over 80% of global trade.[iii] For shipping to decarbonise, adoption of SZEF is one of the key actions necessary.[iv] Developments such as improved energy and operational efficiency, support from novel technologies, and wind assistance are all incredibly important, but at one point, the burning of fossil-derived fuels in shipping must be replaced with scalable, sustainable fuels that have zero greenhouse gas (GHG) emissions over their entire life cycle. Such fuels can propel the industry into a new sustainable future and ensure that global trade can continue for decades to come.

This report builds on the work published in 2022 and 2023[v] which tracked shipping's progress towards SZEF adoption. The report is based on the understanding that a maritime fuel transition can be divided into three distinct phases, in which shipping is currently in the first. These three phases are 'emergence', 'diffusion', and 'reconfiguration'. In the 'emergence' phase, initial research and adoption of a novel fuel begins, which then rapidly increases in the 'diffusion' phase to become the new dominant fuel in the 'reconfiguration' phase, with the shape of this transition usually described as an 'S-Curve' (Figure 1). Alignment with International Maritime Organization (IMO) goals necessitates that at least 5%–10% of SZEF is used by the maritime industry by 2030, which equates to 0.6 EJ–1.2 EJ of energy demand. Depending on the green hydrogen-derived SZEF used, this equates to around 29.8 million tonnes (Mt) of ammonia or 28.1 Mt of methanol.[4]

Figure 1. S-Curve relation to decarbonisation of maritime shipping[5]



Note: Based on a smoothed sigmoid curve forced to 100% at the end given the staring point.
Source: High Level Champions, 2020.

4 Based on internal UCL calculations. Fuels such as methanol would have to be sustainably sourced and produced as e-fuel options in a similar way to other synthetic fuels.

5 S-curve includes adjustments from Smith et al. (2021).

Current efforts to decarbonise shipping, from a regulatory, research and development (R&D), and fuel perspective are contributing to reaching the 5-10% goal by 2030, but more is needed in order for that ambition to be realised. This is the third iteration of this report to monitor and track progress toward the adoption of SZEF by 2030.

Shipping is still in the 'emergence' phase of a fuel transition. Following the ambitious signal from the IMO during MEPC80, multiple actions are necessary to ensure that at least 5% of shipping is from SZEF by 2030.

This report continues to track progress towards the 5-10% 2030 SZEF goal in order to understand what further actions are necessary to make that goal a reality and to go beyond it. The justifications of outcomes for each action in terms of progress tracking are provided in Annex A. The report reviews five system change levers and ascertains whether the actions currently undertaken are in alignment with the 5-10% goal. This process also includes an assessment of current targets, including the addition of specific intermediate 2025 enabling goals. The five change levers include:

i. **Technology and supply** – Key actions relating to the development of necessary on-board and shore-based infrastructure and technology for SZEF-fuelled ships, such as electrolysers, fuel cells, internal combustion engine modifications, bunkering infrastructure, and production facilities.

ii. **Demand** – Necessary developments in terms of demand for SZEF so that – alongside a supportive policy environment – a viable market for SZEF fuels can be developed over time in a gradual manner, avoiding supply issues and facilitating a possibility for rapid production scale-up.

iii. **Finance** – Financial mechanisms necessary for the creation of a viable SZEF market, such as transparent ship finance, climate bonds, blended financing products, subsidies and other associated financial mechanisms.

iv. **Policy** – Necessary policy developments both at the national and international levels to facilitate the adoption of SZEF, such as economic and technical measures, guidelines, and agreements.

v. **Civil society** – Individual, workforce, and community engagement and action including the provision of future decent work, increasing participation of underrepresented groups in shipping climate change discussions such as small island developing states (SIDS) and least-developed countries (LDCs), indigenous communities, and a range of other diverse communities.

The actions are evaluated as:

a. **On track** – The actions and targets of the actions are progressing in line with requirements. All the actors involved are progressing with their respective developments in line with reaching the 5% goal.

b. **Partially on track** – The criteria related to these actions are progressing in a promising direction and are close to being met. However, there is either insufficient evidence to adequately ascertain target progress, significant progress that still falls short of the set target, or significant informal discussions/developments point to future progress, but no official announcements have yet been made.

c. **Not on track** – The action and associated targets are not progressing in line with requirements necessary to reach the 5% goal.

Overview of progress towards 2030's 5-10% scalable zero-emission fuel goal

As was the case in 2023, overall, the actions to reach the 5-10% SZEF goal by 2030 remain partially on track, as highlighted in Table 1. Since last year, the ambition has been modified to more closely align with the 2023 IMO GHG Strategy. Rather than being a 5% goal, it is now a 5-10% goal. To date, the current fleet capable of using SZEF puts potential demand for SZEF at about 0.008 EJ or (1.3% of the goal of 0.6 EJ by 2030), equating to roughly 300,000 tonnes of methanol (or, equivalently 320,000 tonnes of ammonia).

Since last year, there has been some progress along all change levers. However, the pace of the observed progress is not in line with what should be expected. Progress within technology and supply is more on track than it is in demand, which was also the case last year. This is counter to the common perception that the issue is a lack of fuel supply. However, the supply and demand picture are obscured by the broad optionality that exists, with bio-variants that are less scalable but perceived by some as a competitive option – at least in the near term. The demand data is dominated by fuel options that have bio-variants, and it is therefore particularly unclear the extent to which even the low existing ordering of dual-fuelled (DF) or DF-ready vessels is driven by SZEF alignment, and therefore a signal of the sector's longer-term transition to hydrogen-derived fuels.

Although only one of many change levers tracked in this report, a major breakthrough in policy was the adoption of the 2023 IMO GHG Strategy, signalling that the sector can expect a strong driver of its energy transition to come from the IMO. That this outcome is coupled with slow or absent progress in other indicators is a key finding of this study that could be explained in several ways:

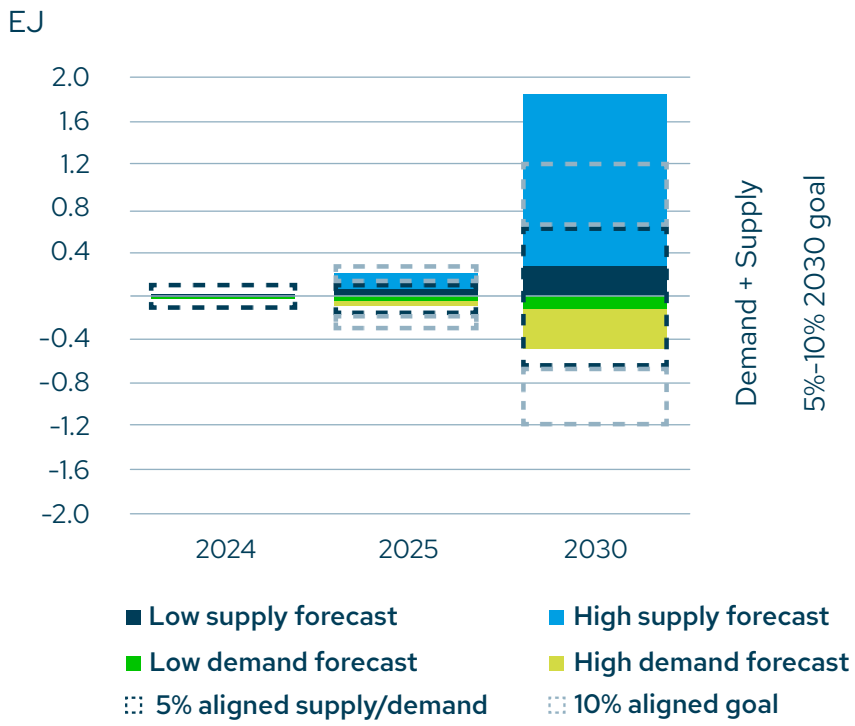
- The broader value chain and stakeholder community does not believe the IMO will convert its stated commitments into policy and therefore the actual rate of technology change will be significantly less than these targets.
- With the 2023 IMO GHG Strategy adopted in July, there was simply not sufficient time in the remainder of the year for the policy signals to translate into actions.
- The promise of strong regulation is not in itself sufficient to unlock the key actions, investments, and/or changes, which will require specific detail in regulation/legislation.
- The promise of strong regulation removes the pressure on others to act. Civil society and national and regional governments/regulators might have felt some relief that their actions were less important given the prospect of a strong IMO GHG action, just when there remains time for the IMO's actions to enter into force and a clear need for efforts to bridge the gaps created by the IMO.

There is another important but under-analysed consideration behind this report's evidence and findings: sentiment and actions regarding wider energy transition. Shipping's energy transition is inextricably coupled with the transition of other sectors. Given the sector's history as a user of residual fuel, the presumption might be that it is a laggard in wider energy transition. The progressiveness of the IMO's new targets relative to many of the land-side commitments, especially in lower-income countries, questions that presumption. **Shipping could now be a sector that leads and adopts changes before they are widespread in other sectors**. Last year may have seen both a realisation of that leadership and some questioning of whether that was a natural position for shipping to be in.

Shipping could now be a sector which leads and adopts changes before they are widespread in other sectors.

Figure 1, in line with the S-Curve projections of SZEF, shows that progress on the supply of SZEF has been more aligned than that of demand, as was the case in 2023. As expected from the adoption rate, the 2024 numbers of supply and demand for SZEF are modest, at 0.00693 EJ existing capacity for e-methanol, and 0.00143 for green ammonia, and potential demand of about 0.006 EJ (i.e. barely visible as a line in 2023 in Figure 1).

Figure 2. Estimated total SZEF supply and demand for shipping compared to 5-10% 2030 SZEF goal aligned supply/demand up to 2030 (i.e., 0.6 EJ in 2030)[6]



6 The figure is based on a simplified combination of the supply and demand figures (i.e., Figure 4 and 5) which are explained in the respective "Technology and supply" and "Demand" sections, with further explanation available in Appendix B.

Overview of progress towards 2030's 5-10% scalable zero-emission fuel goal

Table 1. Summary of progression and key goals by 2030

CHANGE LEVER	PROGRESS	SCALE OF PROGRESS ON ACTIONS	GOALS BY 2030
TECHNOLOGY & SUPPLY		• 3/7 actions 'on track' • 4/7 actions 'partially on track'	• 60 GW green hydrogen electrolyser capacity • Green hydrogen production cost $1.5- $2/kg depending on region • 0.6 EJ of SZEF supply available by 2030 and 0.1 EJ by 2025 (indicative)
DEMAND		• 0/8 actions 'on track' • 2/8 actions 'partially on track' • 6/8 actions 'not on track'	• 600 15k TEU containerships equivalent of SZEF demand[7] • 8.75-12.5% of all TEU-miles to be SZEF by 2030,[8] if other segments also scale out proportionally to SZEF • All new ships to be SZEF-capable • Majority of existing SZEF-ready tonnage to be converted to full SZEF-capability
FINANCE		• 2/5 actions 'partially on track' • 3/5 actions 'not on track'	• Alignment of shipping portfolios for as much of the US$ 500 bn+ of shipping debt to be as close to Poseidon Principles trajectories as possible—with those trajectories expected to match requirements for 1.5oC—but no higher than 10% and the majority to be under 5% • 2/3 or more of all shipping debt to be tied to Poseidon Principles trajectories, increasing coverage from Asia Pacific and Greek lenders, and continued transparency from all Western lenders • Continued or increased issuances and interest for sustainability-linked loans and bonds to shipowners and related segments like ports and fuel suppliers. • Stricter requirements for eligibility for sustainability-linked loans and bonds and focus to shift primarily to SZEF-related assets
POLICY		• 5/10 actions 'on track' • 2/10 actions 'partially on track' • 3/10 actions 'not on track'	• Adoption of ambitious shipping economic instrument with regulatory support for 5%-10% SZEF adoption • Top 20 countries by maritime traffic have ambitious domestic decarbonization policies with increased hydrogen production commitments. • International agreements on zero GHG shipping routes
CIVIL SOCIETY		• 0/5 actions 'on track' • 4/5 actions 'partially on track' • 1/5 actions 'not on track	• Growing SIDS/LDC participation in IMO policy negotiations and or national action plans • Increased NGO pressure • Workforce upskilling/retraining programmes in place

KEY:

On track: Progression in line with requirement across all actors
Partially on track: Close to be met but insufficient evidence
Not on track: Not progressing in line with requirements

7 This would be 18-36 Mt per year of e-methanol, for instance. If all other segments scale up fuel demand representatively, then 150 15k TEU ships-equivalent or the container fleet.

8 For context, total TEU-miles was estimated to have been over 2 tera-TEU miles in 2018, based on numbers from the 4th IMO GHG Study (Faber et al, 2020).

