# CLIMATE ACTION IN SHIPPING

## Progress Towards Shipping's 2030 Breakthrough

GETTING TO ZERO COALITION

UMAS

RACE TO ZERO

2030 BREAKTHROUGHS

**CLIMATE ACTION IN SHIPPING**
**Progress towards Shipping's 2030 Breakthrough**

This report is a joint effort between UMAS and UN Climate Change High Level Champions.


## LEAD AUTHORS

**Domagoj Baresic**
**Vishnu Prakash**
**James Stewart**
**Nishatabbas Rehmatulla**
**Tristan Smith**



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UMAS delivers consultancy services and undertakes research for a wide range of clients in the public and private sectors using models of the shipping system, shipping big data, and qualitative and social science analysis of the policy and commercial structure of the shipping system. UMAS's work is underpinned by state-of-the-art data supported by rigorous models and research practices, which makes UMAS world-leading on three key areas; using big data to understand drivers of shipping emissions, using models to explore shipping's transition to a zero emissions future and providing interpretation to key decision makers.

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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.

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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 COP27 and COP28 – Dr. Mahmoud Mohieldin and H.E. Razan Al Mubarak – to drive real world momentum and action.

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# To reach 5% and go beyond by 2030, immediate action is necessary

The shipping industry transports about 80% of internationally traded goods by sea and involves two million seafarers. However, its global role relies on highly polluting fuels, contributing to 3% of global greenhouse gas (GHG) emissions and inflicting a significant environmental toll. International shipping is on an ambitious, zero emission trajectory aligned to 1.5°C, shifting away from fossil fuels and establishing scalable solutions that support a just energy transition.

The GHG reduction pathway specified in the 2023 International Maritime Organization Strategy on Reduction of GHG Emissions from Ships (2023 IMO GHG Strategy) says that shipping will need to achieve both a maximisation of energy efficiency this decade (2030) and have advanced through the emergence phase of a transition from fossil fuels to fuels produced from renewable energy. This then enables a mass market transition and the rapid diffusion of renewable energy use throughout the sector, thereby enabling it to reach near-zero GHG emissions by 2040.

Previous work has proposed a coding of the transition by setting a significant advance milestone **of at least 5% scalable zero emission fuel (SZEF) use by 2030.**[1] This "2030 Breakthrough" target was adopted and improved by the 2023 IMO GHG Strategy, suggesting "5%, striving for 10% zero and near-zero GHG emission fuel use by 2030", as a share of the total energy used in international shipping. [2]

The overall energy demand for shipping in 2030 is estimated to be just over 12 EJ (ibid.), of which 5-10% represents a minimum of 0.6 EJ, equivalent to 15.8 Mt (million tonnes) of heavy fuel oil or 5.3 Mt of hydrogen. When converted into possible demand for SZEF, this would equate to around 29.8 Mt of ammonia or 28.1 Mt of methanol.

There are no firm definitions of SZEF, or zero and near-zero emission fuels, but there are a few key requirements that these fuels need to meet to be considered as replacements for existing fossil fuels and to realise international shipping's decarbonisation. These include the need to be:

- scalable such that the 200-300 Mt oil equivalent of current 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 lifecycle (well-to-wake) basis;
- competitive in the cost of production in the foreseeable future, assuming continued RD&D and the adoption of viable policy support mechanisms.

The definition of SZEF used in this report, therefore, does not include biofuels, "cleaner" fossil fuels (including liquified natural gas (LNG)), and most blue fuels or applications of carbon capture – all technologies that may have a limited role in the transition and are not critical to the pathway to zero evaluated here. At the same time, it excludes options which are not at a high technological readiness level and have significant barriers to adoption. With the above considerations in mind, the IMO 2030 5-10% ambition for "zero and near-zero GHG emission fuels" should have to be in line with the definition of SZEF given in this report. Taking such alignment into account, this report tracks the progress adoption of SZEF of at least **5% of the international shipping fuel energy mix by 2030** relative to the total energy demand used, and compares this against last year's progress.

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

## Key developments in the last 12 months

In 2022, it was highlighted that the time had come to convert commitments into action. **In 2023, it can be said that some commitments have been actioned, including:**

- **Progress at the regulatory level at the IMO**, in particular, in relation to the revised levels of ambition for 2050: net-zero GHG emissions "by or around" 2050, 5-10% uptake of zero or near-zero GHG emission fuels,[3] indicative checkpoints (i.e., GHG emission reduction by 20%, striving for 30% by 2030 compared to 2008), the adoption of lifecycle GHG assessment guidelines, amongst others. This provides a strong signal that SZEF adoption with rapid scale-up must occur imminently.

- **Additional national actions**, with more than 30 countries releasing hydrogen roadmaps and the current pipeline of IEA hydrogen projects announcements representing 24 Mt of green hydrogen capacity by 2030. Additional developments in the EU, in terms of including shipping into the EU ETS, and national level actions within the UK, US, and several east Asian countries offer promise. There has also been continued growth in announced methanol and ammonia capacity with a current pipeline of 192 Mt of green ammonia and 6 Mt of e-methanol is also a significant step in the right direction.

- **Other announcements** such as the launch of the Zero Emission Maritime Buyers Alliance (ZEMBA), continued announcements from large shipowners on orders of zero emission vessels, and new green corridor announcements.

Despite the above achievements, **progress is still only partially on track** because of a lack of progress in other areas, such as demand for SZEF and specific technological and national policy developments. The IMO outcome has created a major shift in the opportunities and risks landscape which needs to be considered. Companies will need to manage the uncertainties in the period through to end-2025, the point by which the IMO has committed to adopt mid-term measures. During the period before end-2025, governments have a critical role to help bring forward public and private investment decisions worth dozens of billions of US dollars annually by 2030. Now that a new positive signal has come from the IMO after MEPC 80, it should be used **as a clear demand signal for SZEF through increased orders for ships, commitments to finance, infrastructure developments, and targeted national polices for the scaling up of SZEF**. The report reviews five system change levers: technology and supply, demand, finance, policy, and civil society, and ascertains whether the actions currently undertaken across these levers are in alignment with the 5% 2030 breakthrough target.

## Current status of technology and supply

**In terms of technology and the supply of SZEF**, progress remains **partially on track**. Technological progress has been significant, with an increasing number of emergent-phase **pilot and demonstration projects** focusing on SZEF production, bunkering and infrastructure, and a growing trend of cross-industry collaboration to deliver them. The degree to which small-scale technological progress is transferring into large-scale projects capable of facilitating **breakthrough supply-side targets by 2030 is less clear**, with several concerns associated with the capacities of **engine manufacturers and shipyards**. Production costs of green hydrogen are likely to drop below US$2/kg under favourable conditions by 2026. Only around 2.3 Mt of the announced hydrogen pipeline is currently operational or under construction, but the pipeline of electrolyser, green hydrogen, and SZEF production projects continues to grow, and the **aggregate capacity of new announcements** to 2030 will likely be sufficient to meet SZEF demands from the shipping sector.

## Current status of demand

**In terms of demand for SZEF**, progress is **not on track**. There are generally positive signals of a growing interest in developing SZEF corridors (green corridors), testing or piloting new fuels, evaluating the required infrastructure and systems, demand from cargo owners and, critically, the willingness to pay for fuel optionality either through multi-fuelled engines or vessel readiness measures. At the end of 2022, there were 24 ships capable of operating with SZEF (mostly methanol) and currently there are about 144 on order (mostly also with methanol capability).[4] However, these indicators today **appear too weak to meet the SZEF demand trajectory of 0.1 EJ by 2025 and present a challenge for the demand of 0.6 EJ by 2030**. Of the 0.1 EJ SZEF that would need to be in demand by 2025, **current projections of the growth of the SZEF capable fleet**

3 Also including "technologies, fuels and/or energy sources".
4 This is based on only ships existing or ordered with SZEF capability and does not include SZEF-ready vessels or orders.

**—excluding LNG — could create about 0.03-0.05 EJ (30-50% of 0.1 EJ) of potential SZEF demand**. This leaves the second half of this decade for the fleet's compatibility with SZEF to "catch up". A sudden acceleration in fleet SZEF compatibility could be achieved both through newbuilding and retrofitting the existing fleet. For retrofitting to contribute to the demand target, ships that have been designed with "ready" notations, even LNG-ready, may be easier candidates. It is common in transitions that the ordering of new technologies happens almost as a step change, rather than a gradual trend. Both newbuilding and retrofit orders may increase rapidly if initial ammonia users (expected in 2025-26) help de-risk, and provide evidence of the potential for, this fuel, and as wider evidence of production, supply, and use of green ammonia (in power, steel, and agriculture, for instance) occurs. Demand for SZEF compatible vessels may also undertake a rapid increase as policy intent is formalised in legislation (also expected in 2025) and pushes existing tonnage to be converted to SZEF capability. Combinations of retrofitting and newbuilding SZEF compatible fleet could still reach the 0.6 EJ goal, but this will require a structural change from current trends, stronger signals from industry, and legislation. Similarly, although more green corridors have been announced, extensive work needs to go into their realisation and the focus should switch towards "dark green" corridors, which can make material differences to SZEF adoption.[5] Announcements such as ZEMBA's Request for Proposals (RfP), with 20 members seeking "zero-emission fuels" for 600,000 TEUs by 2025, are creating some optimism.[6] Now is the time to extend these types of initiatives to more ambitious targets for 2030, and to **translate them into the scale-up of orders for ships (and conversions of existing tonnage) that can deliver on those ambitions**.

## Current status of finance

**In terms of finance for SZEF**, progress is **partially on track. The alignment of shipping debt to Poseidon Principles trajectories** and **the extent of transparency on this debt have both improved**. Sustainability-linked loans and bonds issued to shipowners or related sectors have remained stable in relative terms at 0.5% of all such loans globally (US$6 bn in 2021 and US$4 bn in 2022), showing continued appetite for lenders to support the industry, despite a slowdown in overall issuances last year. **Public finance and its interest in shipping has been growing too, with an upper-end estimate of such finance possibly available for SZEF sitting at US$ 7.7 bn**. Most of this is based within the EU and US, with limited financing available for the Global South, and many of these options are not directly earmarked for SZEF. Indeed, with most finance indicators and measures tracked, it remains unclear how much is driving the industry towards SZEF or is attached in some manner to the development of SZEF-related assets

## Current status of policy

In terms of **policy to facilitate SZEF uptake**, developments are **partially on track**. The global policy landscape has seen a **marked improvement compared to 2022 with the adoption of the 2023 IMO GHG Strategy at MEPC 80 in July 2023**. The adoption of a net zero target "at or near 2050", in combination with the 5-10% level of ambition for "zero or near-zero GHG emission technologies, fuels and/or energy sources" **sends a clear signal to industry and policymakers that shipping is committed to decarbonisation** and that specific actions from all respective stakeholders must follow. It is important that mid- and long-term measures developed at the IMO are conceived in a way which facilitates reaching at least 5% SZEF by 2030. On a national level, announced **hydrogen strategies should be further strengthened in scale** and followed by targeted policy measures to ensure they are achieved.

## Current status of civil society

**In terms of civil society**, progress is **partially on track**, with the last year having seen continued involvement of multiple NGOs at the IMO level in debates, other voices being heard globally in the decarbonisation narrative, and continued visibility of the need for a diverse range of actors being involved in the decarbonisation debate, including more civil society voices from the Global South, representing the views of LDCs, SIDS,[7] and developing countries. However, **progress needs to continue, and the further involvement of a range of actors across different communities, regions, and backgrounds** is more necessary than ever to ensure the adoption of SZEF is done in a way which is equitable.

5 Based on GMF (2022e), "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.
6 GHG emission reductions of at least 90% compared to traditional fossil fuels on a lifecycle basis.
7 Least Developed Countries (LDCs) and Small Island Developing States (SIDS)

## The goal is still viable, but the window for action is closing

Overall, this report shows that shipping has seen significant progress in the last year towards the 5% SZEF goal. But, as 2030 draws ever closer, the types of necessary developments evolve and become more urgent. The outcome of MEPC 80 removes a major uncertainty and significantly increases opportunity to align to 5% (and beyond). The risk of not being aligned to 5% should be used as a stepping-stone **for industry to commit to SZEF orders and price in future legislation**, which is now made clearer through tapping into opportunities for freight decarbonisation and better considering the risk of inaction on future revenue, whilst continuing a rapid scale of growth in dual-fuel (methanol/ammonia) vessels.

**In addition, policymakers should commit to stringent green hydrogen scale-up** through the adoption of national production subsidies, the development and implementation of safety regulations, the adoption of further policies to facilitate the adoption of SZEF (e.g., national and regional e-fuel mandates and the usage of any GHG pricing revenue to stimulate RD&D developments in SZEF), and for everyone else to continue making ever more progress to keep the urgency and intensity of what needs to be done a reality. **The 5% 2030 SZEF goal is achievable, and progress is being achieved on all fronts**, but now, with more certainty for industry from the IMO, is the time for that significant ambitious push to take place which will **create the conditions necessary for a rapid scale-up of SZEF demand**. The lead times for developing new supply-side production before 2030 are long and leave just a small window for announcements that could credibly be delivered. That window is likely to close within the next two to four years. The lack of demand-side preparedness will result in a large number of ships with much more expensive compliance pathways than is necessary and risks fleet-supply shocks. As a result, **the time for action is now**.