For the 5%-10% goal to be achieved, actions and developments across the five levers of change will need to include:

Technology and supply

- Careful consideration of transition timing and close work with shipyards to ensure that shipbuilding and ship retrofitting capacity is available when needed to produce a smooth and manageable transition.

- Ensure that announced SZEF projects continue being developed through the signing of dedicated offtake agreements and linkage, where possible, to national policy support mechanisms.

Demand

- Continued scaling-up of the shipping transition across all sectors to ensure that demand is pooled from across the industry. This should be done in tandem with increased commitments from both shipowners and freight purchasers for SZEF and associated zero-emission freight through initiatives such as the Zero Emission Maritime Buyers Alliance (ZEMBA).

- As mentioned in the 2023 report, SZEF-capable vessels need to create at least about 0.5-1 Mt a year of, for example, e-methanol demand by 2025 to put shipping on the S-Curve towards 2030. This is equivalent to about 100 15,000 TEU containerships all running on e-methanol all year.

Finance

- A similar ambition to last year remains in terms of stricter conditions on the issuance of debt to shipping, shifting the order book to SZEF-capable vessels, and requiring both SZEF-ready and other vessels to go into full conversions for SZEF use.

Finance

- Stricter conditions on the issuance of debt to shipping, shifting the orderbook into SZEF-capable vessels only, and requiring both SZEF-ready and other vessels to go into full conversions for SZEF use.

Policy

- The pace of development of IMO mid-term measures in line with the timeline set out during MEPC 80 must continue to be maintained in order to give the industry the security it needs to make investment decisions. On a national level, further commitments for the development of bunkering infrastructure and support for SZEF-ready vessels are required.

Civil society

- Increased commitment to actionable training programmes to ensure a just and equitable transition with crews ready to safely operate SZEF ships by 2030. This section tracks progress against individual actions within each system change lever and presents the key findings, which are briefly discussed and accompanied by a more detailed breakdown of each action and its respective timeline in a table. A more detailed explanation for each action is available in Annex A.

System change levers

Actions necessary to reach 5%-10% SZEF adoption by 2030 can be grouped in 5 distinct change levers, which includes Technology and supply, Demand, Finance, Policy, and Civil society.

This section tracks progress against each action within the system change levers. Key findings are briefly discussed, accompanied by a more detailed breakdown of each action and its respective timeline. A more detailed explanation for each action is available in Annex A.

Technology and supply

Overview

The technology and supply actions in this edition continue to focus on both the development of technology R&D and supplying volumes of SZEF consistent with the 5% breakthrough target. The indicators used in the lever remain the same from the 2023 report. However, they include a greater focus on shipyard capacity and the feasibility of manufacturing sufficient SZEF-compatible engines by 2030. Overall, the lever remains partially on track.

1. Pilot and demonstration projects

- The fifth edition of the Global Maritime Forum (GMF)'s Mapping of Zero-Emission Pilots and Demonstration Projects[vi] excludes technologies noted to have developed into a commercial phase. As such, 137 of the 373 projects included in the fourth edition were excluded from further analysis. Two-thirds of these were focused on battery-powered propulsion (30%), methanol internal combustion/dual-fuel engines (20%), and short-sea hydrogen fuel cells.

- Under the updated methodology, the Fifth Edition includes 340 registered pilot or demonstration projects, up from 236 in the previous edition, and demonstrates significant progress with respect to the development of bunkering infrastructure able to couple the maritime value chain to the hydrogen economy. However, much less progress has been observed in pilot and demonstration projects related to upstream fuel production, where delays are common and many projects struggle to reach maturity.

2. Cross-industry collaboration on SZEF ship projects

- Of the 340 projects featured in the fifth edition of the Mapping of Zero-Emission Pilots and Demonstration Projects, 97% involve two or more value-chain segments, an increase from 87% recorded the previous year.

- Projects are associated with more than 900 unique companies, together representing 56 countries. Companies from eight new countries are included, with 20 countries having increased the number of projects they're involved with, and 13 countries associated with a single company involved in over five projects.

3. Key SZEF technological developments

- Long-sea internal-combustion engine (ICE)-based propulsion methods using methanol and ammonia continue to make progress. Examples include the successful launch of the first dual-fuelled ammonia vessel, Fortescue's 'The Green Pioneer', availability of full-scale methanol bunkering at the ports of Antwerp, Rotterdam and Singapore, and early-stage testing of ammonia bunkering in Singapore.

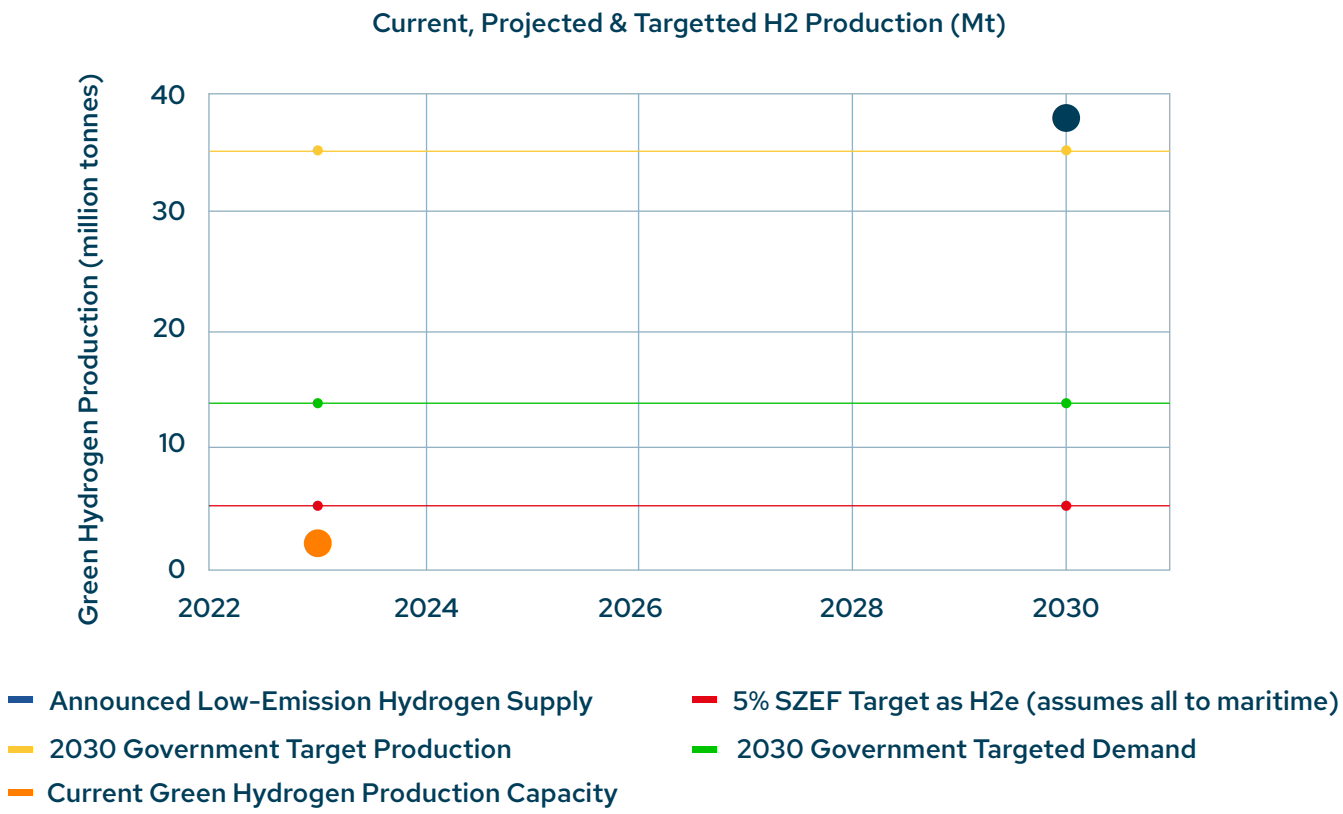
- In the previous edition of this report, an analysis of technology readiness levels was conducted for short-sea and long-sea technologies. Other than the transition of proton exchange membrane electrolysis from a 7 to an 8 on the International Energy Agency's Technology Readiness Level (IEA's TRL), the average IEA TRL score for fuel cell technologies remains identical this year at 5.8.

- Concerns remain surrounding the newbuild and retrofit capacities of shipyards and engine manufacturers to facilitate 2030 breakthrough targets. Work by Lloyd's Register[vii] demonstrates that worldwide shipyard capacity is likely too low to facilitate decarbonisation targets set out for the 2030s and 2040s. However, Danish Ship Finance reports[viii] simultaneously suggest that shipyard capacity is currently substantially underutilised. A conclusive assessment of the constrictive impact that yard capacities may have on reaching the 5% breakthrough target may therefore only be possible once the required demands are in place.

4. Government-energy industry collaboration to scale SZEF production

- As of May 2024, at least 74 countries were involved in strategic planning of the clean hydrogen sector, including the release of 46 national strategies and 8 roadmaps, plus 20 more in the drafting process[ix]. The IEA's Global Hydrogen Review 2023 indicates that government targets for low-emission hydrogen production now amount to 27-35 Mt, up from 15-22 Mt in the 2022 Review.[x]
- These findings indicate positive traction in terms of government-led green hydrogen ambitions. However, there are significant concerns surrounding the likelihood of governments delivering upon their green hydrogen targets. In addition, only a small fraction of the Mapping of Zero-emission Pilots and Demonstration Projects database is publicly funded.
- The government ambitions laid out above ensure the indicator remains on track, but continued monitoring of the extent to which governments are delivering on their commitments will be crucial for the next edition of this tracker.

Figure 3. Estimated hydrogen production compared to requirements under the 5% 2030 goal[9]



9 Data based on 850 GW - using ~215 Mt from the IEA SDS 2030 scenario, 550 GW - IEA Net Zero Emissions by 2050 Scenario, 60 GW - UCL estimates where 5% of 12.9 EJ is 0.64 EJ (Osterkamp et al., 2021).

5. Decrease in green hydrogen production cost

- The production cost of green hydrogen will be an important catalyst for supply scale-up. The previous edition of this report analysed historic learning rates of solar photovoltaic (PV) and onshore and offshore wind technologies between 2010 and 2020.[xi] The analysis indicated that green hydrogen production costs of below $2/kg could be possible by 2030, should these technologies' historic learning rates continue.

- However, despite the continued acceleration of solar PV and wind power generation, green hydrogen production cost declines have stalled since the last edition of this report. [xii] It's becoming clear that learning rate effects alone cannot expedite the rapid reductions in green hydrogen production costs necessary for the 5% breakthrough target, with factors such as continued supply-chain volatility, geopolitical events, and other inflationary pressures limiting progress.

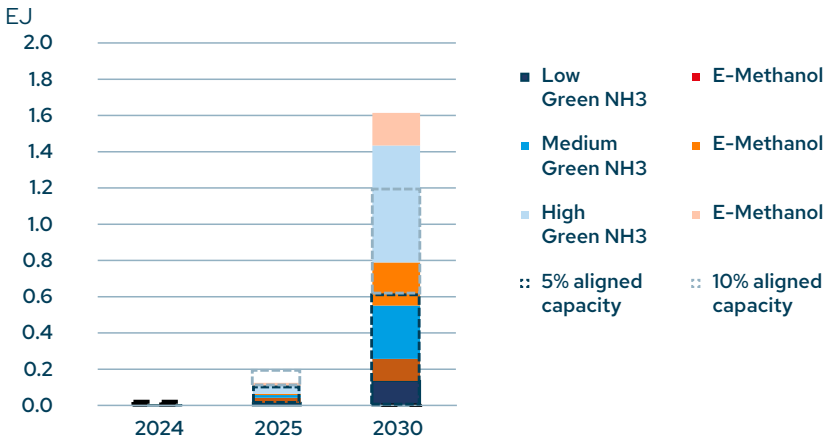
- Whilst the pipeline of green hydrogen projects continues to grow, achieving wide-scale green hydrogen production costs of $2/kg by 2030 looks increasingly unlikely, and the role of policy support mechanisms such as the US Inflation Reduction Act will continue to be necessary to bridge the cost gap between SZEF and incumbent fossil fuels.

6. Increase in electrolyser and green hydrogen production capacity

- In its annual Global Hydrogen Review 2023[xiii] , the IEA indicates that the number of announced low-emission hydrogen projects is expanding rapidly and would amount to 38 Mt by 2030 should all projects be realised. Up from 24 Mt the previous year, this figure is more than 50% greater than that published previously and indicates that substantial acceleration is occurring in early-phase plans for green hydrogen supply projects. However, 38 Mt represents less than 20% of the projected low-carbon hydrogen use across the IEA's '2030 Sustainable Development Scenario' or 'Net-Zero by 2050 Scenario[xiv xv].