# Content

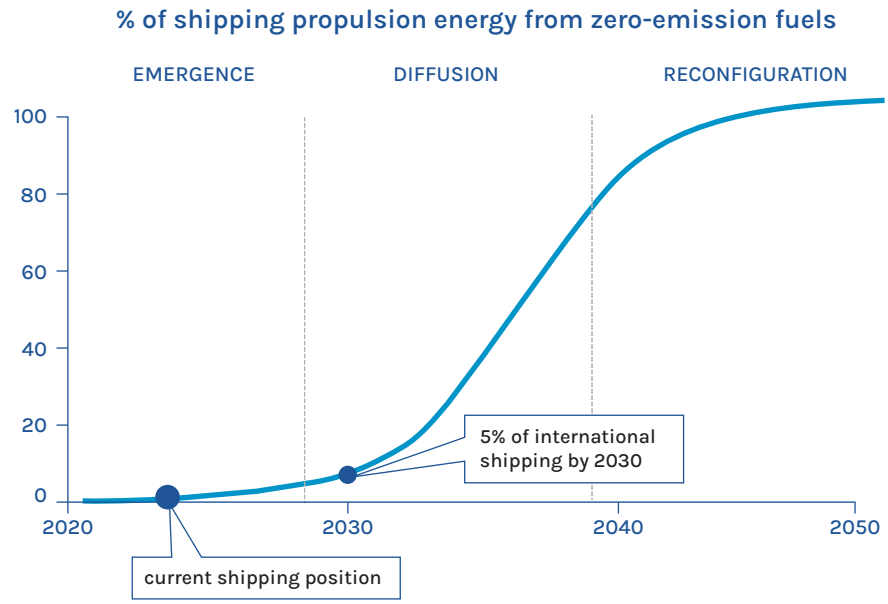
# Introduction

This year has seen a historic development regarding maritime decarbonisation with the adoption of the 2023 International Maritime Organization Strategy on Reduction of GHG Emissions from Ships (2023 IMO GHG Strategy) during MEPC 80 at the International Maritime Organization (IMO) (IMO, 2023c). The 2023 GHG IMO Strategy sends a clear signal to policymakers, industry, and other shipping stakeholders that shipping is committed to a path of decarbonisation and that a key part of that journey is the adoption of scalable zero emission fuel (SZEF).

At any given time, we are likely to be within touching distance of something that has been transported by sea. From our computers to clothes, or the energy powering our homes, maritime shipping accounts for 3% of global greenhouse gas (GHG) emissions whilst transporting around 80% of global trade (UNCTAD, 2022). This is supported by two million seafarers worldwide (ICS, 2023). As other sectors decarbonise and as the global economy continues to expand, the total size of these emissions and their relative share compared to other sectors will likely grow under a business-as-usual scenario. As such, shipping has an instrumental role to play in supporting global efforts to limit global warming to 1.5°C compared to pre-industrial levels. In this process, many solutions will play an important role, including improvements in energy and operational efficiency, novel technologies, and measures such as wind assistance and shore power. However, it is clear that, without the adoption of SZEF, shipping cannot meet its decarbonisation ambitions (Smith, et al., 2021).

This report builds on the work done and published last year (Baresic and Palmer, 2022), which tracked shipping progress towards SZEF adoption. As was outlined in the previous report and in work preceding it (Smith et al., 2021; Osterkamp et al., 2021), shipping is currently in the beginning phase of a three-phase fuel transition. 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). For shipping to progress towards the next phase of this fuel transition and for it to be in line with the ambitions set out at MEPC 80, significant actions across multiple segments are required. In addition, it is estimated that at least 5% SZEF usage will be necessary by 2030 (ibid.) which equates to just over 0.6 EJ of energy demand (Baresic and Palmer, 2022). Depending on the green hydrogen derived SZEF used, this equates to around 29.8 million tonnes of ammonia or 28.1 million tonnes of methanol.[8] With the adoption of the 2023 IMO GHG Strategy and the addition of a new level of ambition to reach “at least 5%, striving towards 10% uptake of zero or near zero GHG emission technologies, fuels and/or energy sources” by 2030 (IMO, 2023c), this goal becomes even more pertinent.

8 Based on internal UMAS 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.




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

**Figure 1. S-Curve relation to decarbonisation of maritime shipping.**[9]

Initial efforts are already taking place to decarbonise shipping, but these must be accelerated if the shipping sector is to achieve the 5% goal as outlined by the UN Climate Change High Level Champions' 2030 Breakthroughs campaign (UNHLCC, 2021). In October 2021, the Climate Champions, UMAS, and the Global Maritime Forum (GMF) published an action plan (Palmer et al., 2021) to achieve the 2030 Breakthrough goal of 5%, which sets out specific near-term actions and milestones. It details what key actors must do and by when to deliver the needed transformation of shipping, creating a shared vision for all players in the maritime value chain and clarifying how the efforts of each actor contribute to the whole, therefore increasing confidence and generating greater impact.

**Shipping is still in the "emergence" phase of a fuel transition. Following the ambitious signal from the IMO during MEPC 80, multiple actions are necessary to ensure that at least 5% of shipping is from SZEF by 2030.**

The last year has seen growing convergence around the goal of 5%, and over this period it has been not only non-state actors such as the Getting to Zero Coalition (GtZ) aligning to this goal. Governments and observer organisations rallied around this ambition during the 2023 IMO GHG Strategy revision discussions at the IMO, resulting in 5% becoming a lower bound ambition of the strategy whilst striving towards 10% by 2030.

The aim of this report is to follow up from the 2022 report, to continue tracking progress towards the 5% 2030 SZEF goal, and to understand what further actions are necessary to make that goal a reality and to go beyond it. The report revisits the change levers, and their respective actions and indicators, some of which have been modified and streamlined since last year to better track

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

progress. The levers are used to understand which actions are on track and which remain to be improved upon. The justifications of outcomes for each action in terms of progress tracking are provided in Annex A. The report reviews five system change levers - technology and supply, demand, finance, policy, and civil society - and ascertains whether the actions currently undertaken are in alignment with the 5% goal. This process also includes the assessment of current targets, including the addition of specific intermediate 2025 enabling goals.

i. **Technology and supply** – key actions relating to the development of necessary onboard 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 can be developed over time in a gradual manner, avoiding supply issues and facilitating the 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 a national and international levels (i.e., IMO) which would be necessary to facilitate the adoption of SZEF, such as economic and technical measures, various guidelines, and agreements.

v. **Civil society** – individual, workforce, and community engagement and action including the provision of future decent work, and increasing participation of underrepresented groups in shipping climate change discussions such as SIDS/LDCs,[10] indigenous communities, and a range of other diverse communities.

The actions are evaluated as:

a. **On track** – the actions and related targets 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 the actions are progressing in a promising direction and are close to being met. However, there is either insufficient evidence to adequately ascertain target progress, or there has been significant progress, but it 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.

10 Small Island Developing States and Least Developed Countries

# Overview of progress towards the 2030 5% Scalable Zero Emission Fuel goal and beyond

As was the case in 2022, overall, the actions to reach 5% SZEF by 2030 remain partially on track, as highlighted in Table 1. However, with the increased ambition at the IMO observed in the 2023 IMO GHG Strategy, consideration should be given to increasing this ambition further to 10%. Such an increase in ambition could lead to a positive feedback loop and further motivate action across all levers (i.e., the "ambition loop"). This report continues tracking progress against the 5% goal. To date, the current fleet capable of using SZEF puts potential demand for SZEF at about 0.006 EJ or (1% of the goal of 0.6 EJ by 2030), equating to roughly 300,000 Mt of methanol (or 320,000 Mt of ammonia).

Since last year, progress has been observed across all change levers, including the adoption of the 2023 IMO GHG Strategy (IMO, 2023c), the launch of the Zero Emission Maritime Buyers Alliance (ZEMBA) (coZEV, 2023), continued announcements from large shipowners on orders of zero emission vessels (Lloyd's List, 2023), new green corridors announcements, as well as multiple national maritime decarbonisation strategies.[11]

**The 5% goal is achievable, but not without increased concrete actions which can facilitate more demand for SZEF. As a result, demand is not on track.**

Progress has been observed in all segments, with announcements of new pilot and demonstration projects (GMF, 2023) facilitating increased R&D and knowledge sharing, newly announced e-methanol and ammonia projects increasing the potential supply of SZEF by 2030, and significant national commitments in terms of hydrogen production and electrolyser targets by 2030. These have all happened concurrently with significant developments in terms of the 2023 IMO GHG Strategy being adopted in July 2023 (IMO, 2023c). In terms of civil society, the presence and interaction of various voices at IMO level have continued to increase, but more remains to be done to ensure that voices from diverse geographies and communities are represented in the debate about SZEF adoption. In terms of demand, compared to last year, the demand lever has been reclassified to "not on track" from "partially on track".

From last year, there has been a shift in focus from policy to demand, with an increased emphasis on actions in terms of the demand change lever. The progress in terms of policy which has been observed is a direct result of the understanding that more was possible and necessary, showing a real-world example of an "ambition loop" in decarbonisation ambition. Now is the time for that loop to continue into demand.

11 Based on desk-based research of available news reports on announcements by different stakeholders and information available from the Global Maritime Forum (GMF) including the Pilot Mapping report (GMF, 2023).

A key component is the evolution in the type of engagement needed by industry now, compared to two to three years ago, to keep demand progress on track. As was mentioned in the 2022 report, it is time to turn the positive commitments into concrete actions. Unfortunately, this change to actions has not been observed in the orderbook for SZEF vessels, which is necessary for the lever to be considered on track.

Figure 2, in line with the S-curve projections for SZEF, shows that progress on the supply of SZEF has been more aligned than that of demand. In 2023, as expected from the adoption rate, the numbers for the supply and demand for SZEF are modest, at 0.00693 EJ existing capacity for e-methanol, and 0.00143 for green ammonia, with potential demand of about 0.006 EJ (i.e., barely visible as a line in 2023 in Figure 2). However, considering SZEF projects under development and expected SZEF-capable fleet growth, the rate of increase over the coming years could be considered more optimistic (Figure 2). For 2025, current projections make it likely that SZEF supply will be partially on track, mostly depending on the successful completion of projects currently under development and the availability of that supply for maritime usage. However, further action will be necessary to increase potential (and actual) demand. For 2030, it remains unclear if either supply or demand will reach the required targets. The supply picture is much more positive and, in the "high" demand scenario, assuming a continued growth rate in project announcements and implementation from the present and at high availability of SZEF supply for maritime,[12] the available supply could exceed the 5% goal and bring us closer to reaching the 10% goal of the 2023 IMO GHG Strategy.

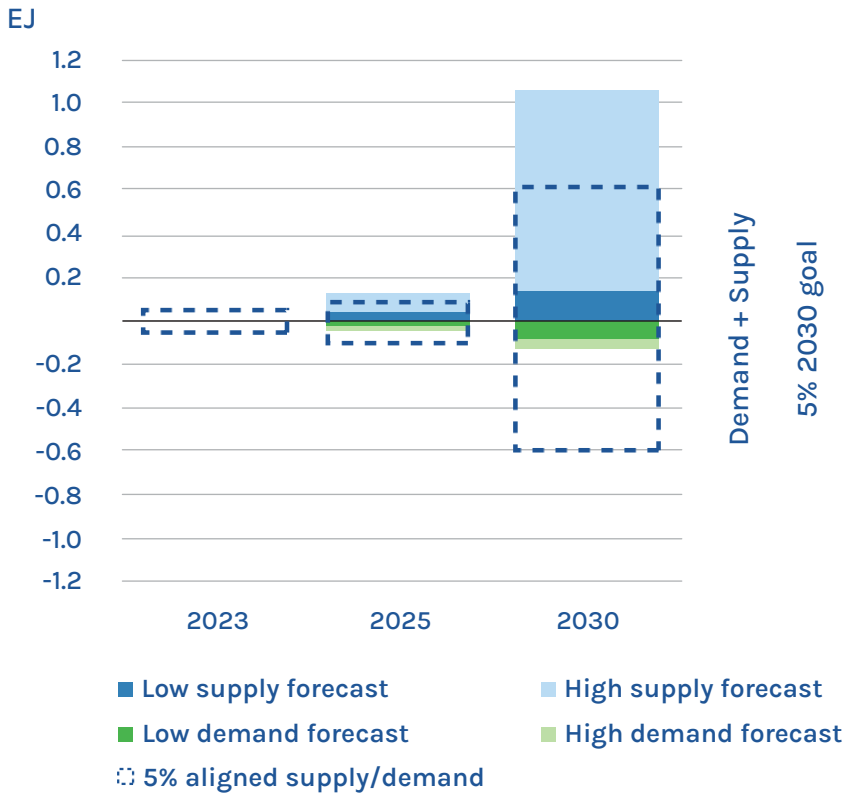
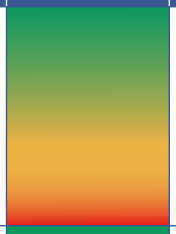
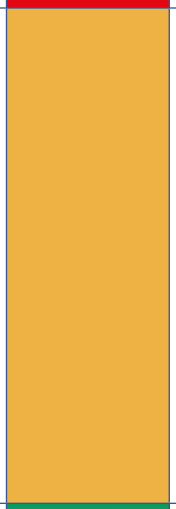
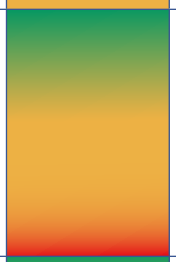
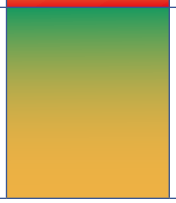



**Figure 2. Estimated total SZEF supply and demand for shipping compared to 5% 2030 SZEF goal aligned supply/demand up to 2030 (i.e., 0.6 EJ in 2030).[13]**

12 In the high scenario, this would mean 50% of green ammonia supply being dedicated for maritime usage and 75% of e-methanol supply.