- In addition, only a small fraction of this total supply capacity has passed a final investment decision (FID). Whilst new announcements to 2030 can be expected, uncertainty remains regarding their scale and the proportion that progress to a construction phase.

Figure 4. Estimated total supply from SZEF for maritime usage compared to 0.6-1.2 EJ 2030 requirement in line with the 5%-10% SZEF 2030 goal[10]



10 The percentages are based on understanding existing capacity of methanol and ammonia which needs to be replaced by green sources, as well as taking into consideration available, albeit limited information on plans for utilization of currently announced projects, based on news reports, and data from the AEA and the Methanol Institute. More information available in Appendix B.

7. Scale-up of SZEF production

- When looking at the databases of green ammonia and e-methanol projects, there has been significant growth in announced projects since 2023. When the revised numbers are used as input to the future supply estimation tool developed in the previous edition of this report, they correspond to a 52% increase in e-methanol and a 62% increase in green ammonia availability under the 'medium' scenario by 2030.
- As presented in Figure 4, the revised figures under the 'medium' scenario are sufficient to reach the 5% goal by 2030; however, the 10% goal is only within reach under the 'high' scenario.
- In addition, a substantial proportion of projects remain at a pre-FID stage with only a small fraction currently under construction. In the near term, there is particular concern about the level of SZEF supply that will be in place by 2025.

Tracking progress – partially on track

Table 2. Technology and supply lever progress

KEY ACTIONS	REQUIRED TIMING			PROGRESS	TARGET BY		
	24	25	30		2024	2025	2030
Pilot and demonstration projects				ON TRACK		10 projects on track	
Cross-industry collaboration on SZEF ship projects				ON TRACK		20 collaborations	
Key SZEF technological developments				PARTIALLY ON TRACK		Ammonia engines commercially available	
Government-energy industry collaboration				ON TRACK	20 collaborations	50 collaborations	
Decrease in green hydrogen production costs				PARTIALLY ON TRACK		Green hydrogen production cost $2/kg	Green hydrogen production cost reaching $1.5/kg in some regions.
Increase in electrolyser and green hydrogen production capacity				PARTIALLY ON TRACK			60 GW green hydrogen electrolyser capacity for shipping offtake.
Scale-up of SZEF production				PARTIALLY ON TRACK		0.1 EJ (indicative target)	0.6 EJ equates to: 29.8 Mt of ammonia or 28.1 Mt of methanol

Demand

Overview

Demand for SZEF from stakeholders across the value chain plays an important role in moving shipping towards the 5-10% goal, especially in setting the pace and ambition of the transition and in stimulating the supply of SZEF. It is estimated that by 2025 there needs to be demand for (and use of) about 0.1 EJ worth of SZEF from shipping, with this increasing quickly to approximately 0.6 EJ by 2030.[xvi] These targets would be the equivalent of about 100 15,000 TEU containerships all running on a SZEF for a year in 2025, scaling up to about 600 similar ships in 2030 if no other shipping sectors take up SZEF[11].

More industry players move to make SZEF such as ammonia a reality. An example comes from the first use of ammonia in a dual-fuelled vessel in the Port of Singapore .

Eight key indicators are now used to help track progress on SZEF demand. These include the number of key industry actors committing to net-zero targets, actions being taken to make zero-emission freight more commonplace, implementations of SZEF pilots and demonstrations, and the development of green corridors. They also cover the growth in the world fleet capable of using SZEF, the fleet ready for conversion to using such fuels, and the evolution of the orderbook for these SZEF-capable and SZEF-ready vessels. Only a few of these, however, appear to be either partially or fully on track.

1. Industry actors commit to net zero by 2050 based on SBTi requirements and actions

- Commitments, for example, to targets and actions as defined in the Science Based Targets initiative (SBTi) grew in 2023. Nine shipowners and operators (up from five) and five ports or shipyards (up from 2) have now made these commitments.
- However, some, if not many, of these companies are small and have limited impact on the global shipping fleet.

2. Zero-carbon freight becomes increasingly commonplace

- The availability of zero-carbon freight remains limited. Cases where it is available remain rare and accessible to only a few cargo owners. ZEMBA's completion of an inaugural tender and Maersk's deliveries of some SZEF-capable vessels are good examples of first movers, but a faster scale-up of such efforts is needed over the coming years to meet the 0.1 EJ target.

3. Owners, freight purchasers, fuel producers, ports, finance, and other stakeholders take part in pilots and demonstrations to unlock SZEF potential

- Whilst pilots and demonstrations are ongoing, their rate of growth has slowed. This is to be expected after an initial period of saturation. It may be more useful to monitor how open these pilots become in sharing their findings as well as how (and if) they get financed, scaled, and implemented.

11 Further explanation of how numbers were derived can be found in Appendix B.

4. "Dark green" corridors for zero-emission shipping start to materialise

- There has been significant progress in advancing existing green corridor projects, and a focus on "dark green" corridors[12] is quite widespread. A couple of corridors are waiting for gaps in policy to be closed to allow their implementation. New developments have also been observed, including announcements of promising new corridors such as the one between Japan and Singapore.[xvii] Whilst these are considered positive changes, most, if not all, planned or announced corridors remain to be implemented and potentially need to be adjusted and deployed at smaller scales than initially planned.

5. Growth in the share of SZEF-capable vessels in the active fleet

- SZEF-capable vessels are vessels that can utilise SZEF without any further modifications, whilst SZEF-ready vessels are those that would require some level of modification or retrofitting to enable SZEF use.

- Whilst the total gross tonnage (GT) of active vessels[13] has grown compared to 2022 by 8%, the share of SZEF-capable GT has stayed constant (at 0.3%).

- To meet at least 5% SZEF uptake by 2030, about 0.1 EJ of SZEF demand is needed in 2025 and 0.6 EJ by 2030. Based on the number of SZEF-capable and SZEF-ready vessels projected to be in the fleet and their expected fuel use, the previous report's projections suggested a minimum of about 0.03 and 0.09 EJ would be demanded in 2025 and 2030, respectively. These have been increased slightly for 2030 to 0.1 EJ. (The latter increase is in part because of the availability and growth in orders for ammonia dual-fuel vessels). If a quadratic curve is fitted to simulate a more non-linear trend in orders, increases in the share of the order book that is SZEF-capable each year could reach 50% by 2030. Using the median lead time from order to delivery of 2 years, an annual average for the size of the order book, and assuming no SZEF-ready (or non-SZEF ready) vessels are converted, this approach suggests that about 0.43 to 0.52 EJ of SZEF demand could materialise by 2030 (of the 0.6 EJ needed).Whilst this is much closer to the required target, no assumptions are made on whether this is realistic, if yard capacity exists, or how pricing and values could influence fleet growth.

- These projections are, however, based on taking an average growth rate over the previous five years, where a large part of the change has occurred in the last year or so and the more recent trend looks more non-linear. Using this trend, a much higher level of SZEF demand can be expected in 2030.

- The moderate adjustment made in this report to the 2025 and 2030 projections is partly due to the lack of a significant change in the removal of conventionally-fuelled tonnage in the fleet.[14]

12 "Dark green" corridors are those which have at least 95% lower lifecycle GHG emissions compared to LSFO, have high scalability, and are based on hydrogen derived fuels and renewable electricity.
13 Vessels counted are those above 5000 GT and cover dry bulk carriers, chemical tankers, containerships, crude tankers, cruise ships, ferries, general cargo vessels, LNG carriers, LPG carriers, pure car carriers, product tankers, and Ro-Ro vessels. This includes both international and domestic carriers.
14 Conventionally fuelled means vessels that have neither the capability nor readiness to utilise any

6. Growth in the SZEF-ready vessels in the active fleet

- Tonnage noted as being "ready" for SZEF has grown from 0.1% to 0.3% of the total fleet since the previous report, but this part of the fleet remains in its infancy.
- Clarity and consensus on what these notations mean and how ready they are for a conversion remain uncertain, and, hence, "ready" tonnage is not considered a sure sign of potential demand.
- There is, however, greater diversity in the type or combinations of fuel readiness that have been provided for delivered vessels, including ammonia-LNG, ammonia-methanol, LNG-methanol, and methanol—compared to the presence of just LNG, ammonia, and hydrogen-ready vessels seen in the previous year. The greater diversity could be indicative of looming uncertainty, but it could also just be an indicator that these notations are unreliable until the vessels are delivered.

7. Share of order book with SZEF-capable vessels

- The order book in 2023 is about 30% larger in GT terms than the vessels ordered in 2022. Bulkers and products/chemical tankers dominated the order book in 2023, followed by pure car carriers and crude tankers.
- The order book has started to reveal a few preferences between the segments on fuel options (see Figure 6). Over 90% of all bulkers and product and chemical tankers opted for conventional fuel only, but container ship orders were evenly split between conventional and methanol dual fuel. Over 70% of crude tankers went for conventional fuel only, with the remainder largely opting for LNG and LNG dual-fuel engines. And, although fewer than ten appear to have been ordered, cruise ships appear to be the first to lean away from conventional fuels altogether and show an appetite for both hydrogen and LNG dual-fuel engines.
- Given the significant share of the order book opting for dual-fuel capability, the market signal may be considered weaker for SZEF as companies are preserving the option of using non-SZEF should fuel and carbon prices make it favourable to do so.

8. Share of order book with SZEF-ready tonnage

- Ammonia-ready and methanol-ready orders dominated the order book for vessels opting for some level of readiness, making up 10.2% of the total order book in GT terms.
- There also appears to be a level of hedging, with ammonia-methanol, ammonia-LNG, and LNG-methanol-ready vessels being ordered.
- The "ready" tonnage in total, including the order book, has grown from about 0.5% of total GT in the previous report to 0.9%.

Table 3: Share of the order book for SZEF-capable and SZEF ready

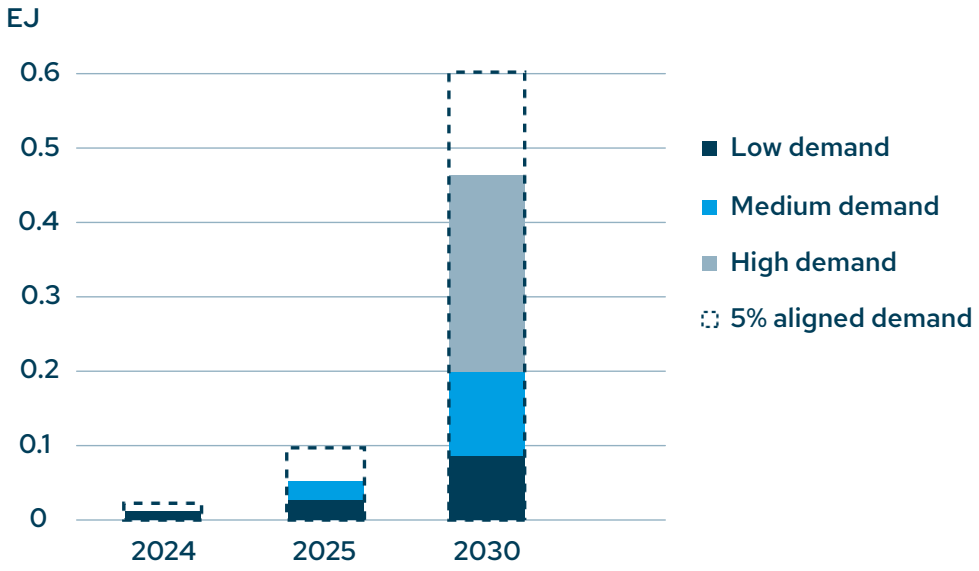
	Share of orderbook		
	SZEF capable	**SZEF ready**	**Total**
2022	3%	15.9%	19.3%
2023	6%	14.1%	20.2%
2024*	9%	15.3%	23.7%

*Extrapolated to end 2024 using data up to August 2024

Table 4: Projected fleet and fuel composition[15]