13 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.

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"<br>• 3/7 actions "partially on track"<br>• 1/7 actions "not on track" | • 60 GW green hydrogen electrolyser capacity<br>• Green hydrogen production cost of US$1.5-2/kg depending on the region<br>• 0.6 EJ of SZEF supply available by 2030 and 0.1 EJ by 2025 (indicative) |
| DEMAND |  | • 2/8 actions "on track"<br>• 1/8 actions "partially on track"<br>• 5/8 actions "not on track" | • 600 15k TEU containerships equivalent of SZEF demand[15]<br>• 8.75-12.5% of all TEU-miles to be SZEF by 2030 if other segments also scale out proportionally to SZEF[16]<br>• All new ships to be SZEF-capable<br>• Majority of existing SZEF-ready tonnage to be converted to full SZEF-capability |
| FINANCE |  | • All actions "partially on track" | • Alignment of shipping portfolios for as much of the US$ 500 bn+ of shipping debt to be as close to Poseidon Principles trajectories as possible — with those trajectories expected to match requirements for 1.5°C — but no higher than 10% and the majority to be under 5%<br>• 2/3 or more of all shipping debt to be tied to Poseidon Principles trajectories, increasing coverage from APAC and Greek lenders, and continued transparency from Western lenders<br>• Continued or increased issuances of sustainability-linked loans and bonds to, and interest from, shipowners and related segments including ports and fuel suppliers<br>• Stricter requirements for eligibility for sustainability-linked loans and bonds and the focus to shift primarily to SZEF-related assets |
| POLICY |  | • 3/10 actions "on track"<br>• 5/10 actions "partially on track"<br>• 2/10 actions "not on track" | • Adoption of ambitious shipping economic instruments with regulatory support for 5% SZEF adoption<br>• Top 20 countries by maritime traffic have ambitious domestic decarbonisation policies with increased hydrogen production commitments<br>• International agreements on zero GHG shipping routes |
| CIVIL SOCIETY |  | • 2/5 actions "on track"<br>• 3/5 actions "partially on track" | • Growing SIDS/LDC participation in IMO policy negotiations and or national action plans<br>• Increased NGO pressure<br>• Workforce upskilling/retraining programmes in place |

**KEY:**

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

14 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 for container fleet.
15 For context, total TEU-miles were 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% goal to be achieved, actions and developments across the five levers of change will need to include:

- **Technology and supply**: Further action in terms of increased commitment in hydrogen strategies and electrolyser capacity to take into account maritime demand for hydrogen to produce SZEF. This should be linked to specific funding streams dedicated to SZEF production and regulatory mechanisms to facilitate development (e.g., CfDs, national targets, etc.)

- **Technology and supply**: Increased scaling up of SZEF production through the development of required facilities whilst earmarking production capacity across the entire production chain for maritime to ensure that the required supply is available.

- **Demand**: Increased focus on technical and safety regulations for SZEF that can enable the rapid scale-up and safe operation of SZEF vessels.

- **Demand**: 5-10% of TEU-miles to be dedicated to SZEF by 2025, if the transition is largely to be led by containerships.[16] If all other segments also scale up the use of SZEF proportionally to their share of total shipping $CO_2$ emissions, then about 1.5-3% of TEU miles need to operate on SZEF. For context, if a single 15,000 TEU containership were to conduct repeated voyages between Los Angeles and Yokohama all year, it would cover somewhere in the range of 0.05% to 0.08% of total annual TEU-miles. Thus, around 20 to 60 of these ships completing the same voyage all year round would be necessary to reach 1.5%-3% SZEF TEU-miles.[17]

- **Demand**: SZEF capable vessels need to create 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**: Greater alignment of shipping debt to Poseidon Principles' trajectories, an immediate update of these trajectories to the 2023 IMO GHG Strategy as a minimum whilst aiming for 1.5°C, and increased transparency from lenders on their shipping debt and its alignment. The latter needs to include more lenders from Asia-Pacific and Greece, whose shipping portfolios are growing, to ensure that shipping portfolios continue to be on track towards the 2030 goal. Additionally, the updating of Poseidon Principles in line with a 1.5°C pathway.

- **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**: Further action at the IMO is required to make the 5% goal more easily achievable, in particular, converting the commitments in the 2023 GHG Strategy for a 5-10% "uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources" into concrete technical and economic instruments.

- **Civil society**: Continued inclusion of diverse voices with a range of perspectives whilst ensuring that SZEF adoption is managed in a way which ensures geographic heterogeneity and the equitable sharing of benefits.

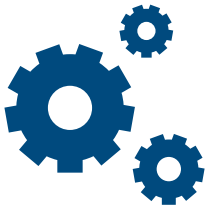
16 Initiatives such as ZEMBA can play an important role in aggregating demand.

17 Los Angeles to Yokohama is about a 5,000 nm journey and takes about 12 days to sail at average speeds of about 16 knots. Based on the average days at sea in a year for this size class of vessel of 250 days (Faber et al., 2020), that would mean about 20 voyages a year generating a total of approximately 1.5 bn TEU-miles.

# System change levers

**Actions necessary to reach 5% SZEF adoption by 2030 can be grouped into five distinct change levers: technology and supply, demand, finance, policy, and civil society.**

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.



## Technology and supply

### Overview

Similar to the 2022 report, the technology and supply actions focus on the development of technology R&D and meeting the planned demand for SZEF. Compared to 2022, the lever indicators were modified to better reflect the supply necessary to reach the 5% goal. Several indicators were merged where any overlap in necessary actions was identified, and a more nuanced focus on tracking key technology developments and cost components necessary for SZEF production was made. Overall, the lever remains partially on track to reach the 2030 goal.

### Technology

Technological progress across all aspects of the maritime transition has remained strong. The latest edition of the Getting to Zero Coalition (GtZ) Mapping of Pilot & Demonstration Projects (GMF, 2023) recorded 373 separate projects, up from just over 200 in the third edition (GMF, 2022b). The data indicates a strong trend of cross-industry collaboration in the development of zero-emission vessels, with 80 of the 373 initiatives involving collaboration between four or more value-chain segments and an additional 240 involving collaboration between at least two value-chain segments. Projects focusing on fuel production, bunkering, and infrastructure have continued to increase year-on-year since the initiative's inception and demonstrate a dominant focus on hydrogen-based technologies. Progress on ammonia and methanol internal combustion engines has remained strong, with the first methanol-powered vessels entering service and the first ammonia engine due to be delivered in 2024 (Lloyd's List, 2023). However, there is uncertainty as to whether the manufacture of such engines will be possible at a rate capable of delivering the 5% goal by 2030. Modelling suggests the equivalent of 600 containerships of 15,000 TEU capacity will be required.

## Supply

The degree to which emergent-phase technologies are scaling at a rate consistent with supplying volumes of SZEF aligned with the 5% goal in 2030 is less clear. An important catalyst for supply scale-up will be the cost of production for green hydrogen. An analysis of learning rates for solar PV and onshore and offshore wind technologies observed between 2010 to 2020 and extrapolated to 2030 indicates that production costs of green hydrogen are likely to drop below US$2/kg under favourable conditions by 2026. That is the point at which around 15% of total transport sector demand could be powered competitively using green hydrogen (Hydrogen Council, 2020). However, the conversion steps required for green hydrogen to be useable as a maritime SZEF, even at a US$1.5/kg green hydrogen production price, ensure significant cost differentials with incumbent fossil fuels are likely to remain (Smith et al, 2021; LR&UMAS, 2020), and policy support mechanisms will be required to overcome them (GMF, 2022a).

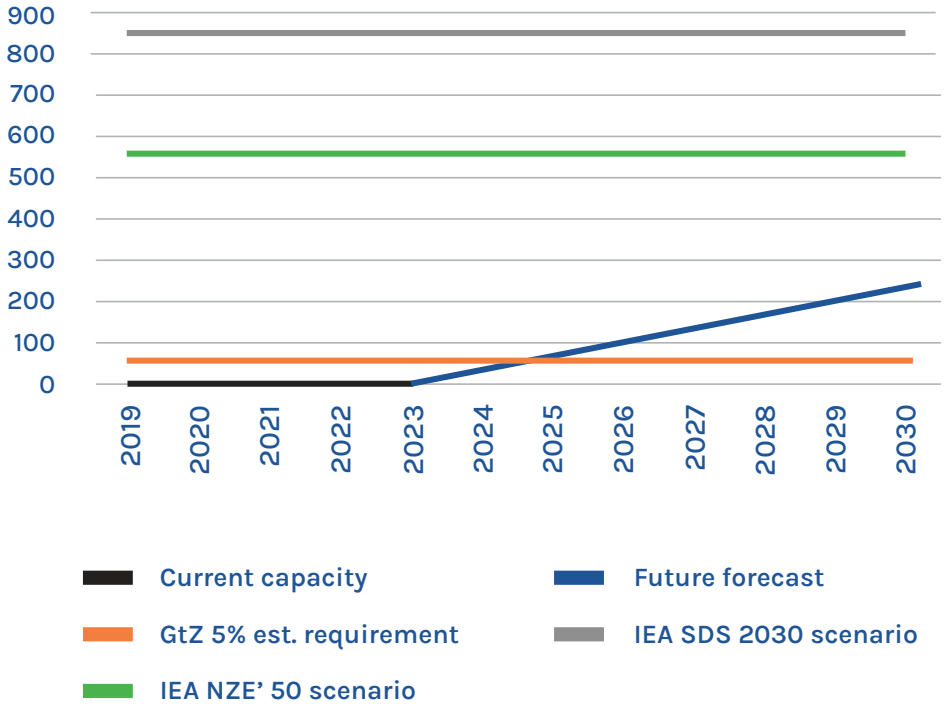



**Figure 3. Estimated electrolyser capacity and hydrogen production compared to requirements under the 5% 2030 goal.[18]**

More than 30 countries have released hydrogen roadmaps, including 16 of the top 20 nations[19] ranked by TEU traffic, and more than 13 national hydrogen strategies have been published. Multiple GW-scale green hydrogen targets have been announced by governments in recent years, aggregating to 160-210 GW at the end of 2022 (IEA, 2023c). The current pipeline of project announcements in the IEA's hydrogen database represents up to 24 Mt

18 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 - UMAS estimates where 5% of 12.9 EJ is 0.64 EJ (Osterkamp et al., 2021).

19 Based on an analysis of publicly-available information from press releases, government-issued reports, and other associated documents for the 20 countries outlined: Belgium, Brazil, China, Germany, India, Indonesia, Italy, Japan, Malaysia, Netherlands, Philippines, Singapore, South Korea, Spain, Thailand, Turkey, United Arab Emirates, United Kingdom, United States, and Vietnam.

of green hydrogen capacity by 2030. Only around 2.3 Mt of the announced pipeline is currently operational or under construction. However, the ramp-up of "new" future capacity announcements and the degree to which they will align with what is required by 2030, in terms of their scale and the proportion that reach a final investment decision, is uncertain. Electrolyser and green hydrogen capacity is, therefore, considered partially on track.

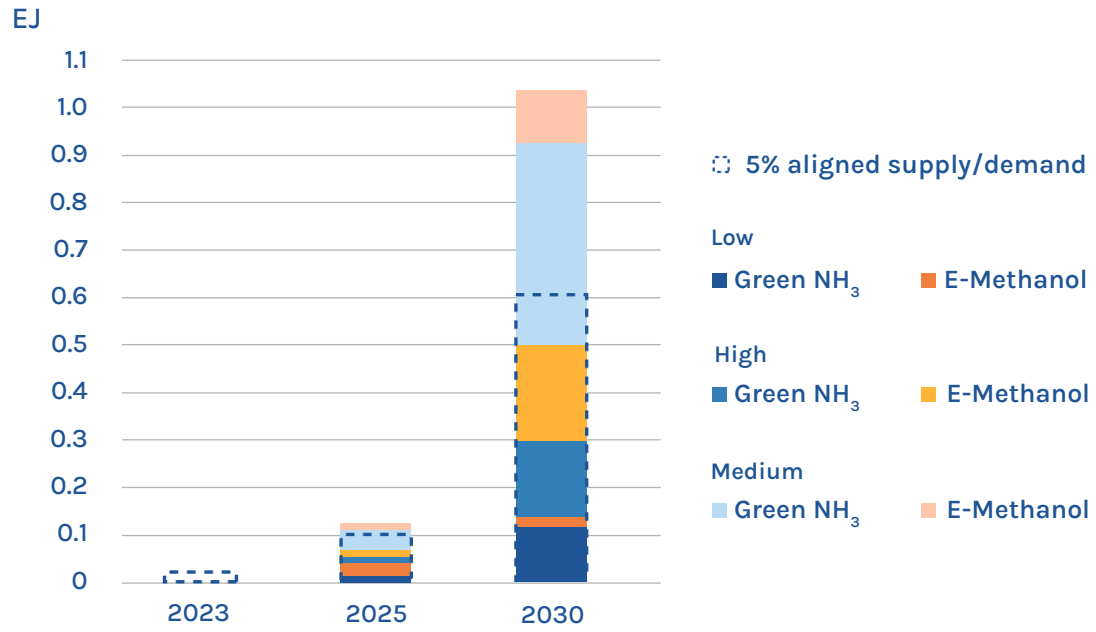



**Figure 4. Estimated total supply from SZEF for maritime usage compared to 0.6 EJ 2030 requirement in line with the 5% SZEF 2030 goal.[20]**

AEA data (AEA, 2023) suggests the current pipeline of green ammonia production announcements represents 192 Mt (4.3 EJ). Data from the Methanol Institute (Methanol Institute, 2023) suggests there is a current pipeline of e-methanol production representing around 6 Mt (0.1 EJ). Of this possible supply, 0.8 Mt (0.02 EJ) of green ammonia capacity is currently operational or under construction. Around 0.1 Mt (0.002 EJ) of e-methanol is estimated to be currently available each year, however, data for the capacity currently under construction is not available. It is clear that new project announcements will, therefore, be required to meet the 2030 5% goal, especially given possible competition from other industries. However, understanding how new SZEF capacity announcements will materialise and the extent to which they will align with what is required by 2030, in terms of their scale and the proportion that will reach a final investment decision, is highly uncertain. As can be seen from Figure 4, depending on considerations of future capacity growth rate for green ammonia and e-methanol, a range of potential future capacity scenarios for SZEF can be created. These will also depend on the amounts of these fuels which are available for maritime use and do not go to other sectors; a significant consideration which went into the creation of the three scenarios (Appendix B). Overall, the scale of SZEF production is, therefore, considered partially on track.