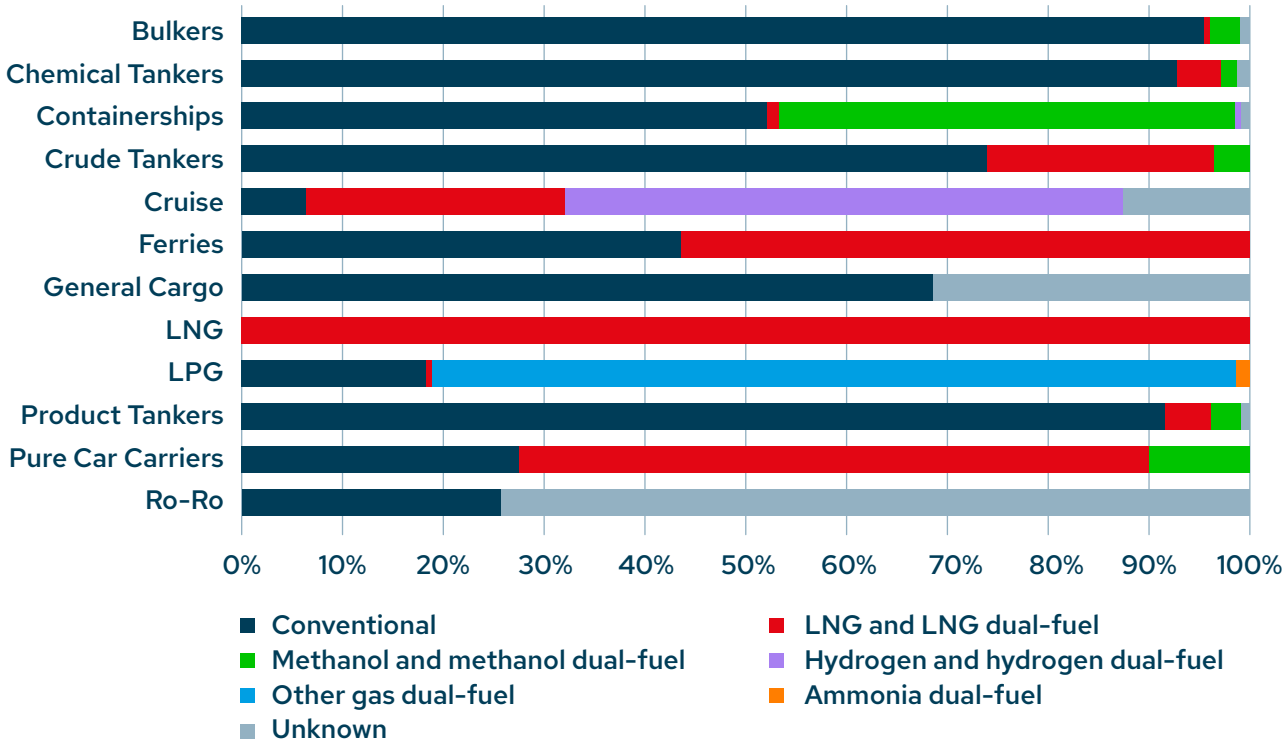
	2025	2030
	% of GT	% of GT
Hydrogen and hydrogen dual-fuel	0.01%	0.04%
LNG and LNG dual-fuel	5.71%	11.11%
Methanol and methanol dual-fuel	0.21%	0.79%
Nuclear and nuclear dual-fuel	0.00%	0.00%
Other	0.24%	0.27%
Other gas dual-fuel	0.69%	1.48%
Ammonia	0.001%	0.005%
Projected total	6.87%	13.69%
EJ demand estimate low (excluding LNG and other gas dual-fuel)	0.02	0.1
EJ demand estimate high (excluding LNG and other gas dual-fuel)	0.03	0.2

Figure 5: Estimated total potential SZEF demand based on fleet growth, and targets for 2025 and 2030 (based on targets from Smith et al., 2021)



15 Projections are made by taking into account the historical growth rate of each type of fuelled fleet in GT terms, including the trend in the order book, and projecting linearly towards 2025 and 2030. Source: Clarksons World Fleet Register

Figure 6: Preferences for fuel optionality in the order book by segment



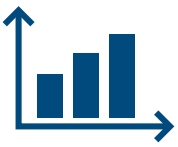
Tracking progress – not on track

Table 5. Demand lever progress

KEY ACTIONS	REQUIRED TIMING			PROGRESS	TARGET BY		
	24	25	30		2024	2025	2030
Industry actors commit to net zero by 2050 based on SBTi requirements and actions				PARTIALLY ON TRACK	5-10 shipowners and operators committed. 1-5 ports or yards committed.	20-30 shipowners or operators, as well as 10-20 ports or yards, committed to both near and 2050 targets and have actions set per SBTi requirements.	30+ ship owners join "Race to Zero" 30+ have SBTi commitment, at least half of whom are already taking stated actions
Zero-emissions freight becomes increasingly commonplace				NOT ON TRACK	Commitments from freight purchasers to secure zero-emissions tonnage for at least 1% of all TEU miles.	5-10% of TEU miles to be SZEF if transition led by container ships. If other segments also scale, then about 1.5-3% of TEU miles need to be SZEF.	8.75–12.5% of all TEU-miles to be SZEF, if other segments also take up SZEF
Owners, freight purchasers, fuel producers, ports, finance, and other stakeholders take part in pilots and demonstrations to unlock SZEF potential				PARTIALLY ON TRACK	Over 150 projects on fuel production, and similar number on bunkering and infrastructure.	200+ fuel production and bunkering and infrastructure projects ongoing, at least 20 going beyond pilot stage into development.	Slowdown in piloting and significant increase in capital deployment to build out fuel production and bunkering systems
Dark green corridors for zero-emission shipping start to materialise				NOT ON TRACK		3-6 "dark green" corridors on major deep-sea routes with multiple vessels on each using SZEFs on a regular basis. 3-4 routes have a roadmap in place, 2-3 further routes are being considered for development.	30+ deep sea "dark green" corridors in operation, contributing substantially to the 0.6 EJ SZEF fuel target
Growth in the share of SZEF-capable vessels in the active fleet				NOT ON TRACK		100 15,000 TEU container ships running on e-methanol[16], or 20-30 15,000 TEU ships if other segments in line[17]	600 15,000 TEU equivalent ships running e-methanol or ammonia, or about 150 ships if other segments take up SZEF at a similar pace 18-36 Mt a year of SZEF to be demanded by the alternative fuel capable fleet

16 Equivalent to 0.1 EJ worth of energy in potential SZEF.
17 Potential demand for methanol, as an example, would be equivalent to 3-6 million Mt a year.

Growth in the SZEF-ready vessels in the active fleet				NOT ON TRACK		SZEF-ready ships in the fleet to become SZEF capable at their first dry dock on or before 2025	All SZEF-ready vessels ordered before 2030 to have been converted to SZEF capability
Share of orderbook with SZEF-capable vessels				NOT ON TRACK		All new orders to be SZEF capable or SZEF only	All new orders to be SZEF capable or SZEF only
Share of orderbook with SZEF-ready vessels				NOT ON TRACK		All new orders to be SZEF-capable or SZEF only	All new orders to be SZEF-capable or SZEF only



Finance

Overview

Finance is a critical change lever in facilitating the transition to SZEF, both by encouraging and facilitating uptake of SZEF but also by discouraging the uptake of fuels, vessels, and related infrastructure that are not supportive of SZEF.

Four indicators measure the changes that finance is having on the transition towards SZEF. These cover a range of topics from the alignment of existing shipping debt towards 2030 and 2050 targets (for example via the Poseidon Principles and the Net Zero Banking Alliance), the change in the level of transparency on such debt and its alignment, issuances and changes in the appetite for lenders to provide sustainability-linked loans, bonds, and other instruments, and the availability and growth in public finance.

1.Increase the share of shipping debt aligned to trajectories needed to meet 2030/50 targets

- In the 2023 report, the alignment of portfolios relative to the IMO's 2018 Strategy, weighted by each reporting entity's portfolio size, was 6% – i.e. of the $159 billion out of the $200 billion covered by Poseidon Principles, the weighted average score was 6% above the required trajectory for a 50% reduction in (tank-to-wake) CO_2 emissions by 2050.
- In this edition, the weighted alignment score to this same trajectory has significantly improved to 2%, whilst also representing a greater amount of debt ($175 billion vs. $159 billion). Of the $175 billion that can be tracked, 65% of those assets are less than 5% above the required 2018 IMO trajectory.
- When measured against the trajectories of the IMO's 2023 Strategy's "minimum" and "striving" targets, the weighted alignment score is 23% and 28% above the required targets, respectively.
- The adoption of new IMO targets and the significantly larger discrepancy that results mean that it is no longer appropriate to suggest that this lever is on track. These changes indicate the need to move towards far less carbon-intensive (well-to-wake) tonnage.

2. Increase in willingness to report financing attached to shipping and its alignment to climate targets

- Measured until the end of 2022, 34 Poseidon Principle signatories represented a total shipping portfolio value of about $240 billion of the $525 billion[18] estimated to be in existence (including all forms of lending, leasing, export finance, and alternative providers). This has grown by 20% compared to the previous assessment that looked at portfolios to the end of 2021 (30 signatories and $200 billion).
- Of these 34 signatories, four did not report their shipping debt. For the remaining 30, it is possible to either explicitly identify or estimate the size of the signatory's shipping debt for 21 entities (about 70%), compared to last year when this was only possible for 19 out of 28 reporting entities (68%).
- These 21 banks represent an estimated $175 billion of debt, equivalent to about 33% of the $525 billion total estimated size of shipping debt at the end of 2022. At the end of 2021, a total of $159 billion of the $500 billion estimated as total shipping debt for that year was allocable to individual banks.
- A consistent if not slightly higher rate of willingness to report is especially more laudable this year as Poseidon Principles adopted more stringent trajectories aligned with the IMO's new strategy. It will be key to maintain appetite to report and find ways to more rapidly transition debt towards the new targets and trajectories.

3. Increase or maintain sufficient issuances of sustainability-linked loans and bonds to shipowners and operators

- In calendar year 2023, approximately $2.4 billion was issued through sustainability-linked loans or green bonds to shipping-related entities, of which $1.9 billion went to ship owners and operators[19] and about $500 million was issued to shipyards.
- $15 billion was issued to energy producers and equipment manufacturers. In total, therefore, $17.5 billion has been tracked.
- Most issuances were in Europe and the US. Only about $1.5 billion went to Asian entities, but it is likely that the source providing this information[xviii] may not cover other loans and issuances made in countries known to be investing heavily in SZEF (e.g. China).
- None of these issuances guarantees or implies an application to the development of SZEF, vessels that could use such fuels, or the infrastructure required for their distribution and uptake.
- GSS+ (green, social, and sustainability) bonds, as per the Climate Bonds Initiative[xix], totalled $871.6 billion in 2023, up slightly from 2022. Hence, compared to 2021 and 2022, the amount allocated to shipping has dropped ($2.4bn in 2023, compared to $4bn in 2022 and $6bn in 2021).
- The cumulative total recorded is up from $10.1 billion at the end of 2022 to $12.5 billion at the end of 2023.

18 Based on research from Petrofin (2023).
19 Based on information supplied to and on the Clarksons Shipping Intelligence Network (SIN).

- The slowdown in funding and issuances suggests that the lever is not on track for 2025 but this slowdown may be due to several factors including but not limited to the lack of applicable assets or solutions to fund and the lack of clarity in regulation.

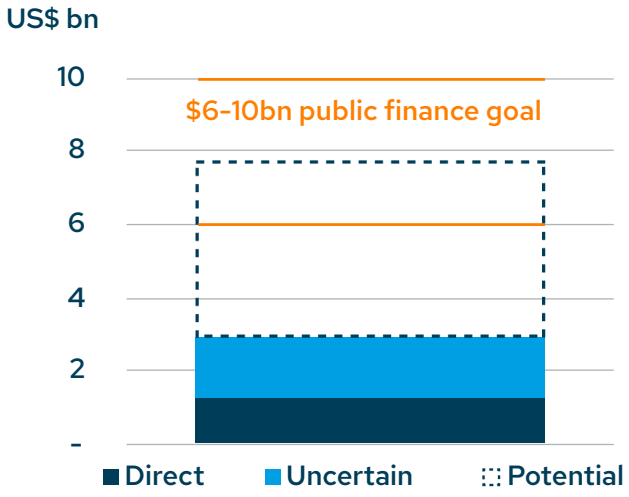
4. Mobilise industry funding for SZEF bunkering and production investment

- Issuances recorded to energy suppliers and equipment producers cannot be attributed to ports or SZEF-related activities, and therefore it is unclear whether this lever is on track. Whilst encouraging with $15 billion seen issued last year, more clarity and better sources are needed to attribute the extent to which this is going towards SZEF bunkering and production.

5. Increase public finance (i.e. grants and loans) for SZEF-related activities

- There has been an 11% increase in the amount of public finance directly available for maritime decarbonisation since last year. The main bulk of this increase comes from additional commitments in the Dutch Maritime Masterplan[xx] and from the German federal Maritime Research Programme.[xxi] Beyond direct decarbonisation funding, there has also been an increase in wider funding that can be used for various projects, including maritime decarbonisation, such as US funding by the Department of Transportation through the Port Infrastructure Development Program (PIDP).