20 The scenarios are based on understanding the existing production capacity of e-methanol and green ammonia, as well as taking into consideration available, albeit limited information on plans for the utilisation of currently announced projects, based on news reports, and data from the AEA and the Methanol Institute. More information is available in Appendix B.

**To reach 5% SZEF by 2030, 60 GW of electrolyser capacity dedicated to SZEF production will be required.**

Finally, domestic shipping may be able to provide a significant contribution to the 5% target (Osterkamp et al, 2021). The decarbonisation of domestic shipping could provide necessary RD&D synergies for technological development with international shipping and, by targeting optimal technological solutions for domestic shipping, avoid any competition with international shipping for the same SZEF. With developed nations constituting roughly half of domestic shipping emissions, a 30% transition to zero-emission sources in those countries would represent a reduction of 15% across all domestic shipping and a 2-3% reduction in terms of total shipping energy (ibid.). This highlights the contribution that short-sea technologies such as battery-electric and fuel-cell propulsion systems, as well as 4-stroke methanol and ammonia engines, could indirectly provide towards achieving the 5% target. Battery-electric methods of propulsion are well developed technologically, with a technology readiness level of 8.5 assigned by the IEA (IEA, 2023b) and a plethora of battery-electric vessels currently on the orderbook, under construction, or operational. Fuel cell propulsion methodologies are less mature, with the IEA assigning a technology readiness level of 5.8 and much fewer fuel cell-enabled vessels on the orderbook or under construction (Lloyd's Register, 2023). Based on orderbook calculations and assumptions used in the 4th IMO GHG Study (Faber et al, 2020), the impact of battery-electric and fuel-cell vessels on 2030 is still relatively small. Therefore, despite continuing technological progress, a significant scale-up of the pipeline for battery-electric and fuel-cell vessels will be required.

## Tracking progress – partially on track

**Table 2. Technology and supply lever progress**

| KEY ACTIONS | TIMELINE: | | | PROGRESS | TARGET BY: | | |
|---|---|---|---|---|---|---|---|
| | 22 | 25 | 30 | | 2023 | 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 | | | | NOT 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 US$2/kg. | Green hydrogen production cost reaching US$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% goal, especially in setting the pace and ambition of the transition and in stimulating the supply of SZEF. It was 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. These targets would be the equivalent of about 100 15,000 TEU containerships all running on SZEF for a year in 2025 and about 600 similar ships in 2030, if no other sectors take up SZEF.[21]

Eight key indicators are now used to help track progress on SZEF demand. These cover everything from the number of key industry actors committing to net zero targets, actions being taken to make zero-emission freight more commonplace, the implementation of pilots and demonstrations related to SZEF, to 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.[22]

**To reach the 5% goal by 2030 is the equivalent of 100 15,000 TEU containerships all running on SZEF for a year in 2025 and about 600 similar ships in 2030.**

Commitments, for example, to targets and actions as defined in the Science Based Targets initiative (SBTi) (SBTi, 2023) have been growing, with five ship owners or operators,[23] as well as two ports or shipyards, now committed to the level required by SBTi for net zero by 2050 and to be in line with keeping global warming to below 1.5˚C. These commitments are so far only partially sufficient. The number of companies committed to SBTi needs to rapidly increase by 2025, and the commitments each one makes need to translate to measurable actions. However, a growing number of pilots being evaluated suggest both that there is a positive trend towards the transition, but also that a lot of uncertainties (and opportunities) are being evaluated to make the demand and supply of SZEF realistic (GMF, 2022). As these pilots evolve and uncertainties become better understood, further commitments would likely be made across the industry. Hence, commitments appear to be partially on track.

The trend in announced green corridors is also progressing, but there remains considerable ambiguity about the type of fuel to be used and the progress of several corridors. The new impetus on urgency for SZEF adoption because of the 2023 IMO GHG Strategy puts even more focus on ensuring that any material impact green corridors can have on SZEF adoption occurs sooner

21 Further explanation of how numbers were derived in Appendix B.
22 A lot of the demand methodology and indicators from the previous report have been modified or updated. This has led to a change in the overall progress for demand. Many of the changes introduced utilise new datasets and improved modelling capability, but also help provide a clearer picture of the evolution of demand in this report and the ones to follow.
23 These include, for example, A.P. Moller – Maersk, Evergreen, Nordic Ferry Infrastructure, and ports or yards such as DP World.

rather than later. As a result, progress on green corridor helping create demand is only partially on track, and the definition of "dark green" corridors has been included for those corridors that are more specifically in line with the 5% goal.[24]

Many more vessels, however, will still need to turn to SZEF to help reach 5% by 2030, as the current demand trajectory is not even in line with what is needed for 2025 (Figure 5). To put the scale of this challenge in perspective, if this transition was undertaken by the container fleet alone, then about 5-10% of all TEU-miles would need to be sailed using SZEF in 2025.[25] Projecting the current growth in SZEF-fuel capable tonnage and trends in the orderbook, there would be about 20-40 15,000 TEU containerships-worth of potential demand for SZEF in 2025, or the equivalent of about 1.5-3% of total TEU-miles or 0.03-0.05 EJ. Other segments would need to then contribute significantly to reach 0.1 EJ in total by 2025. By 2030, with other segments also switching to SZEF, SZEF would need to be used on about 8.75%-12.5%[26] of all TEU-miles. These projections, however, assume that the capability to utilise SZEF and, hence, the hypothetical demand estimated for those fuels translates to actual uptake, which cannot be guaranteed given that most orders allow for fossil fuels to also be used.

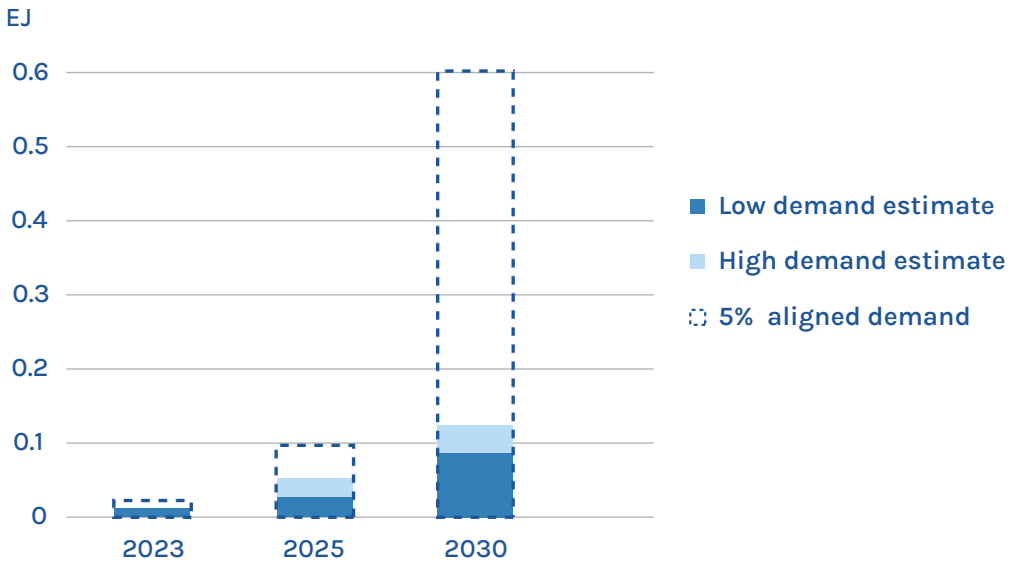


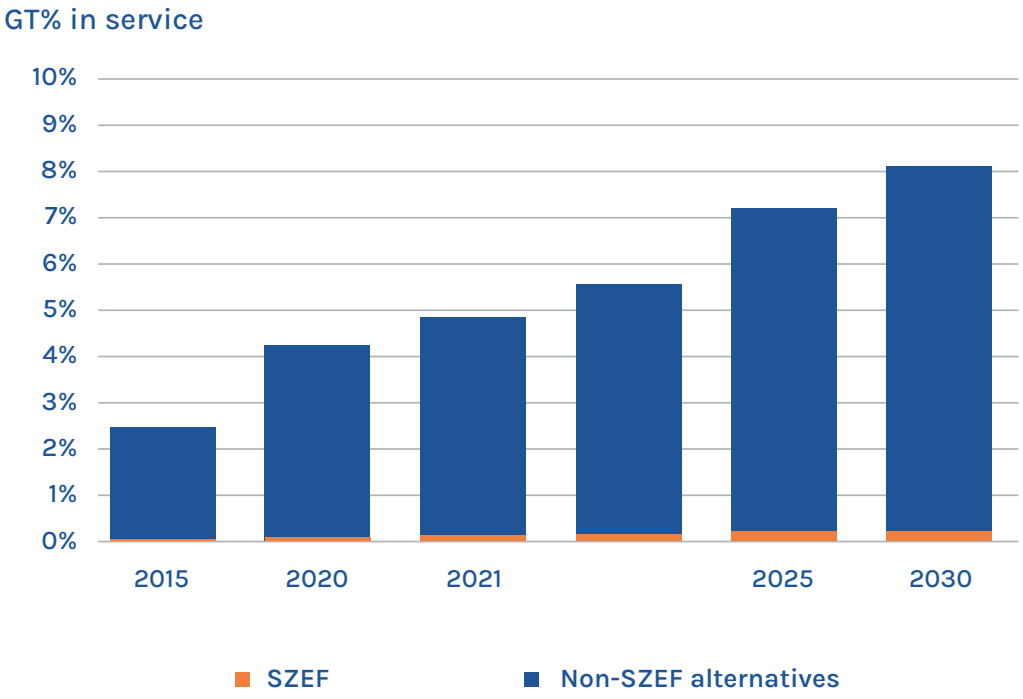

**Figure 5. Estimated total potential SZEF demand based on fleet growth, and targets for 2025 and 2030.[27]**

Growth of the alternative-fuel capable tonnage has been dominated by LNG, with LNG-powered and LNG-capable vessels more than doubling in GT terms between 2015 and end-2022 (5% of total world GT from 2.2%). LNG-powering or capability, however, is not considered SZEF compliant. In the same period, methanol-capable tonnage has increased six-fold, from 0.01% to 0.06%, but remains a very small proportion of the whole fleet. Likewise, vessels capable of

24 Based on GMF (2022e), "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.
25 In 2018, the container fleet is estimated to have supplied over two tera-TEU-miles, based on the 4th IMO GHG Study (Faber et al, 2020).
26 See Annex B for further insight on how this was estimated.
27 UMAS internal analysis based on orderbook information and future growth estimates for ammonia ready, methanol, methanol DF, hydrogen, and hydrogen DF.

using other fuels like LPG or ethane have increased 13.5 times, from 0.02% to 0.27% of total GT. Whilst ammonia-capable tonnage could also play a crucial role in supplementing the demand potential for SZEF, such capability is only expected to come to market in late 2024 (Lloyd's List, 2023) (Figure 6).

**Figure 6. SZEF-capable vessels and other vessels as a share of global total GT.** [28]




If tightening legislation from IMO and local authorities, and shorter timelines for adoption following the 2023 IMO GHG Strategy, were factored in, hypothetical demand for SZEF in 2025 could go beyond the current projection of 0.03-0.05 EJ and move closer to the target of 0.1 EJ. This would have to occur in combination with a rapid slowdown or diversion away from new, non-SZEF-capable vessels, the conversion of existing tonnage to SZEF capability, and an increase in (early) scrappage of legacy tonnage running with non-SZEF-capable engines. The indicators measured today are not strong enough to suggest that these changes are occurring conclusively, but will likely move into being partially on track in the coming few years.

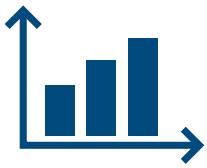
28 Source: Clarksons WFR (2023). Projections made by taking into account the historical growth rate of each type of fuelled fleet in GT terms, including the trend in the orderbook, and projecting linearly towards 2025 and 2030.