Figure 7. Estimate of public finance commitments that could be used for shipping decarbonisation



Tracking progress – not on track

Table 6 Finance lever progress

KEY ACTIONS	REQUIRED TIMING			PROGRESS	TARGET BY		
	24	25	30		2024	2025	2030
Increase the share of shipping debt aligned to trajectories needed to meet 2030/50 targets				NOT ON TRACK		Alignment of known portfolios to be below 10% for as much of observed shipping debt as possible. A greater percent of this to be below 5% than in 2022 (more than 14%).	Given stricter targets for 2030 Poseidon Principles trajectory, same requirement as in 2025 to stay below 10% and a larger share to be below 5%.
Increase in willingness to report financing attached to shipping and its alignment to climate targets				PARTIALLY ON TRACK		Greater transparency of debt from APAC and Greek lenders through inclusion in Poseidon Principles. Continued or improved transparency from Western lenders. 50% of total ship financing to be covered under Poseidon Principles targets.	2/3 of total shipping debt to be transparent about alignment to Poseidon Principles targets.
Increase or maintain sufficient issuances of sustainability-linked loans and bonds to shipowners and operators				NOT ON TRACK		Maintain or increase the share of total sustainability-linked debt issued to shipping. Total cumulative amount to reach at least $20 bn (twice the 2022 level). Conditions for eligibility and use of sustainability-linked loans to strengthen towards SZEF	Cumulative amount of sustainability linked loans and bonds to $50 bn. Conditions for eligibility and use of sustainability-linked loans to become focused on SZEF-related assets.
Mobilise industry funding for SZEF bunkering and production investment				NOT ON TRACK		$1bn/year by 2025	$25bn/year by 2030
Increase public finance (I.e. grants, loans) for SZEF related activities				PARTIALLY ON TRACK		$2-4 bn in total by 2025	$6-10 bn in total by 2030

Policy

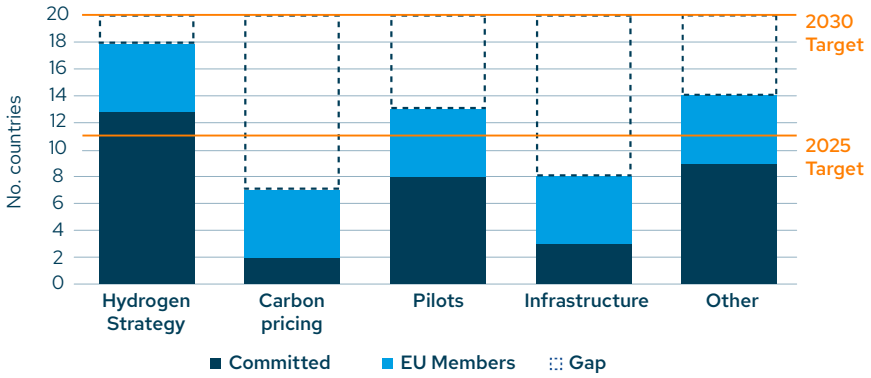
Overview

Policy actions are related to multiple industry, national/international commitments, and regulatory developments that facilitate the decarbonisation of domestic (i.e. coastal and short-sea shipping) and international shipping. When thinking of SZEF adoption, it is important to consider not only global developments but also national and regional actions, as the combined actions on multiple levels can lead to positive reinforcement and create multiple pathways towards decarbonisation.[xxii] Policy actions remain partially on track, as they were in the 2023 report. However, there have been some changes, primarily increased progress in international fora, spearheaded by IMO developments, whilst on a national level progress has been somewhat slower.

Progress on guidelines and certification, mainly driven by certification societies, has continued since last year, and the work on developing SZEF-ready frameworks and guidelines is still considered to be on track, particularly when it comes to bunkering and safety standards. Development of draft interim guidelines for the safety of ships using hydrogen and ammonia has continued at the IMO, while regulatory developments on a national level are moving at a somewhat slower pace. There have been additional announcements on ammonia safety in Japan (NYK, 2024). At the IMO, progress was made at the Sub-Committee on Carriage of Cargoes and Containers in September 2023 (CCC 9) for the development of draft interim guidelines for the safety of ships using hydrogen and ammonia as fuel with a scheduled intersessional working group convened on the issue in September 2024, ahead of CCC 10 and due to be adopted at Maritime Safety Committee (MSC) in December 2024.

There have been some new hydrogen strategy or roadmap publications, including outside of Europe, and initiatives at the port/industry level have also gathered strength. However, there has been limited movement on new targeted regulatory development of maritime decarbonisation outside of those that were under development in 2023. As was the case in 2023, progress is still regionally skewed with the Global South being significantly underrepresented.

Figure 8 Regulatory developments in top 20[20] countries[21]



20 The 'Top 20' countries metric has been revised to include the top 20 countries by TEU traffic, using figures from 2021 and 2022 where available and 2019 figures where not, based on the information from UNCTAD (World Bank, 2023) to better reflect countries which can have a profound impact on adoption of SZEF as early movers.

21 Internal UCL analysis based on multiple sources including government announcements, news reports, hydrogen strategies and policy documents. Other in this sense means different policies which directly or indirectly can stimulate adoption of SZEF, but are not easily categorised, these can be subsidies for which maritime projects can apply for, favourable port dues and tax arrangements for 'clean' ships, government grants, etc. Infrastructure refers to any funding for SZEF bunkering infrastructure in ports and related SZEF bunkering barges.

Further national action is needed to secure that supply and demand conditions are met.

Some positive movement in terms of hydrogen strategies provides some promise of more green hydrogen and derived fuels being available for all sectors, including shipping. However, it remains to be seen how these commiments will translate into real world projects and long term increase in hydrogen supply. Some additional momentum also came from, other regulations, such as the inclusion of shipping into the EU Emissions Trading System (EU ETS),[xxiii] . However, more specific policies targeting 1.5°C-aligned pathways are still lacking in many national jurisdictions and in many places hydrogen strategies are still disconnected from what is being developed in terms of green hydrogen supply. On an international level it will be important that any measures developed at the IMO lead to concrete policy signals on the ground.

1. Classification societies adopt robust zero-emission ready guidelines

- Progress has continued since last year and the work on development of SZEF-ready frameworks and guidelines is still considered to be on track.
- Since last year, additional announcements have been made, such as Bureau Veritas's rules for hydrogen-fuelled ships,[xxiv] the updated American Bureau of Shipping (ABS)'s advisory on hybrid electric power systems,[xxv] a new chapter on ammonia added to classification society DNV's 'Alternative Fuels for Containerships' guidance,[xxvi] and Lloyd's Register's new edition of 'LR Rules and Regulations for the Classification of Ships using Gases or other Low-flashpoint Fuels'. [xxvii]

2. Classification societies research and set operational, bunkering and safety standards for SZEF

- Continued progress since last year with more announcements. Observed discussions show continued engagement by classification societies at the global and national levels in policy fora in regard to creation of relevant bunkering safety standards. Multiple class societies have been involved in such developments both at the IMO and beyond, such as the Lloyd's Register involvement on ammonia studies and various risk assessments[xxviii] and the 2024 published 'Technical and Operational Advisory' on ammonia bunkering by ABS.[xxix]

3. Governments publish 1.5°C aligned decarbonisation plans for domestic shipping

- As was the case in the 2023 report, governments committing to 1.5°C aligned decarbonisation plans are still not on track based on a review of existing national policy documentation and existing information on implementation progress.

4.Governments set production targets for zero-carbon fuels (intermodal usage)

- In terms of national commitments to green hydrogen production, there has been some positive movement. Government targets for low-emission hydrogen production have grown from 15-22 Mt to 27-35 Mt in one year.[xxx]
- This equates to up to 3.5 EJ of possible SZEF demand being met by 2030. However, as was the case in 2023, it is expected that most of this supply will be necessary to meet non-maritime demand, and even though optimism remains that the 5%-10% goal is within reach, continued updating of hydrogen strategies and respective production goals should be kept under review.
- Consequently, the current hydrogen strategy figures, particularly those of the top 20 countries,[22] offer optimism for the 5%-10% SZEF goal to be reached.
- There have been some new hydrogen strategy or roadmap publications, with hydrogen strategy development observed outside of Europe in Vietnam[xxxi] and Malaysia.[xxxii]

5. Government policies targeting SZEF adoption in maritime

- With regard to regulatory developments on a national level, progress has continued but at a somewhat slower pace. In other areas, initiatives at the port/industry level have also gathered traction such as the development of the 'Alliance for Decarbonisation Initiative' in Brazil[xxxiii] and the 'Strategy for Decarbonisation of Ports' in Mexico.[xxxiv] However, there has been limited movement on targeted regulatory development of maritime decarbonisation outside of those already under development in 2023. In this sense, progress is still regionally skewed with the Global South significantly underrepresented.

6. Submission to IMO of national action plans to address GHG emissions from international shipping

- There has been no significant movement regarding national action plan submissions to the IMO.
- However, there seems to be some discussion within several Global South nations regarding these developments which might offer optimism for future national action plans.

7. IMO to agree on mid- and long-term measures for shipping aligned with 5% SZEF by 2030 and full decarbonisation by 2050

- Following the adoption of the 2023 IMO GHG Strategy, the momentum towards global maritime decarbonisation has continued. The IMO's work on an economic instrument and technical measures for shipping has continued at the latest meeting of the Intersessional Working Group on Reduction of GHG Emissions from Ships (ISWG-GHG 16) and MEPC 81. The IMO's 5%-10%

22 The 'Top 20' countries metric has been revised to include the top 20 countries by TEU traffic, using figures from 2021 and 2022 where available and 2019 figures were not, based on the information from UNCTAD (World Bank, 2023) to better reflect countries which can have a profound impact on the adoption of SZEF as early movers.

goal for "zero or near-zero GHG emission technologies" by 2030 means that progress can be considered to be moving in the right direction. However, there is continuing uncertainty on what effect any adopted measures will have on the adoption of SZEF in the short to medium term.

- There is hope that by MEPC 83 in Spring 2025, the needed mid-term measures will be adopted. Even though uncertainty remains on how these measures will look, there is clarity that a rapid technological change will be necessary and that GHG intensity limits for a GHG Fuel Standard will be in line with reduction targets and indicative checkpoints.

- The next 12 months will be crucial for the IMO to provide the right signals to the industry to move forward in a rapid scale-up of demand for SZEF. At this stage, the policy discussions can be said to be moving at pace.

8. IMO requires new ships to be zero-emission ready, e.g., GHG reduction plan with zero emission (i.e. SZEF) propulsion capability

- There has been very limited progress at the IMO regarding these developments, based on analysis of IMO materials.

9. IMO adopts guidelines to estimate well-to-tank GHG emissions and regulation/incentives for SZEF

- With regard to the Life Cycle Assessment (LCA) guidelines at the IMO, the process seems to be developing at pace, but the required GESAMP (Group of Experts on the Scientific Aspects of Marine Environmental Protection) review does add some additional uncertainty. With this in mind, progress is currently partially on track but could soon be fully on track. It should be noted that multiple streams of work have already been undertaken within and outside of the IMO on the development of LCA guidelines showing that expertise in this area already exists.[23]

10. IMO agrees on a comprehensive decarbonisation strategy and zero-by-2050 target

- The 2023 IMO GHG Strategy aims "to peak GHG emissions from international shipping as soon as possible and to reach net-zero GHG emissions by or around, i.e. close to, 2050". Whilst this statement has several caveats, and it still remains to see what measures will be used to enforce it, this progress is significant and it can be argued that these developments are on track.

23 For example work by ZEMBA on its LCA Guidelines.

Tracking progress – partially on track

Table 7 Policy lever progress

KEY ACTIONS	REQUIRED TIMING			PROGRESS	TARGET BY		
	24	25	30		2024	2025	2030
Classification societies adopt robust zero-emission ready guidelines				ON TRACK	In place – for key SZEF.		
Classification societies research and set operational, bunkering and safety standards for SZEF				ON TRACK		In place – at least 5 large class. soc.	
Governments publish 1.5°C aligned decarbonisation plans for domestic shipping				NOT ON TRACK		In place for 10 out of top 20 countries (by TEU traffic).	In place for all 20 top countries.
Governments set production targets for zero-carbon fuels (intermodal usage)				ON TRACK		In place for 10 out of top 20 countries. Clear policy support.	In place for all 20 top countries. Policy to meet 5% goal (i.e. 0.6 EJ) in terms of hydrogen and ammonia/methanol production.
Government policies targeting SZEF adoption in maritime				PARTIALLY ON TRACK		In place for 10 out of top 20 countries across the board[24]	In place for 20 out of top 20 countries across the board.
Submission to IMO of national action plans to address GHG emissions from international shipping				NOT ON TRACK	In place for 10	In place for 20 countries	In place for 100 countries.
IMO to agree mid- and long-term measures for shipping aligned with 5% SZEF by 2030 and full decarbonisation by 2050.				ON TRACK		Mid-term measures agreed.	Long-term measures agreed
IMO requires new ships to be zero-emission ready, e.g., GHG reduction plan with zero-emission (i.e. SZEF) propulsion capability				NOT ON TRACK		In place	
IMO adopts guidelines to estimate well-to-tank GHG emissions and regulation/ incentives for SZEF				PARTIALLY ON TRACK		In place	
IMO agrees on comprehensive decarbonisation strategy and zero by 2050 target				ON TRACK		In place	

24 Including economic instrument, cost gap support such as a Contract for Difference (CfD)

Civil society

Overview

The civil society lever tracks progress along actions necessary from non-state actors, including seafarers, ports, NGOs, and others, to ensure a more just and equitable transition while pursuing the 5-10% goal. While the 5-10% goal can be achieved without such developments, the aim of these indicators is to provide additional metrics on how such a transition can be made more just and equitable.

To improve the tracking of civil society development relevant to reaching the SZEF 2030 goal, several indicators have been modified since last year. In particular, three indicators were merged and superseded with indicators from the Maritime Just Transition Task Force's (MJTTF) ten-point action plan to achieve a just transition for seafarers.[xxxv]

Ensuring multiple voices from the Global South are represented in discussions around SZEF capacity building remains a key priority.

This is not meant to say that there are no other relevant ways of tracking progress, but the MJTTF indicators were used as a proxy for developments that were previously not as closely tracked by the civil society indicators. Their inclusion aims to improve the visibility of seafarers in the transition and take their needs into account. Similarly, the refined indicators have also kept the focus on civil society actors from SIDs and LDCs whilst recognising the importance that local communities play in ensuring a just and equitable transition from a port perspective.

The MJTTF action plan tracks progress along several areas of development crucial to the decarbonisation of shipping, which includes seafarers and other segments of the maritime value chain. In particular, points of the action plan relating to transition principles such as gender equality, diversity, a global labour standard, and seafarer recruitment and training were taken into consideration. The importance of the civil society lever has continued to be critical in not only reaching the 5-10% goal of SZEF by 2030 but also in reaching it in a just and equitable manner.

1. Indigenous groups from SIDs and LDCs become more prominent and increase participation in shipping decarbonisation negotiations

- Some progress has continued since last year, as seen with the increased presence of various organisations, researchers, and non-state actors from SIDs and LDCs in IMO debates during MEPC 81. However, further involvement in the submission process and co-authorship of submissions are necessary to show deeper involvement.
- There is an under-representation of NGOs from across the Global South in debates, with resource availability limiting participation. An additional challenge remains language access, with limited translation services available during several types of meetings and some participants struggling to access necessary technical capabilities.

2. Fundamental just transition principles in terms of inclusion of global labour standards, gender/diversity and health/safety

- Global Labour Standards: The MJTTF's decarbonisation training project was established to shape global future legislation and approaches to training at the IMO through submissions to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) Convention
- Gender and Diversity: The Women's International Shipping & Trading Association (WISTA) has brought renewed focus on the issue of gender disbalance within the maritime workforce and emphasised how current opportunities for training and decarbonisation can be used to overcome some of the associated gender challenges.
- Health and safety: Projects have been launched to study crew safety in low/zero emission ships. The MJTTF looks at competency standards whilst developing a training framework and learning materials.
- Overall, progress is being made on several different levels in regard to the fundamental principles of a just maritime transition at the IMO. However, most of the observed progress thus far is based on commitments and more is needed in terms of further actions to put progress fully on track.

3. Seafarer recruitment and attrition with support for career pathways connected to maritime decarbonisation

- The International Transport Workers' Federation (ITF) has outlined the challenges associated with maritime decarbonisation and the need to offer seafarers training to adequately perform in a SZEF future. The MJTTF is currently in the planning and scoping phase for its recruitment and retention project, which will address cross-sectoral career opportunities and transferable skills for seafarers.

4. Skills and training investment, strengthening of training standards, delivering fair training and monitoring of skills

- Investing in skills and strengthening global training standards,the MJTTF, through its joint project with the IMO on training for decarbonisation, is strengthening global training standards by creating competencies for alternative fuels such as ammonia, hydrogen, and methanol. Other projects have also been undertaken to offer skills and training, but again, more work is needed to understand how these projects are changing standards on the ground.

5. Local civil society actors surrounding the top 50 global ports calling for air pollution mitigation

- Progress has continued in port decarbonisation beyond the Global North, with multiple examples of movements towards higher visibility of the need for decarbonisation. A good example comes from Brazil, where several ports have launched the 'Alliance for Decarbonisation initiative'.[xxxvi]

- Other developments have also been recognised. The African Union Commission's Green Ports Forum Africa is convening ports and regional port management authorities for collaboration on climate action.[xxxvii] Other examples come from C40 Cities, where an alliance of over 40 ports and cities are collaborating as members of C40's Green Ports Forum whilst multiple other NGOs are partnering with local communities to engage and deliver relevant action.[xxxviii]

Tracking progress – Partially on track

Table 8 Civil society lever progress

KEY ACTIONS	REQUIRED TIMING			PROGRESS	TARGET BY		
	24	25	30		2024	2025	2030
Indigenous groups, SIDs, and LDCs become more prominent and increase participation in shipping decarbonisation negotiations				NOT ON TRACK	Observer status and attending IMO meetings.	Participate in submissions.	
Fundamental just transition principles in terms of global labour standards, gender/ diversity, and health/safety				PARTIALLY ON TRACK			Transition planning aligned with the Maritime Labour Convention
Seafarer recruitment and attrition with support for career pathways				PARTIALLY ON TRACK		Address seafarer attrition	Support seafarer career pathways
Skills and training investment, strengthening of training standards, delivering fair training, and monitoring of skills				PARTIALLY ON TRACK			
Local NGOs surrounding top 50 global ports calling for air pollution mitigation				PARTIALLY ON TRACK		NGOs at 10 of the top 100 ports.	NGOs at 25 of the top 100 ports.

Key conclusions

Overall, there has been some progress in reaching the 5-10% goal, but as 2030 nears ever closer, observed progress is not on track with what is needed to reach the levels of SZEF necessary to hit the target.
Developments at the IMO have offered some optimism that a set of mid-term measures will be adopted that will provide additional signals to the industry and galvanise more demand for SZEF. However, a real risk remains that the outcomes reached will not be sufficient to provide the regulatory certainty needed to reach the 5-10% goal.

On a national level, hydrogen production strategies have continued to increase and offer cause for optimism but the pace of how these will be developed into active projects remains uncertain. The case has remained as strong as ever for policymakers both at the IMO and at a national level to commit to strong regulatory mechanisms that support both the production of SZEF through green hydrogen projects as a first step and also by creating viable demand for SZEF by supporting 2030 targets that can drive this demand.

In the supply and demand interface, some positive signs in terms of new ammonia projects remain visible, but the interplay between supply and demand remains challenging, with the industry still on the fence over what fuel to commit to. This uncertainty inevitably affects the level of demand seen in the order book and the number of projects for green ammonia and e-methanol being developed. Regarding e-methanol, concerns around its long-term scalability and price competitiveness are seen as a plausible explanation for the relatively slow progress of new projects being developed, whilst ammonia, a potentially techno-economically more suitable option, is still waiting for the right policy signals, industry commitments, and safety protocols.

With just eight of the 35 individual indicators on track, it is clear that the transition to SZEF is not going fast enough. To rapidly scale-up the demand for zero-emission fuels for shipping, there is now much work to do in a rapidly shrinking window of time.

Methodology

The analysis used in this report is based on the developed Transition Strategy for shipping[xxxix] and the MarSTF[25] conceptual framework,[xl] which applies a holistic approach to shipping decarbonisation by examining how different segments of the maritime zero-carbon transition are interconnected. The approach is similar to the one taken in the previous edition of this report, with some modifications to the civil society indicators.

Progress towards the five change levers was assessed by comparing currently available information on shipping developments against necessary target progress. The data used in the analysis was collected through a three-step approach:

1. **Update of quantitative information** – using up-to-date information from a range of different sources, including updated energy demand scenarios from University College London (UCL) analyses, a recent analysis of zero-carbon shipping corridors, as well as a range of diverse internally collected data sources from UCL and the Global Maritime Forum (GMF). For supply, this included data on announced and under-development ammonia projects from the Ammonia Energy Association; for methanol, from the Methanol Institute; data on the development of hydrogen projects from the IEA; as well as several relevant reports from IRENA, the Global Maritime Forum, and other sources. For finance, Clarksons Shipping Intelligence Network[xli] provided data on sustainability-linked loans and bonds issued in the industry, whilst Petrofin Global Bank Research[xlii] provided information on total shipping finance and breakdowns by lender. Clarksons World Fleet Register[xliii] was used to track trends in alternative-fuelled tonnage and extrapolate to 2025 and 2030.

2. **Desk-based research** – a review of up-to-date academic literature[26], grey literature and news reports was carried out to ascertain the most recent information relevant to the analysis. This also included a review of public finance initiatives and individual lenders or bank reports where specific information was available on shipping-related financing, as well as reports from climate-related trackers for bonds and sustainability-linked loans and other commitments like SBTi. Furthermore, up-to-date information from multiple sources regarding the production of SZEF was also gathered, including from news reports. Additionally, information from the Global Maritime Forum on pilot projects and green corridor developments played an important role in ascertaining respective progress.

25 Maritime Sustainability Transitions Framework – based on combining parameters from several conceptual approaches, including spatial and non-spatial proximity (Boschma, 2005), work on the dynamics of protective spaces (I.e., 'shielding, 'nurturing' and 'empowering') (Smith and Raven, 2012) and the multilevel perspective (Geels, 2002).

26 Information from various industry reports, policy, government documents and other relevant information.

Acronyms

bn – Billion

CfD – Contracts for Difference

COP – Conference of the Parties

coZEV – Cargo owners for Zero Emission vessels

CVF – Climate Vulnerable Forum

DF – Dual-fuel

DNV – Det Norske Veritas

EEDI – Energy Efficiency Design Index

EEXI – Energy efficiency Existing Ship Index

EJ – Exajoule

EU – European Union

ESG – Environmental, social, and governance criteria

ETS – Emissions trading scheme

FID – Final Investment Decision

GHG – Greenhouse gas

GloTraM – Global transport model

GMF – Global Maritime Forum

GtZ - Getting to Zero Coalition

GT – Gross tons

GT/y – Gross tons per year

GFANZ - Glasgow Financial Alliance for Net Zero

GCMD – Global Centre for Maritime Decarbonisation

GW – Gigawatt

H_2 – Hydrogen

HFO – Heavy fuel oil

IAPH – International Association of Ports and Harbours

IEA – International Energy Association

ICE - Internal combustion engine

IGO – Intergovernmental organisation

IMO - International Maritime Organization

ITF – International Transport Workers Federation

IRENA – International Renewable Energy Agency

Kg – Kilogram

LCA – Life cycle analysis

LCOE – levelized cost of electricity

LDCs - Less Developed Countries

LMA – Loan Market Association

LNG – Liquified natural gas

LPG – Liquified petroleum gas

LR – Lloyd's Register

MarSTF – Maritime Sustainability Transitions Framework

MBM – Market-based mechanisms

MEPC – Marine Environment Protection Committee

MJTTF – Maritime Just Transition Task Force

mn – Million

Mt – Million tons

MtHFOe – Megatons of HFO -equivalent

MW – Megawatt

MWh – Megawatt-hour

MJ – Megajoule

MJ/Mt – Megajoule/million tons

Mt – Megaton (million tonnes)

NAP – National Adaptation Plan

NDC – Nationally determined contribution

NGO – Non-governmental organisation

NH_3 – Ammonia

PP - Poseidon Principles

PV – photovoltaic

R&D – Research and Development

RD&D – Research, Development, and Deployment

RINA – Registro Italiano Navale

SBTi – Science Based Targets Initiative

SEEMP – Ship Energy Efficiency Management Plan

SGMF – Society for Gas as a Marine Fuel

SIDs – Small Island Developing States

SZEF – Scalable Zero Emission Fuel

TCFD – Climate-Related Financial Disclosures

TCO – Total cost of ownership

TEU – Twenty-foot equivalent unit

TRL – Technology Readiness Level

TWh – terawatt-hour

UK – United Kingdom

UN – United Nations

UNEP – United Nations Environment Programme

UNEP FI – United Nations Environment Programme Finance Initiative

US$ – United States Dollar

VMDTF – Voluntary Multidonor Trust Fund

ZEMBA – Zero Emission Maritime Buyers Alliance

ZEV – Zero Emission Vessel

ZEVI – Zero Emission Vessel and Infrastructure

Endnotes

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Annex A

This annex provides detailed and full explanations of the progress of the actions along with the evidence source.