## Tracking progress – not on track

Table 3. Demand lever progress

| KEY ACTIONS | TIMELINE: | | | PROGRESS | TARGET BY: | | |
|---|---|---|---|---|---|---|---|
| | 22 | 25 | 30 | | 2023 | 2025 | 2030 |
| Key industry actors commit to net zero by 2050 based on SBTi requirements and actions | | | | ON TRACK | 5-10 shipowners and operators committed<br><br>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"<br><br>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 containerships. If other segments also scale up, 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 | | | | 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 | | | | PARTIALLY ON TRACK | | 3-6 "dark green" corridors on major deep-sea routes functioning with multiple vessels on each using SZEF on a regular basis<br><br>3-4 routes have a roadmap in place, 2-3 routes 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 containerships running on e-methanol,[31] or 20-30 15,000 TEU ships, if other segments in line[32] | 600 15k TEU equivalent ships running on e-methanol or ammonia, or about 150 ships, if other segments take up SZEF at a similar pace<br>18-36 Mt/year of SZEF to be demanded by the alternative fuel capable fleet |
| 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 as a change lever is critical to facilitating the transition to SZEF, by encouraging and facilitating the uptake of SZEF, but also in discouraging the uptake of fuels, vessels, and related infrastructure that are not supportive of SZEF.

Four indicators measure these critical aspects that help illustrate 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, 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, all the way to the availability and growth in public finance.

At the end of 2022, about US$200 bn of an estimated US$525 bn of shipping debt (all financing, including leasing, export finance, and alternative providers) was tied to Poseidon Principles and its trajectories.[31] For the lenders, where it is possible to separately calculate or estimate their shipping portfolio sizes - about US$160 bn of the US$200 bn – the weighted average Poseidon Principles

29 Equivalent to 0.1 EJ worth of energy in potential SZEF.
30 Potential demand for methanol, as an example, would be equivalent to 3-6 million Mt/year.
31 Utilising Petrofin Research (2021-23) annual reports and research from Clarksons SIN (2023).

alignment score is 6% in 2022 compared to 4% in 2021 (Figure 7).[32][33] In 2022, a larger proportion of debt under Poseidon was below or equal to 5% than in 2021 (14% compared to 10%), despite the target alignment number being stricter than in 2021. Thus, compared to 2021, portfolios appear to have either stayed where they were or have improved slightly.[34]

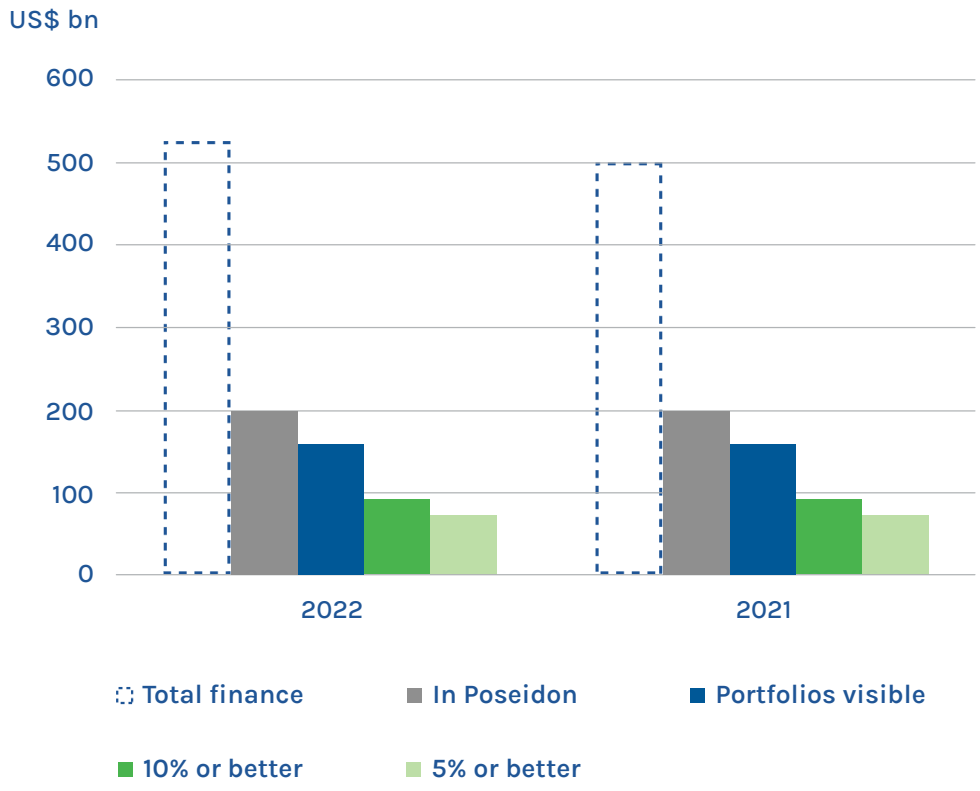



**Figure 7. Ship finance estimates, coverage under Poseidon Principles, and share aligned to 10% or 5% or better.[35]**

A weighted average alignment score of the portfolios to Poseidon Principles trajectories is an indicator of commitment — that about US$160/525 bn (30% of total financing) is aligned to the trajectories and appear to be improving slightly. However, Poseidon Principles trajectories, for the years evaluated, were only targeting a 50% reduction in emissions by 2050 and are therefore, not in line with keeping global warming below 1.5°C or the 5% goal for 2030 for SZEF. Whilst aligning finance to the less ambitious trajectories is not helpful in reaching the goal of 5% SZEF by 2030, it may be helpful in the overall transition and its facilitation. Moreover, there is little to suggest conditions within the issued finance are sufficiently stringent, are leading to SZEF development specifically, or are incentivising such activity. Updating Poseidon Principles to be in line

**Updating Poseidon Principles to be in line with a 1.5°C pathway is something that should be considered a priority.**

32 For each lender's shipping portfolio, given its either known or estimated size, the alignment score to Poseidon Principles is weighted relative to the size of this portfolio over total shipping debt. As an example, if total debt was US$500 bn and there were only two lenders, one with US$400 bn in assets and the other US$100 bn, and lender A's portfolio had an alignment of 5% and lender B 10%, the weighted alignment of the US$500 bn would be 0.8 x 5% + 0.2 x 10% = 6%.

33 Note that Poseidon Principles show progress to a year before their date of reporting and, therefore, there is a lag.

34 However, note that also Poseidon Principles trajectories, at the time of writing, are aligned only to the Initial IMO GHG Strategy (2018).

35 Source: Petrofin Research (2021, 2022, 2023), Poseidon Principles (2022, 2023).

with a 1.5°C pathway should be considered a priority.

Transparency and alignment of debt have also seen improvements. 8% more in total debt is covered under Poseidon Principles in 2022 compared to 2021 (a 33% increase since 2020). This growth may, however, stagnate going forward. Asia Pacific and Greek lenders show the fastest growth in lending appetite to shipping (Petrofin Research, 2022), and their acceptance of Poseidon Principles requirements will be critical to maintaining high levels of transparency and commitments across sources of funding over the next seven years. Western banks' exposure to shipping, in contrast, has been declining, so progressive mandates from EU, US, or UK lenders may be outweighed by less progressive behaviour by Asia Pacific or Greek lenders and the correct balance could be missed in these indicators if their debts are not captured. Sustainability-linked loans and bonds issued to shipowners and operators have also shown signs of progress (Figure 8). Despite the slowdown in issuances across most industries in 2022, about 0.5% of all such bonds and loans issued globally went to shipping in 2021 and 2022.[36] Cumulatively, this amounts to about US$10 bn since 2021. At the current rate of US$5 bn per year, it could be expected that a cumulative total of about US$25 bn could be issued by end of 2025. However, these issuances are not explicitly tied to financing SZEF-related assets, and conditions or terms are neither consistent nor strict enough to drive change. Thus, at present, a relatively stable allocation in percentage terms of all such issuances are indicative only of an appetite to acquire such financing mechanisms in the industry.

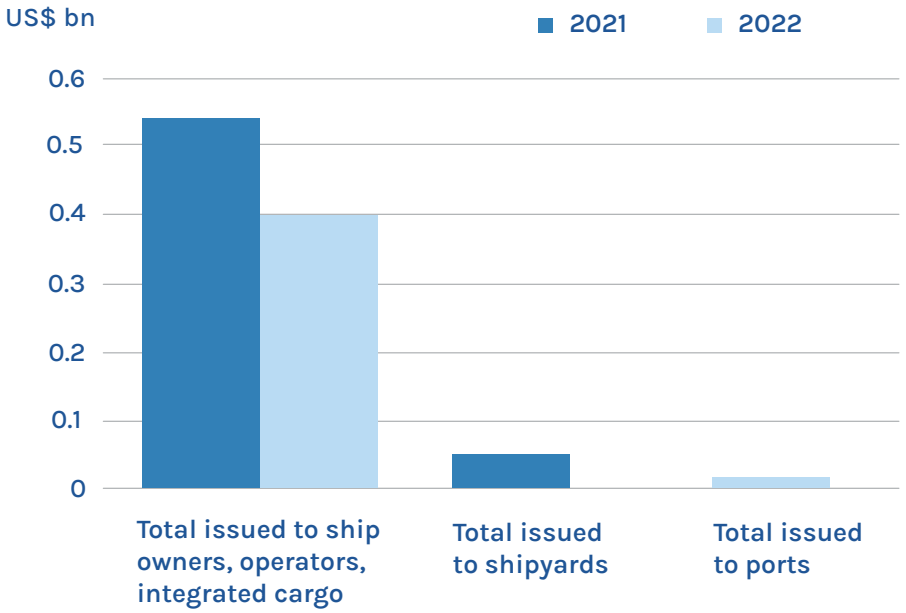



**Figure 8. Issuance of sustainability-linked loans and bonds between 2021 and start of 2023.[37]**

Sustainability-linked loans and bonds were also issued to ports of approximately US$195 mn in 2022, and to shipyards of US$500 mn in 2021 (Clarksons SIN, 2023). Again, it is unclear if this was directed towards SZEF production or bunkering capabilities, or, for instance, yard modifications needed for SZEF shipbuilding.[38] Assuming a constant rate of US$195 mn per

36 Based on data from Clarksons SIN (2023).
37 Source: Clarksons SIN (2023).
38 Proceeds for these instruments do not necessarily have to be linked to specific projects, but instead can be allocated to general capex or even corporate purposes, as long as they fit within a broader, demonstrated sustainability plan.

year, close to US$0.78 bn could have been cumulatively issued to ports by 2025. This remains less than the US$1 bn per year estimated to be needed by 2025.[39] However, the estimate used, and the growth rate may be very conservative. Sustainability-linked loans and bonds to port infrastructure are a recent development, with both lenders and capital markets only beginning to be more comfortable with issuing larger amounts. In Australia and in 2023 alone, more than half a billion dollars of such instruments have been issued.[40] Hence, a more rapid expansion of such funding to ports could be more than realistic in the coming years.

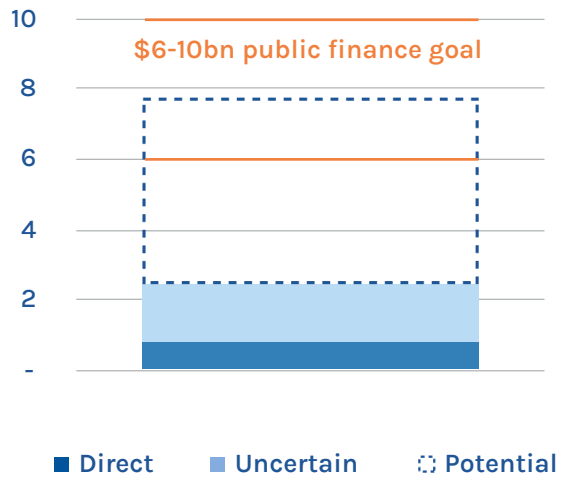



**Figure 9. Estimated public finance commitments which could be used for shipping decarbonisation.[41]**

On the public finance side, declared potential funding by governments that could be used for shipping decarbonisation is estimated to total around US$7.7 bn (Figure 9).[42] Such funds need to be more equally geographically distributed, with most current commitments coming from the EU and US. Many are also earmarked for "decarbonisation-related activities" more broadly, such as improvements to port infrastructure, energy efficiency, and associated activities. Although this can include SZEF, a significant part of those funds needs to be allocated explicitly to SZEF, or new, more SZEF-aligned funds need to be created. Future policy should also play a role to ensure that more is done to align these funds, or parts of those funds, directly for SZEF adoption. Uncertainties also remain on the available quantities, with large amounts still dependent on long-term developments like the possible revenue coming from the inclusion of shipping in the EU ETS. This would mean that a portion of funding will depend on the carbon price at the time, the actual or alternate usage of those revenues, as well as the rate at which shipping gets included into EU ETS.

39 Based on the 2022 progress report (Baresic & Palmer, 2022) and aimed at SZEF bunkering and maritime production investment.
40 Port of Melbourne, for example, received a US$475 mn loan this year (Port of Melbourne, 2023).
41 UMAS internal analysis based on government announcements from the top 20 countries. Further explanation of analysis behind figure given in Annex B.
42 Based on an analysis of the top 20 countries by TEU traffic through literature research of announced demonstration and pilot projects, the announced EU ETS inclusion into shipping, and the announced US Clean Ports Program. The combined amount is based on the finance announcements made likely to be available by 2030. Further explanation available in Annex B.

## Tracking progress – partially on track

Table 4 Finance lever progress

| KEY ACTIONS | TIMELINE: | | | PROGRESS | TARGET BY: | | |
|---|---|---|---|---|---|---|---|
| | 22 | 25 | 30 | | 2023 | 2025 | 2030 |
| Increase the share of shipping debt aligned to trajectories needed to meet 2030/50 targets | | | | PARTIALLY ON TRACK | | Alignment of known portfolios to be below 10% for as much of observed shipping debt as possible. A greater percentage of this to be below 5% than in 2022 (more than 14%) | Given stricter targets for 2030 Poseidon trajectory, the 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<br><br>Continued or improved transparency from Western lenders<br><br>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 ship owners and operators | | | | PARTIALLY ON TRACK | | Maintain or increase the share of total sustainability-linked debt issued to shipping<br><br>Total cumulative amount to reach at least US$20 bn (x2 2022 level)<br><br>Conditions for eligibility and use of sustainability-linked loans to strengthen towards SZEF | Cumulative amount of sustainability-linked loans and bonds to US$50 bn<br><br>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 | | | | PARTIALLY ON TRACK | | US$1 bn/year by 2025 | US$25 bn/year by 2030 |
| Increase public finance (i.e., grants, loans) for SZEF-related activities | | | | PARTIALLY ON TRACK | | US$2-4 bn in total by 2025 | US$6-10 bn in total by 2030 |

# Policy

## Overview

Policy actions are related to multiple industry, national and international commitments, and regulatory developments which facilitate the decarbonisation of domestic (i.e., coastal and short-sea shipping) and international shipping. It is important to consider, when thinking of SZEF adoption, a range of 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 (Smith et al., 2021). Compared to last year, several indicators were combined, and others modified to make the process of following progress more streamlined and aligned to the 5% goal. Industry commitments remained similar to last year with the main focus on classification society guidelines and standards for SZEF vessels. Domestic policies remain a key focus due to their ability to directly support the decarbonisation of domestic fleets,[43] address standards such as monitoring and controlling from a port state perspective, whilst also facilitating the development of 1.5°C aligned decarbonisation ambitions and SZEF production goals, either directly or through commitments towards green hydrogen capacity building. Indicators referring to green corridor developments and associated policies have been merged with indicators in close association within the demand space to make the process of tracking more streamlined. In addition, indicators of more general aims which can facilitate the lowering of shipping's GHG footprint, such as the improvement of energy efficiency measures or long-term commitments to phase out of fossil fuels, have been modified or removed.

Policy actions are partially on track. Regarding classification society developments, there have been positive signals from several societies on the development of SZEF-ready frameworks and guidelines.[44] Such developments also included work on bunkering safety standards and guidelines continuing at pace at the IMO, and this work will also inform International Association of Classification Societies (IACS) developments related to SZEF safety. On a national level (Figure 10), significant progress has been made in terms of regulations to facilitate domestic maritime decarbonisation and to scale up of SZEF production.

Out of the top 20 countries,[45] 16 have published some form of hydrogen strategy or roadmap, with majority having some form of policy facilitating domestic decarbonisation and can directly benefit the maritime industry. Most recently, progress has been made in the UK (UK Government, 2023a) and EU (European Commission, 2023a) to include shipping in their respective carbon pricing mechanisms, in addition to several other measures by the EU, such as FuelEU Maritime (European Parliament, 2022). However, from a SZEF decarbonisation perspective, most of the developments are currently taking place within the context of the EU and several other developed economies,

43 In line with an average 30% decarbonisation of the 32 developed nations in terms of domestic shipping size. Refers to fleets engagement in domestic trades (cabotage).
44 Such as those by Lloyd's Register (2022d), ClassNK (2022), and DNV (2021).
45 Belgium, Brazil, China, Germany, India, Indonesia, Italy, Japan, Malaysia, Netherlands, Philippines, Singapore, South Korea, Spain, Thailand, Türkiye, United Arab Emirates, United Kingdom, United States, and Vietnam

meaning that progress is regionally skewed. A more diverse range of nations, especially from the Global South and developing economies, would need to be involved in such processes to ensure a diverse and global push towards 5% by 2030.

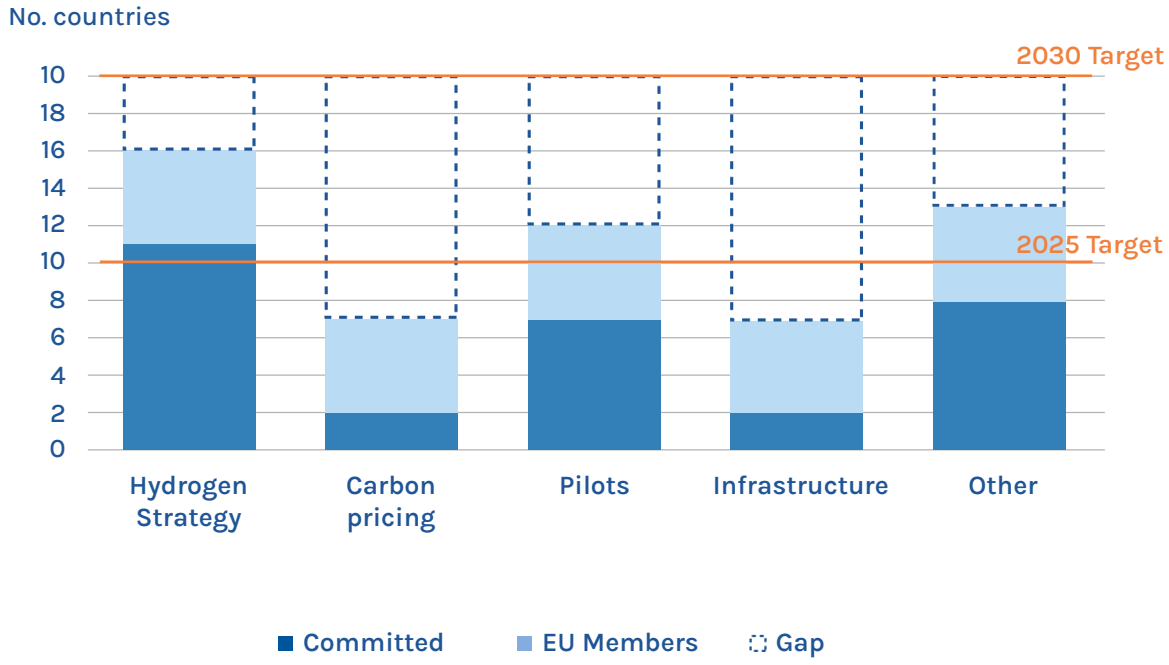



**Figure 10. Regulatory developments in the top 20 countries.**[46][47]

**The revised IMO GHG Strategy sends a strong signal to industry that shipping is committed to decarbonisation.**

As was the case in the 2022 report, governments committing to 1.5°C-aligned decarbonisation plans are still only partially on track. For example, out of the eight countries which have submitted their national action plans (NAPs) to the IMO regarding shipping decarbonisation, four make some mention of 1.5°C.[48] It should be noted that eight NAPs submitted make up only 5% of IMO member states,[49] but when the same countries are looked at in terms of ownership (dwt) they account for just over 29%, and just over 25% in terms of registered tonnage (dwt) (UNCTAD, 2022). When looking at progress towards production targets for SZEF in the context of general availability of green hydrogen by 2030,[50] it should be considered that 55 Mt of green hydrogen would be necessary to reach 0.6 EJ (i.e., the required amount of hydrogen for the 5% goal of SZEF by 2030).[51] The more optimistic IEA forecasts put green hydrogen supply in 2030 at 24 Mt,[52] whilst non-maritime annual demand for hydrogen by 2030 is

46 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, or 2019 figures where not, based on information from the UNCTAD (World Bank, 2023) to better reflect countries which can have a profound impact on the adoption of SZEF as early movers.

47 Internal UMAS 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 the 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, and government grants, etc. "Infrastructure" refers to any funding for SZEF bunkering infrastructure in ports and related SZEF bunkering barges.

48 Based on an analysis of submitted NAPs to the IMO.

49 Based on 175 member states as members of the IMO (IMO, 2023d)

50 Based on UMAS analysis of announced national hydrogen strategies, press briefings, white papers, and statements by government officials relating to 2030 targets for hydrogen production and for electrolyser developments.

51 Based on UMAS analysis, see the "Technology and Demand" section.

52 Based on the IEA Hydrogen Database and the upper end of IEA data forecasts for projected hydrogen production capacity.

estimated at 130-200 Mt (IEA, 2022). If it is assumed that other sectors should also decarbonise along 1.5°C trajectories, it is likely that a significant part of the 24 Mt estimated green production capacity will be needed to meet non-maritime hydrogen demand. It can, therefore, be concluded that even though a significant amount of green hydrogen will be available in 2030, it is important for national governments to continuously keep their hydrogen strategies and policies supporting production of green hydrogen under review to ensure that sufficient volumes will be available to meet maritime demand.

In the multilateral policy forum, the IMO this year has seen significant progress towards reaching the 5% goal, with the adoption of the 2023 IMO GHG Strategy during MEPC 80 at the IMO (IMO, 2023c). The 2023 IMO GHG Strategy, through its indicative checkpoints, the "by or around" 2050 shipping GHG net zero target, and the announcement that the level of ambition should "take into account" well-to-wake emissions, also shows that progress has been made internationally compared to last year. This progress sends a clear signal to national governments and industry actors that shipping is on a pathway towards decarbonisation and that now is the time to begin preparing for such a future with more national level actions and industry commitments to SZEF. The 5-10% 2030 level of ambition for the "uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources" and the ambitious 2030 "indicative checkpoints" further highlight the urgency of such developments (UMAS, 2023). The 2023 GHG Strategy also agreed to adopt mid-term measures by the end of 2025 with entry into force in 2027/2028. It is imperative now that these ambitions are followed by specific technical and economic instruments as part of the basket of measures which can facilitate the reaching of the desired outcomes. Similarly, further understanding of how exactly well-to-wake emissions will be considered in such measures, which is currently under development as part of the IMO LCA guidelines, is important so that no room is left for solutions with limited GHG mitigation benefits.

In future regulatory developments, it is becoming more apparent that consideration should be given to policies which can ensure that all new vessels are SZEF-ready. Currently, such developments are not observed in any material way and can be considered as not being on track.

## Tracking progress – partially on track

Table 5. Policy lever progress

| KEY ACTIONS | TIMELINE: | | | PROGRESS | TARGET BY: | | |
|---|---|---|---|---|---|---|---|
| | 22 | 25 | 30 | | 2023 | 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 | | | | PARTIALLY ON TRACK | | In place – at least five large classification societies | |
| Governments publish 1.5°C-aligned decarbonisation plans for domestic shipping | | | | PARTIALLY ON TRACK | | In place for 10 out of top 20 countries | In place for 20 out of top 20 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 20 out of top 20 countries Policy to meet 0.6 EJ target in terms of hydrogen and ammonia/methanol production |
| Governments create policies targeting SZEF adoption in maritime | | | | PARTIALLY ON TRACK | | In place for 10 out of top 20 countries across the board[55] | In place for 20 out of top 20 countries across the board |
| Submission to IMO of NAPs to address GHG emissions from international shipping | | | | NOT ON TRACK | In place for 10 | In place for 20 | In place for 100 |
| IMO to agree mid- and long-term measures for shipping (e.g., MBMs and non-MBMs) which are aligned with 5% SZEF and decarbonisation by 2050 | | | | PARTIALLY ON TRACK | | Mid-term measures agreed | Long-term measures agreed |
| IMO to require new ships to be zero-emission ready (e.g., GHG reduction plan with zero-emission (SZEF) propulsion capability) | | | | NOT ON TRACK | | In place | |
| IMO to adopt 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 emissions by 2050 target | | | | ON TRACK | | In place | |

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

# Civil society

## Overview

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

Civil society has remained a key lever in the path towards the adoption of SZEF during the last year. The participants at the GtZ workshops in Paris and Singapore during 2023 also expressed the importance of the role that actors such as NGOs, local communities,[54] and representatives of a range of diverse groups can and must play in the path towards a decarbonised shipping industry. Following on from the work in the 2022 report, the outlined actions continued to focus on several types of communities and associated representative bodies. These are local communities affected by port air pollutant emissions; indigenous communities, and their international representation regarding shipping decarbonisation; and representatives from SIDS and LDCs at the IMO. As the adoption of SZEF gathers pace, civil society plays a crucial role, not only in facilitating decarbonisation on the grounds of its societal and environmental importance, but in ensuring that the economic benefits of new SZEF production, green corridor initiatives, and supply and bunkering developments are accessible to all, including the remotest communities. The indicators have remained consistent with those in 2022, with some minor adjustments to the wording to better reflect the goals of the report.