ACTION	PROGRESS	JUSTIFICATION WITH SOURCE
TECHNOLOGY AND SUPPLY		
Pilot and demonstration projects	**ON TRACK**	The methodology of the fifth edition of the Global Maritime Forum's Mapping of Zero-Emission Pilots and Demonstration Projects was updated to exclude a number of key technologies deemed to have progressed into a commercial phase. There has been a significant increase in numbers of the remaining project types.
Cross-industry collaboration on SZEF ship projects	**ON TRACK**	The fifth edition of the Global Maritime Forum's Mapping of Zero-Emission Pilots and Demonstration Projects indicates an increasing trend in cross-industry collaboration.
Key technological developments	**PARTIALLY ON TRACK**	Longer-range ICE-based methods of propulsion using methanol and ammonia are progressing well, with battery-electric propulsion systems already well-developed. Concerns remain surrounding the capacity of engine manufacturers, and newbuild and retrofit yards to facilitate renewal of the global fleet sufficient to achieve the breakthrough 2030 target, however this capacity is likely to remain untested until demand for such vessels picks up.
Government-energy industry collaboration	**ON TRACK**	There are a large number of gigawatt-scale, government-led targets for developing green hydrogen capacity across all regions of the world. However, continued monitoring of the extent to which governments are delivering on their ambition will be essential in the next 12 months.
Decrease in green hydrogen production costs	**PARTIALLY ON TRACK**	Reductions in the costs to produce green hydrogen have continued to stall in the face of accelerating renewable energy deployments worldwide, instead being held up by continued supply-chain volatility, geopolitical events, and other inflationary pressures. Achieving green hydrogen costs of less than $2/kg therefore looks increasingly unlikely and the significant competitiveness gap with incumbent fuels looks likely to remain.
Increase in electrolyser and green hydrogen production capacity	**PARTIALLY ON TRACK**	The IEA's Green Hydrogen Review 2023 highlights that low-emission hydrogen projects are rapidly expanding in scale, with the database 50% greater in size than a year ago. However, only a fraction of this potential supply has passed final investment decision, and projected volumes remain substantially below 2030 usage in the IEA's Sustainable Development Scenario or Net-Zero by 2050 Scenario.
Scale-up of SZEF production	**PARTIALLY ON TRACK**	When the updated database of e-methanol and green ammonia projects is used as input to the future supply estimation tool developed in the previous edition of this report, projected availability of both fuels in 2030 is more than 50% greater compared to last year under the 'medium' growth scenario. However, there is still significant uncertainty given the numbers of projects that are struggling to reach the construction stage.

DEMAND		
Key industry actors commit to net zero by 2050 based on SBTi requirements and actions	PARTIALLY ON TRACK	Progress has not accelerated as quickly as anticipated, with a small increase in the number of shipowners or operators setting targets or commitments relative to SBTi requirements. However, these owners cover a small fragment of the world fleet, and therefore have little impact on the industry's overall commitment.
Zero-carbon freight becomes increasingly commonplace	NOT ON TRACK	To reach 2025 energy requirement for SZEF to take off by 2030, about 5-10% of all container TEU miles would need to be green. This is the equivalent of about 100 15,000 TEU containerships all running on, for example, e-methanol for a year. If other segments also transition, we could reduce the demand on the container fleet proportionally to about 1.5-3% TEU miles, or about 20-30 15,000 TEU. There are little to no signs that this will change or is changing at the rate required for 2025 or 2030.
Owners, freight purchasers, fuel producers, ports, finance, and other stakeholders take part in pilots and demonstrations to unlock SZEF potential	PARTIALLY ON TRACK	A number of projects or pilots related to fuel production, bunkering, and infrastructure/systems are ongoing, indicative of both the interest and of challenges being evaluated and addressed to allow SZEF to scale. Together with the increase in cross-stakeholder collaboration, there is room for optimism, but the actual level of R&D is not at the level where it would need to be to put the indicator fully on track. Towards 2025 and 2030, this may need to be renamed or adjusted to reflect projects turning into scale-ups. An indicator of how open these pilots become in sharing their findings may also be appropriate to monitor, as sharing of this knowledge will be critical (not least to minimise duplicated efforts).
"Dark green" corridors for zero-emission shipping start to materialise	NOT ON TRACK	Whilst planned green corridors have matured and a few are getting closer to final investment decision stages, there hasn't been as much progress in turning plans into reality since the previous report. "Dark green" corridors seem a little further away, with many planned corridors leaning towards sourcing fuels that are more realistically obtainable in the coming years. Public sector engagement will need to continue and also quickly morph into funding (and or subsidies) to help facilitate first-mover economics.
Growth in the share of SZEF-capable vessels in the active fleet	NOT ON TRACK	The current fleet and projected growth do not indicate there will be sufficient demand for SZEF in 2025 or 2030 to reach the 5% goal of 0.1 EJ. SZEF-capable and SZEF-ready tonnage together only represent about 0.44% of total GT at the end of 2023, up only marginally from 0.32% at the end of 2022. SZEF-capable tonnage is projected to approach 0.02-0.03 EJ (of the 0.1 EJ required) by 2025 and 0.1 to 0.2 EJ by 2030 (of the 0.6 EJ required).
Growth in the SZEF-ready vessels in the active fleet	NOT ON TRACK	Greater diversity in the types of fuel options and an increase in deliveries for SZEF-ready tonnage is encouraging, but questions remain on what each readiness notation implies in practice and how costly or cumbersome conversions will be in practice to go from SZEF-ready to SZEF-capable in the future. Ammonia, ammonia-LNG, ammonia-methanol, LNG-methanol, and methanol-ready vessels were added to the fleet in 2023, with ammonia and methanol readiness being the most common choices. Excluding LNG-ready tonnage in the fleet at the end of 2023, the others represent only about 0.14% of total GT.

Share of order book with SZEF-fuel capable vessels	**NOT ON TRACK**	Greater diversity in the types of fuel options and an increase in deliveries for SZEF-ready tonnage is encouraging, but questions remain on what each readiness notation implies in practice and how costly or cumbersome conversions will be in practice to go from SZEF-ready to SZEF-capable in the future. Ammonia, ammonia-LNG, ammonia-methanol, LNG-methanol, and methanol-ready vessels were added to the fleet in 2023, with ammonia and methanol readiness being the most common choices. Excluding LNG-ready tonnage in the fleet at the end of 2023, the others represent only about 0.14% of total GT.
Share of order book with SZEF-fuel capable vessels	**NOT ON TRACK**	There has been a significant preference for conventionally-fuelled vessels in the 2023 order book (more than 75% of total ordered GT), which has tempered the impact other SZEF fuel capable orders have been able to have in the potential future fuel mix. LNG-capable came second at 11%, other gas (like LPG, at 6.2%), methanol (6%), hydrogen (0.3%), and ammonia (0.1%). These preferences also appear to vary across the different shipping
FINANCE		
Increase the share of shipping debt aligned to trajectories needed to meet 2030/50 targets (especially Poseidon Principles)	**NOT ON TRACK**	The Poseidon Principles adopted trajectories that are now more aligned with the 2023 IMO Strategy, which has resulted in requiring a sharper shift in debt towards increasingly more carbon-efficient tonnage. Thus, whilst alignment of observed shipping debt to the old Poseidon Principles trajectories has improved (from 6% above the trajectory to only 2% above at the end of 2023), alignment towards the new trajectories is much further apart.
Increase in willingness to report financing attached to shipping and its alignment to climate targets like Poseidon Principles	**PARTIALLY ON TRACK**	Shipping debt covered by the Poseidon Principles has increased since the end of 2022, even whilst total ship finance was estimated to have risen from about $525 billion. A similar share of this debt is attributable to individual lenders, but continued increases in transparency would be necessary to keep this lever on track.
Increase or maintain sufficient issuances of sustainability linked loans and bonds to ship owners and operators	**NOT ON TRACK**	Observed issuances of green bonds and sustainability-linked loans to shipowners and operators fell from $4 billion to $2.4 billion, with total issuances now up by $5 billion to $12.5 billion since 2022.
Mobilize industry funding for SZEF bunkering and production investment	**NOT ON TRACK**	Sustainability loans and bonds $500 million to shipyards in 2023. Whilst short of the $1 bn/year target set, the availability and uptake of such instruments provide a positive sign. Investments in planned activity towards ammonia, for example, of about $24 billion would bring us closer to the targets set for 2030.
Increase public finance (i.e. grants, loans) for SZEF related activities	**PARTIALLY ON TRACK**	Public finance has not changed significantly since the 2023 report, with limited movement on additional financing being made available for shipping decarbonisation projects since then. Overall, there has been an 11% increase in the amount of public finance which is directly available for maritime decarbonisation. The main bulk of this increase comes from additional commitments in the Dutch Maritime Masterplan and from the German federal Maritime Research Programme.

POLICY		
Classification societies adopt robust zero-emission-ready guidelines	**ON TRACK**	Growing attention by classification societies to develop various notations, guidelines, and classifications for zero-emission fuels, specific zero-emission ready guidelines are still under developments in many classification societies with some announcements already made such as the Lloyd's Register 'Zero Ready Framework' and the ClasNK 'Zero-Emission Transition Support Services' including 'Guidelines for Ships Using Alternative Fuels (Edition 1.1)', following earlier developments by societies such as DNV on 'Fuel Ready' notations. Since last year, additional announcements have been made, such as Bureau Veritas rules for hydrogen fuelled ships, the 'ASD Advisory on hybrid electric power systems' and DNV's new chapter on ammonia added to its 'Alternative Fuels for Containerships' guidance.
Classification societies research and set operational, bunkering, and safety standards for SZEF	**ON TRACK**	Safety guideline work continued to develop. On a global level, significant progress has been made at the IMO with work progressing at pace at the Sub-Committee on Carriage of Cargoes and Containers in September 2023 (CCC 9) for the development of draft interim guidelines for the safety of ships using hydrogen and ammonia as fuel with a scheduled intersessional working group convened on the issue in September 2024, ahead of CCC 10.
Governments publish 1.5°C-aligned decarbonisation plans for domestic shipping	**NOT ON TRACK**	Since last year there has not been significant progress in this regard, as was the case in 2023. Eight national action plans were published, of which four mention 1.5°C in one shape or another. Out of top 20 countries by TEU traffic, only one seems to have a general decarbonisation pathway (all sectors) aligned with 1.5°C. However, 11 have some form of aspiration towards 1.5°C. When looking into these aspirations and minimal movement from last year we can say that this aspect of development is not on track.
Governments set production targets for zero-carbon fuels (intermodal usage)	**ON TRACK**	Out of top 20 countries, 18 (plus the EU) have some type of hydrogen strategy already published. Most of these strategies have a 2030 target for hydrogen production or electrolyser capacity. When converted into potential green hydrogen production, this equates to a total of just over 55 Mt of annual hydrogen production by 2030. This on its own would be sufficient to meet over 5 EJ of energy demand of ammonia and methanol respective if met, so at the moment the indicator is considered as being on track. This equates to just around 10% of this overall hydrogen production being sufficient to meet the needs of the shipping industry. However, many of these targets are not substantiated with actual policies and IEA's database of actual planned projects in 2030, put a figure closer to 40% of that capacity. This combined with the likelihood that most of this supply is not intended for maritime, and that there are no clear plans for ammonia and methanol plants, risks the long-term viability of this indicator being on track.