Since 2022, progress has continued along all the followed indicators, but for now the actions can be considered as being partially on track. Further efforts are needed to ensure that the adoption of SZEF occurs in an equitable manner. As was reported in the 2022 report, the International Transport Workers' Federation (ITF) has shown the commitment of the maritime workforce to decarbonisation, which was followed by the creation of the Just Transition Maritime Taskforce, launched at COP26. Since then, the ITF has published a position paper on mapping a maritime just transition for seafarers (ITF, 2023). Interactions between SIDS, LDCs, and the IMO have also continued; an example coming from the Voluntary Multidonor Trust Fund (VMDTF) supporting the attendance of delegates from SIDS and LDCs at IMO meetings (IMO, 2023e). Following the 2021 granting of IMO observer status to the Inuit Circumpolar Council in December 2022, last year also saw the Zero Emission Ship Technology Association (ZESTAs) and the Environmental Defense Fund (EDF) being granted IMO Consultative Status (IMO, 2023b). This shows a continuation of the trend towards an increase in multiple voices representing both diverse communities and a range of industry voices in the decarbonisation debate. However, continued progress will be necessary, both at the IMO, at a national level, and locally with communities and ports by all levels of civil society and respective industry and policy stakeholders, to ensure that SZEF adoption and the creation of necessary rules are managed in a spirit of transparency and inclusiveness. Actions such as stakeholder consultations, transparent data sharing, public discussions of benefits and pathways to decarbonisation, and progress reports on inclusivity can all play a role. In addition, within the IMO, Global South civil organisations are still underrepresented and their increased participation would also be welcomed.

54 Including those directly dependent on the sea for their livelihood, such as fisheries.

## Tracking progress – partially on track

Table 6. Civil society lever progress

| KEY ACTIONS | TIMELINE: | | | PROGRESS | TARGET BY: | | |
|---|---|---|---|---|---|---|---|
| | 22 | 25 | 30 | | 2023 | 2025 | 2030 |
| Indigenous groups, SIDS, and LDCs become more prominent, with increased participation in shipping decarbonisation negotiations | | | | PARTIALLY ON TRACK | Observer status and attending IMO meetings | Participate in submissions | |
| Observers in the IMO increase focus on climate | | | | PARTIALLY ON TRACK | IMO observers (i.e., NGOs and IGOs) publish maritime decarbonisation reports | Major NGOs push for accelerated pace on maritime decarbonisation | Campaign to phase out fossil fuels in shipping |
| Key labour organisations voice support for decarbonisation | | | | ON TRACK | Public statements issued | | |
| Green skills gaps identified and recommendations in place to address those gaps for both jobs at sea and across the supply chain | | | | PARTIALLY ON TRACK | | Policy recommendations accepted an corporate actors mobilised | |
| Local NGOs surrounding top 50 global ports calling for air pollution mitigation | | | | ON TRACK | | NGOs at 10 of top 100 ports | NGOs at 25 of top 100 ports |

# Methodology

The analysis used for the purposes of this report is based on the UMAS- and GMF-developed Transition Strategy for shipping (Smith et al, 2021) and the MarSTF (Baresic, et al., 2020) conceptual framework,[55] which apply a holistic approach to shipping decarbonisation by looking at the way different segments of the maritime zero-carbon transition are interconnected. The approach is similar to the one taken in the 2022 report (Baresic and Palmer, 2022) with some changes. These changes included modifying the indicators by combining those where significant interconnection in developments was identified, modifying others to make them more relevant to tracking progress toward the 5% 2030 goal, and removing those which were deemed not relevant to the respective 2030 goal, but were more relevant for tracking broader decarbonisation trends.

Progress towards the five change levers was assessed based on comparing currently available information on shipping developments with the assessment of necessary target progress. The data used in the analysis was collected though a three-step approach:

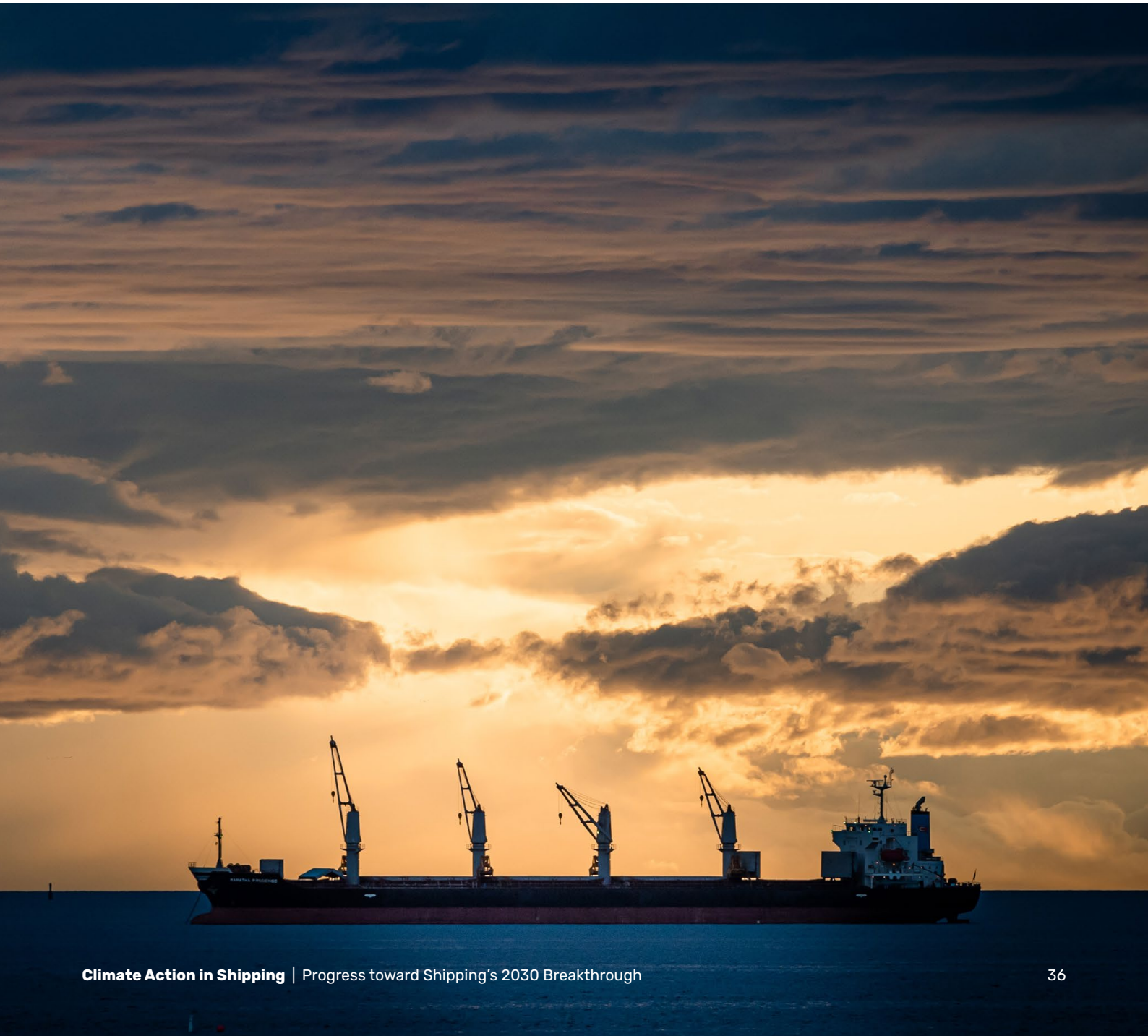
1. **Update of quantitative information** – using up-to-date information from a range of different sources, including updated energy demand scenarios from UMAS analysis, recent analysis of zero carbon shipping corridors, as well as a range and diverse internally collected data sources from UMAS and the GMF. For supply, this included data on announced and under-development ammonia projects from the AEA (AEA, 2023), for methanol from the Methanol Institute (Methanol Institute, 2023), data on the development of hydrogen projects from the IEA (IEA, 2023), as well as several relevant reports from IRENA, the GMF, and other sources. For finance, Clarksons Shipping Intelligence Network (Clarksons SIN, 2023) provided data on sustainability-linked loans and bonds issued in the industry, whilst Petrofin Global Bank Research (Petrofin, 2020-2023) provided information on total shipping finance and breakdowns by lender. Clarksons World Fleet Register (Clarksons WFR, 2023) was used to track trends in alternative fuelled tonnage and extrapolate to 2025 and 2030.

2. **Stakeholder data gathering exercise** – Getting to Zero Coalition (GtZ) workshops were organised in Singapore and Paris on the 26th April and 31st May, 2023, respectively, at which events senior maritime stakeholders from across the maritime value chain were asked to ascertain the level of progress for each change lever, what changes and/or modifications to the actions should be taken, and what their opinions on the current goals were. This information was collected and used to inform the updated set of actions.

55 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).

3. **Desk based research** – a review of up-to-date academic literature, grey literature,[56] and news reports was carried out to ascertain the most recent information relevant for the analysis. The information was collected for each of the actions in every lever category. This also included a review of public finance initiatives and individual lender 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 (Climate Bonds Initiative) 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 GMF on pilot projects and green corridor developments played an important role in ascertaining respective progress (GMF, 2023).

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



# Key conclusions

Overall progress to reach the 5% by 2030 SZEF goal can be considered to have remained partially on track from last year. The past 12 months have seen significant developments in terms of international commitments at the IMO, national policy developments, industry announcements, and technological developments. However, in order to reach the 5% goal, significant progress remains necessary, especially in terms of concrete national policies turning the IMO's level of ambition into specific economic and technical measures. There is also a need to turn growing appetite for zero carbon freight into concrete demand on the orderbook for SZEF vessels which can send the right signals to SZEF suppliers. The strong technological progress observed in recent years must continue to be capitalised on to ensure sufficient supply of SZEF in 2030, both in terms of expanding the announced pipeline of production and ensuring a sufficient proportion of announced capacity passes the final investment decision stage.

Additionally, there are multiple financial mechanisms and funding options available now which can be used to support such a challenging but achievable task, but many of the available financial mechanisms and sources of finance are shared across multiple areas and must be tapped into by the industry. Policymakers must do their utmost to ensure that specific finance for SZEF developments is earmarked and directed into the right areas. The adoption of the 2023 IMO GHG Strategy can be considered as a historical moment in showing that the 5% SZEF goal can be considered a minimum ambition on the pathway of maritime decarbonisation and one for which the utmost efforts must be made to ensure that 5% is reached and, hopefully, surpassed to bring us to 10%. Additionally, it will be important to guarantee that further diversification of funding, policy, and projects is made to ensure more even and equitable geographic distribution of developments, whilst also ensuring that progress in terms of civil society engagement is maintained and further strengthened.

# References


1. ABB (2022). Fuel cell systems for ships. https://new.abb.com/marine/systems-and-solutions/electric-solutions/fuel-cell

2. AEA (2023). Low-Carbon Ammonia Plants Project List © 2023 by Ammonia Energy Association. Licensed under CC BY-NC-SA 4.0.

3. Baresic, D. (2020). Sustainability transitions in the maritime transport industry: the case of LNG in northern Europe. UCL. https://discovery.ucl.ac.uk/id/eprint/10112016/

4. Baresic, D. & Palmer, K. (2022). Climate action in shipping: Progress towards shipping's 2030 breakthroughs. UMAS and UN Climate Change High-Level Champions.

5. Boschma, R. (2005). Proximity and innovation: A critical assessment. Regional Studies, 39(1), 61–74. https://doi.org/10.1080/0034340052000320887

6. C40 (2022). Port of Los Angeles, Port of Shanghai, and C40 Cities announce partnership to create world's first transpacific green shipping corridor between ports in the United States and China. News. https://www.c40.org/news/la-shanghai-green-shipping-corridor/

7. City of Yokohama (2022). The City of Yokohama conclude MoU for Acceptance of Ammonia-Fuelled Tugboat. Press Release. https://www.city.yokohama.lg.jp/lang/overseas/port/kankyo/fuel.files/0005_20220520.pdf

8. ClassNK (2021). ClassNK has published guidelines for ships using alternative fuels. IIMS News. https://www.iims.org.uk/classnk-has-published-guidelines-for-ships-using-alternative-fuels/

9. ClassNK (2022). ClassNK Zero-Emission Transition Support Services. https://www.classnk.or.jp/hp/en/info_service/ghg/

10. Clarksons SIN (2023). Clarksons Shipping Intelligence Network. https://sin.clarksons.net/

11. Clarksons WFR (2023). Clarksons World Fleet Register. https://www.clarksons.net/wfr/

12. Climate Bonds (2022). Shipping. Standard. https://www.climatebonds.net/standard/shipping

13. Climate Bonds (2023). Global State of the Market Report 2022. https://www.climatebonds.net/resources/reports/global-state-market-report-2022

14. Climate Bonds (2022). Sustainable Debt Global State of the Market 2021. https://www.climatebonds.net/resources/reports/sustainable-debt-global-state-market-2021

15. Climate Bonds (2021). Sustainable Debt: Global State of the Market 2020.

https://www.climatebonds.net/resources/reports/sustainable-debt-global-state-market-2020

16. CVF (2021). Dhaka-Glasgow Declaration of the Climate Vulnerable Forum. https://thecvf.org/wp-content/uploads/2021/10/Dhaka-Glasgow-Declaration-of-the-CVF_Final-1.pdf

17. coZEV (2022). Leaders of the movement to decarbonize shipping set an ambitious 2040 target. https://www.cozev.org/#:~:text=The%20coZEV%202040%20Ambition%20Statement,by%202050%20at%20the%20latest

18. coZEV (2023). The Aspen Institute, Amazon, Patagonia and Tchibo launch the Zero Emission Maritime Buyers Alliance (ZEMBA) to accelerate maritime shipping decarbonization. https://www.cozev.org/thelatest/the-aspen-institute-amazon-patagonia-and-tchibo-launch-the-zero-emission-maritime-buyers-alliance-zemba-to-accelerate-maritime-shipping-decarbonization

19. Department for Transport (2022). UK Domestic Maritime Decarbonisation Consultation: Plotting the Course to Zero. UK Government. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1092399/uk-domestic-maritime-decarbonisation-consultation-plotting-the-course-to-zero.pdf

20. DNV (2021). New DNV Fuel Ready and Gas fuelled ammonia class notations provide maximum flexibility to tackle shipping's carbon curve. https://www.dnv.com/news/new-dnv-fuel-ready-and-gas-fuelled-ammonia-class-notations-provide-maximum-flexibility-to-tackle-shipping-s-carbon-curve-203646

21. DNV (2022a). DNV selected to lead pioneering ammonia bunkering safety study in Singapore. News. https://www.dnv.com/news/dnv-selected-to-lead-pioneering-ammonia-bunkering-safety-study-in-singapore-216787

22. DNV (2022b). Class services. https://www.dnv.com/maritime/hub/decarbonize-shipping/services/class-services.html

23. Edenbrandt, A., K. & Lagerkvist, C-J. (2021). Is food labelling effective in reducing climate impact by encouraging the substitution of protein sources? Food Policy, Volume 101, May 2021, 102097.