Governments policies targeting SZEF adoption	**PARTIALLY ON TRACK**	Of the top 20 countries, 14 have some form of regulations targeting maritime decarbonisation, seven include some form of domestic shipping carbon pricing, 13 have some form of support for development of pilot projects, eight for infrastructure and 14 some other form of support mechanism. Since 2023 these numbers have remained mostly unchanged, but with new decarbonisation plans for maritime developments in Singapore, Malaysia and South Korea, progress has continued. Domestic policies are considerably developed, and since last year more progress has continued to take hold outside of the European Union.
Submission to IMO of national action plans to address GHG emissions from international shipping	**NOT ON TRACK**	Eight national action plans have so far been submitted and since 2023 there has been no new national action plans submissions. This is below the current target and when taking into consideration the number of the IMO member states (i.e. 175), as well as the scale of the decarbonisation challenge and relevance of local/national action to facilitate the complex socio-technical changes necessary for a global transition, it can be said that this indicator is not on track.
IMO to agree mid- and long-term measures for shipping which are aligned with 5% SZEF and decarbonisation by 2050.	**ON TRACK**	Since last year and MEPC 80, the IMO work on an economic instrument and technical measures for shipping has continued at ISWG-GHG 16 and MEPC 81. At MEPC 80, the IMO agreed a 5%-10% goal for 'zero or near zero GHG emission technologies' by 2030, meaning that progress can be considered to be moving in the right direction. There is hope that by MEPC 83 in spring 2025, the needed mid-term measures will be adopted. Even though uncertainty remains on how these measures will look, there is clarity that a rapid technological change will be necessary, and that GHG intensity limits for a GHG Fuel Standard will be in line with the GHG reduction targets and indicative checkpoints. The next 12 months will be crucial to see whether the IMO provides the right signals to industry to move forward it a rapid scale up of demand for SZEF. At this stage, the policy discussions can be said to be moving at pace.
IMO requires new ships to be zero-emission ready, e.g., GHG reduction plan with zero emission propulsion capability	**NOT ON TRACK**	There has been very limited progress at the IMO regarding these developments.
IMO adopts guidelines to estimate well-to-tank GHG emissions and regulation/ incentives for SZEF	**PARTIALLY ON TRACK**	The 2023 IMO GHG Strategy mentions that the "basket of candidate mid-term GHG reduction measures should take into account the Well-to-Wake GHG emissions" which are further supporting the correct progress which combined with the expectation of adoption of 'economic elements' gives much hope for optimism. Since then, there has been some progress on development of the Life Cycle Analysis (LCA) Guidelines at the IMO, especially during ISWG-GHG 16 and MEPC 81, with the decision made to have two processes going forward – one being a correspondence group to finalize the less complete guideline aspects and a separate working group under GESAMP to review LCA Guidelines agreed to date. The process seems to be developing at pace, but the GESAMP review does add some additional uncertainty due to providing a new perspective on the LCA Guidelines. With this in mind progress is currently partially on track but could soon be fully on track.

IMO agrees on comprehensive decarbonization strategy and zero by 2050 target	**ON TRACK**	The 2023 IMO GHG Strategy agreed "to peak GHG emissions from international shipping as soon as possible and to reach net-zero GHG emissions by or around, i.e. close to, 2050". Whilst this statement has several caveats and it still remains to see what measures will be used to enforce it, at this stage this progress can be considered significant and so far it can be argued that these developments are on track.
IMO agrees on comprehensive decarbonisation strategy and zero emissions by 2050 target	**ON TRACK**	The 2023 IMO GHG Strategy has agreed "to peak GHG emissions from international shipping as soon as possible and to reach net-zero GHG emissions by or around, i.e., close to, 2050". Whilst this statement has several caveats, and it still remains to see what measures will be used to enforce it, at this stage this progress can be considered significant. It can be argued that, at this instance in time, these developments can be considered to be on track.
CIVIL SOCIETY		
Indigenous groups, SIDs and LDCs become more prominent and increase participation in shipping decarbonisation negotiations	**NOT ON TRACK**	Progress has continued since last year and observed in multiple areas with increased presence in IMO debates during MEPC 81. However, further involvement in the submission process and co-authorship of submissions necessary to show deeper involvement.
Fundamental just transition principles in terms of global labour standards, gender/ diversity, and health/safety	**PARTIALLY ON TRACK**	**Global Labour Standards** – The Maritime Just Transition Taskforce (MJTTF) 'training for decarbonisation project' was established with the aim to shape global future legislation and approaches to training at the IMO through submissions to the STCW Convention review and through the training framework being developed. **Gender and Diversity** – Recently, the Women's International Shipping & Trading Association brought renewed focus on the issue of the gender disbalance within the maritime workforce and emphasised how current opportunities for training and decarbonisation can be used to overcome some of the associate gender challenges. The MJTTF is also working on a blueprint for National Level Advisory Bodies to support work on 'Diversity, Equity and Inclusion' **Health and safety** – Projects have been launched to study crew safety in low/zero emission ships. Within the MJTTF the 'training for decarbonisation project' with the IMO looks at competency standards, whilst developing a training framework and learning materials. **Overall**, the MJTTF shows that progress is being made on several different levels in regards to fundamental principles of a just maritime transition at the IMO. Similarly, progress is being made beyond the MJTTF, but all of the observed progress is based on commitments and more is needed in terms of further actions to put progress fully on track.

Seafarer recruitment and attrition with support for career pathways	PARTIALLY ON TRACK	**Support seafarer career pathways** – The ITF has outlined the challenges associated with maritime decarbonisation and the need to offer training to the seafarers to be able to adequately preform in a SZEF future. The MJTTF is currently in its planning and scoping phase for the recruitment and retention project. In this project cross-sectoral career opportunities and transferable skills for seafarers will be addressed. **Address attrition and recruitment** – The MJTTF is going to take active steps to address seafarer attrition in its recruitment and retention project, which is currently in its planning and scoping phase.
Skills and training investment, strengthening of training standards, delivering fair training and monitoring of skills	PARTIALLY ON TRACK	**Investing in skills and strengthening global training standards** - The MJTTF, through its joint project with the IMO on training for decarbonisation, is strengthening global training standards by creating competencies for alternative fuels such as ammonia, hydrogen and methanol. Other projects have also been undertaken to offer skills and training but more work is needed to understand how these projects are changing standards on the ground.
Local NGOs surrounding top 50 global ports calling for air pollution mitigation	PARTIALLY ON TRACK	There has been growing NGO presence in several key international ports. Pressure by NGOs has continued globally. It seems highly likely that this trend will continue and through time become more visible in most global regions. Various types of pressure have seen progress towards port decarbonisation actions beyond the Global North. An example comes from Brazil, where several ports have launched the 'Alliance for Decarbonisation initiative'.

Annex B

Technology and supply

Ammonia and Methanol Supply Estimate up to 2030

The ammonia and methanol supply estimated are based on data of announced projects obtained from the Ammonia Energy Association (AEA) and the Methanol Institute. The data is used to develop three scenarios of future supply for ammonia and methanol as marine fuels. In all cases, the assumption is based on projects relating to the development of green ammonia (i.e. from electrolysis using renewable electricity) and e-methanol (i.e. synthetic methanol produced using electrolysis and excluding usage of bio-methanol) as these fuels are in line with the definition of SZEF used for the purposes of this report. The scenarios are based on the following assumptions:

i. **Low scenario** – based on the assumption that 10% of all existing and planned green ammonia projects and 40% of all e-methanol projects which are currently planned to be operational by 2030 will be utilized for the supply of SZEF for international shipping.

ii. **Medium scenario** - based on the assumption that 20% of all existing and planned green ammonia projects and 50% of all e-methanol projects which are currently planned to be operational by 2030 will be utilized for the supply of SZEF for international shipping. In addition, this scenario also assumes a compounded annual growth rate of new capacity announcements/construction of 150% annually between now and 2030 will take place based on historical rates of announced capacity changes over the years as observed in databases for green ammonia and e-methanol projects modified with the removal of outliers from the average (i.e. observed annual growth over 500% in some early years for some categories).

iii. **High scenario** - based on the assumption that 50% of all existing and planned green ammonia projects and 75% of all e-methanol projects which are currently planned to be operational by 2030 will be utilized for the supply of SZEF for international shipping. In addition, the scenario also assumes a compounded annual growth rate of new capacity announcements/construction of 150% annually between now and 2030 will take place based on historical rates of announced capacity changes over the years as observed in databases for green ammonia and e-methanol projects modified with the removal of outliers from the average (i.e. observed annual growth over 500% in some early years for some categories).

The proportions of 10%, 20%, and 50% of maritime supply vs. non-maritime for green ammonia and 40%, 50%, and 75% for e-methanol are based on historical trends in project announcements, desk-based research of available data on planned usage of projects under development and discussions with methanol and ammonia experts on the likely breakdown of future demand.

Demand

Ship-equivalent fuel demand estimates

The equivalent number of 15,000 TEU vessels that would be needed to reach 0.1 and 0.6 EJ is calculated by using fuel consumption estimates from the 4th IMO GHG Study [xliv] for an average vessel of this size and type and then comparing to the total amount of fuel needed if it were, for example, methanol to cover 0.1 or 0.6 EJ in energy. A 5% efficiency improvement is added to cover changes since 2018. 20,000 MJ/Mt is used for the energy content of methanol, 18,800 MJ/Mt for ammonia, and 40,490 MJ/Mt for HFO, to help with conversion.[27]

2025 and 2030 required TEU estimate

Using data from the 4th IMO GHG Study on the days at sea, average speed, and median TEU capacity in each size category, it is possible to estimate the average expected TEU miles sailed for each size class of container ship. This is multiplied by the total number of vessels in each size class, to get to an estimate of the total TEU miles provided in 2018 by the whole fleet. Similarly, based on 600 15,000 TEU ships being needed to cover 0.6 EJ in 2030, the total TEU miles these 600 ships would sail in a year is estimated and used to work out the relative share of total TEU miles that would then potentially need to be SZEF-capable. This comes to about 40% of all TEU miles, but since the container fleet contributes about 25% of all merchant shipping emissions (based on 2018 estimates), the required TEU miles are reduced proportionally. An error margin is added to account for uncertainty on TEU-mile growth (or decline) from 2018 to 2025 and 2030, fuzziness in the average speed and time spent at sea, the resolution loss when using size-class level averages, and uncertainty in how size classes themselves might evolve. This leads to the 8.75-12.5% TEU-miles estimate for 2030, and the similar estimate of 1.5-3% for 2025 targets, both of which hold if other segments take up SZEF proportionally.

Estimated total SZEF-capable tonnage and potential SZEF demand for 2025 and 2030

The average growth in GT over the last four years (2020-2023) for the fleets with different fuel capabilities is calculated based on Clarksons WFR (2023) data, combined with the average GT ordered based on the same source, and then extrapolated to get 2025 and 2030 estimates of total SZEF-capable GT. The average values for the various fuel types are shown in Table A below.

Table A – Approximate growth rates used for SZEF-capable tonnage[28]

	Fleet growth rate, GT/y	Orderbook growth, GT/y
Hydrogen and hydrogen dual-fuel	25000	70000
LNG and LNG dual-fuel	3500000	20000000
Methanol and methanol dual-fuel	110000	2100000
Nuclear and nuclear dual-fuel	0	0
Other	0	230000
Other gas dual-fuel	1200000	2000000
Ammonia	0	14000

27 Utilizing figures used by UCL which are based on a literature review of several sources of conversion factors for SZEF fuels.
28 Clarksons WFR (2023)

A ship type and size weighted average fuel consumption estimate for the whole fleet based on the 4th IMO GHG Study is used to estimate the potential consumption in HFO terms for these SZEF-capable GT in 2025 and 2030, with a 5% fuel efficiency improvement on the consumption estimates from 2018. This averages out to approximately 0.2 Mt of HFO per GT, before applying a 5% efficiency improvement. The estimated HFO-demand is then converted to its equivalent in EJ terms and compared to 0.1 and 0.6 to evaluate progress to those targets.

Finance

Weighted average portfolio alignment to Poseidon Principles targets

A weighted average alignment score was created to better assess how shipping debt across lenders is really aligned to Poseidon Principles and IMO 2023 GHG Strategy trajectories. Poseidon Principles annual reports, however, only show each lender's alignment score without the size of each lender's shipping portfolio on which that score is based. Portfolio size estimates (or actual values) for many of the lenders were available in Petrofin Research (2021-23) reports, and this was used to calculate the real level of alignment. The scores were weighted by the size of the lender's portfolio relative to the total amount of shipping debt issued in the respective years calculated.

Public finance estimate

This is based on an analysis of the top 20 countries by TEU traffic through literature research of announced demonstration and pilot projects, the inclusion of shipping into the EU ETS and the US Clean Ports Program. The combined amount is based on the finance announcements made likely to be available by 2030. In terms of breakdown by type of finance in the figure, the analysis can be broken down in the following manner:

i. **Direct** – this figure includes funding which is considered as being directly available for the usage of maritime shipping decarbonisation and, as such, can directly facilitate SZEF adoption. It is based on the literature review of grey literature, news reports, government papers and other related publicly available information from the top 20 countries.

ii. **Uncertain** – this is funding which has been committed by governments for projects which might include SZEF adoption but the affect which it can have on reaching the 2030 5%-10% goal remains to be seen due to certain timeline of the funding coming into force and/or still remaining ambiguity of when and how these announcements will be complemented.

iii. **Potential** – this is funding which is generally available for a multitude of projects which can include SZEF activities, but these are usually only one possible beneficiary of a range of other activities which these can fund, such as port infrastructure improvements, improvements in vessel energy efficiency, air pollution activities, and similar.

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