24. EPA (2023). Biden-Harris Administration Announces $4 Billion Through the Investing in America Agenda for Clean Port Upgrades and Clean Heavy-Duty Vehicles to Improve Air Quality and Protect Public Health. https://www.epa.gov/newsreleases/biden-harris-administration-announces-4-billion-through-investing-america-agenda-clean

25. ETC (2021). Global Hydrogen Report.

26. European Commission (2020). A hydrogen strategy for a climate-neutral Europe. Brussels, 8.7.2020 COM (2020) 301 final. https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf

27. European Commission (2022). Reducing emissions from the shipping sector. Climate Action. https://ec.europa.eu/clima/eu-action/transport-emissions/reducing-emissions-shipping-sector_en

28. European Parliament (2022). Sustainable maritime fuels 'Fit for 55' package: The FuelEU Maritime proposal. Briefing. https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698808/EPRS_BRI(2021)698808_EN.pdf

29. European Commission (2023a). Reducing emissions from the shipping sector. https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector_en

30. European Commission (2203b). FAQ – Maritime transport in EU Emissions Trading System (ETS). https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector/faq-maritime-transport-eu-emissions-trading-system-ets_en

31. Faber et al (2020). 4th IMO GHG Study. https://www.imo.org/en/ourwork/Environment/Pages/Fourth-IMO-Greenhouse-Gas-Study-2020.aspx

32. Federal Ministry of Finance (2021). Immediate climate action programme for 2022. https://www.bundesfinanzministerium.de/Content/EN/Standardartikel/Topics/Priority-Issues/Climate-Action/immediate-climate-action-programme-for-2022.html

33. Financial Times (2021). Dutch pension giant ABP to dump €15bn in fossil fuel holdings. Pensions Industry. https://www.ft.com/content/425d7c82-e69a-4fe2-9767-8c92bda731e7

34. Financial Times (2022). Shipping heavyweight Japan tables carbon tax proposal for industry. Shipping. https://www.ft.com/content/ae5893a1-4a7e-4152-8fb2-65679ebc73c4

35. FuelCellWorks (2021). World's First Liquid Hydrogen-Powered Vessel Wins Ship of the Year Award. News. https://fuelcellsworks.com/news/worlds-first-liquid-hydrogen-powered-vessel-wins-ship-of-the-year-award/

36. Geels, F.W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, Research Policy, 31 (2002), pp. 1257-1274.

37. GMF (2020). The scale of investment needed to decarbonize international shipping. UMAS. https://www.globalmaritimeforum.org/news/the-scale-of-investment-needed-to-decarbonize-international-shipping

38. GMF (2022a). Closing the Gap: An Overview of the Policy Options to Close the Competitiveness Gap and Enable an Equitable Zero-Emission Fuel Transition in Shipping. Baresic, D., Rojon, I., Shaw, A., Rehmatulla, N. London, United Kingdom: University Maritime Advisory Services. https://www.globalmaritimeforum.org/content/2021/12/Closing-the-Gap_Getting-to-Zero-Coalition-report.pdf

39. GMF (2022b). Mapping of Zero Emission Pilots and Demonstration Projects. Getting to Zero Coalition. https://www.globalmaritimeforum.org/content/2022/03/Mapping-of-zero-emission-pilots-and-demonstration-projects_third-edition.pdf

40. GMF (2022c). Getting to Zero Coalition. Energy Transition. https://www.globalmaritimeforum.org/getting-to-zero-coalition/members

41. GMF (2022d). Annual Progress Report on Green Shipping Corridors 2022. https://cms.globalmaritimeforum.org/wp-content/uploads/2022/11/The-2022-Annual-Progress-Report-on-Green-Shipping-Corridors.pdf

42. GMF (2022e). Green Corridors: Definitions and Approaches, https://www.globalmaritimeforum.org/content/2022/08/Discussion-paper_Green-Corridors-Definitions-and-Approaches.pdf

43. GMF (2023). Mapping of Zero Emission Pilots and Demonstration Projects. Getting to Zero Coalition. Fourth edition. https://cms.globalmaritimeforum.org/wp-content/uploads/2023/05/Getting-to-Zero-Coalition_Mapping-of-Zero-Emission-Pilots-and-Demonstration-Projects_Fourth-edition.pdf

44. Government of Japan (2023). Basic Hydrogen Strategy. https://www.meti.go.jp/shingikai/enecho/shoene_shinene/suiso_seisaku/pdf/20230606_5.pdf

45. Government of Sweden (2021). Sweden supports international declarations for transport sector's climate transition. Government Offices of Sweden. https://www.government.se/press-releases/2021/11/sweden-supports-international-declarations-for-transport-sectors-climate-transition/

46. Hydrogen Council (2020). Path to Hydrogen Competitiveness: A Cost Perspective. https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf

47. Hydrogen Council (2023). Hydrogen Insights 2023.

48. Hydrogen Council (2022). Hydrogen Insights 2022.

49. IAPH (2022). IAPH Clean Marine Fuels WG. https://www.iaphworldports.org/clean-marine-fuel-cmf/

50. ICS (2023). Shipping and World Trade: Global Supply and Demand for Seafarers. https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-global-supply-and-demand-for-seafarers/.

51. IEA (2019). The Future of Hydrogen. Seizing today's opportunities. https://iea.blob.core.windows.net/assets/9e3a3493-b9a6-4b7d-b499-7ca48e357561/The_Future_of_Hydrogen.pdf

52. IEA (2020). Power generation in the Sustainable Development Scenario, 2000-2030. https://www.iea.org/data-and-statistics/charts/solar-pv-power-generation-in-the-sustainable-development-scenario-2000-2030.

53. IEA (2021). Global hydrogen demand by sector in the Net Zero Scenario, 2020-2030. https://www.iea.org/data-and-statistics/charts/global-hydrogen-demand-by-sector-in-the-net-zero-scenario-2020-2030

54. IEA (2022). Global Hydrogen Review 2022.

55. IEA (2023a). Hydrogen Projects database (accessed: May 2023).

56. IEA (2023b). IEA ETP Clean Energy Guide (accessed July 2023).

57. IEA (2023c). IEA Tracking Clean Energy Progress (accessed August 2023).

58. Köhler, J., Geels, F. W., Kern, F., Markard, J., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M. S., Nykvist, B., Onsongo, E. Pel, B., Raven, R., Rohracher, H., Sandén,

B., Schot, J., Sovacool, B., Turnheim, B., Welch, D., & Wells, P. (2019) An agenda for sustainability transitions research: State of the art and future directions. Environmental Innovation and Societal Transitions 31: 1-32.

59. IMO (2022a). Market-Based Measures. Website. https://www.imo.org/en/OurWork/Environment/Pages/Market-Based-Measures.aspx

60. IMO (2022b). National Action Plans. https://www.imo.org/en/OurWork/Environment/Pages/RELEVANT-NATIONAL-ACTION-PLANS-AND-STRATEGIES.aspx

61. IMO (2022c). Cutting ships' GHG emissions - working towards revised strategy. https://www.imo.org/en/MediaCentre/PressBriefings/pages/MEPC-78-.aspx

62. IMO (2022d). GHG Working Group finalizes carbon intensity measures guidance and agrees to further develop a "basket of candidate mid-term measures". Latest News. https://www.imo.org/en/MediaCentre/PressBriefings/pages/ISWGHGMay2022.aspx

63. IMO (2022e). Intergovernmental Organizations which have concluded agreements of cooperation with IMO. https://www.imo.org/en/OurWork/ERO/Pages/IGOsWithObserverStatus.aspx

64. IMO (2022f). Non-Governmental international Organizations which have been granted consultative status with IMO. https://www.imo.org/en/OurWork/ERO/Pages/NGOsInConsultativeStatus.aspx

65. IMO (2023a). Pacific nations updated on IMO work to reduce emissions from ships. IMO. https://www.imo.org/en/MediaCentre/Pages/WhatsNew-1887.aspx

66. IMO (2023b). Non-Governmental international Organizations which have been granted consultative status with IMO https://www.imo.org/en/OurWork/ERO/Pages/NGOsInConsultativeStatus.aspx

67. IMO (2023c). 2023 IMO Strategy on Reduction of GHG Emissions from Ships. https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/annex/2023%20IMO%20Strategy%20on%20Reduction%20of%20GHG%20Emissions%20from%20Ships.pdf

68. IMO (2023d). Member States. https://www.imo.org/en/OurWork/ERO/Pages/MemberStates.aspx

69. IMO (2023e). Voluntary Multi-Donor Trust Fund (VMDTF) for financial support to attend IMO GHG meetings. https://www.imo.org/en/OurWork/Environment/Pages/Revision-of-the-Strategy.aspx

70. IPE (2022). KLP, Nordic banks, launch transition financing code for shipping. News. https://www.ipe.com/news/klp-nordic-banks-launch-transition-financing-code-for-shipping/10057939.article

71. IRENA (2021), Renewable Power Generation Costs in 2020, International Renewable Energy Agency, Abu Dhabi.

72. ITF (2021). ITF's Sustainable Shipping Position Paper. International Transport Workers' Federation. https://www.itfglobal.org/en/reports-publications/itfs-sustainable-shipping-position-paper

73. ITF (2023). Mapping a Maritime Just Transition for Seafarers - Maritime

Just Transition Task Force https://www.itfglobal.org/en/reports-publications/mapping-just-transition-seafarers

74. KPMG (2021). National Hydrogen Strategies. https://home.kpmg/xx/en/home/insights/2021/08/national-hydrogen-strategies.html

75. Lloyd's List (2021). Shipping's transparency revolution. Analysis. https://lloydslist.maritimeintelligence.informa.com/LL1135916/Shippings-transparency-revolution

76. Lloyd's List (2022). CMA CGM orders six methanol-fuelled box ships. News. https://lloydslist.maritimeintelligence.informa.com/LL1141124/CMA-CGM-orders-six-methanol-fuelled-box-ships

77. Lloyd's Register (2020). LR and Methanol Institute launch guidance on methanol bunkering. Latest News. https://www.lr.org/en/latest-news/lr-methanol-institute-guidance-on-methanol-bunkering/

78. Lloyd's Register (2021). Industry collaboration to develop guidance on the safe use of Ammonia as a fuel. News. https://www.lr.org/en/latest-news/industry-leaders-collaborate-to-develop-guidance-on-the-safe-use-of-ammonia-as-a-shipping-fuel/

79. Lloyd's Register (2022a). Zero Carbon Fuel Monitor. https://www.lr.org/en/marine-shipping/maritime-decarbonisation-hub/zcfm/findings/

80. Lloyd's Register (2022b). Classification of Ships using Gases or other Low-flashpoint Fuels. Rules. https://www.lr.org/en/rules-and-regulations-for-ships-using-gases-or-low-flashpoint-fuels/

81. Lloyd's Register (2022c). Three Members of The Castor Initiative Ink MOU for Zero-Emission VLCCs. News. https://www.lr.org/en/latest-news/three-members-of-the-castor-initiative-ink-mou-for-zero-emission-vlccs/

82. Lloyd's Register (2022d). LR launches 'Zero Ready Framework' for vessels operating on zero carbon fuels. https://www.lr.org/en/about-us/press-room/press-release/lr-launches-zero-ready-framework-for-vessels-operating-on-zero-carbon-fuels/

83. Lloyd's Register (2023). Zero Carbon Fuel Monitor. https://www.lr.org/en/expertise/maritime-energy-transition/maritime-decarbonisation-hub/zcfm/

84. LR&UMAS (2020). Techno-Economic Assessment of Zero-Carbon Fuels

85. Lloyd's List (2023). MAN to deliver first ammonia engine in late-2024 https://lloydslist.maritimeintelligence.informa.com/LL1146731/MAN-to-deliver-first-ammonia-engine-in-late-2024

86. Lloyd's Register/UMAS (2020). Techno-economic assessment of zero-carbon fuels.

87. Maersk (2021). A.P. Moller - Maersk accelerates fleet decarbonisation with 8 large ocean-going vessels to operate on carbon neutral methanol. Press Release. https://www.maersk.com/news/articles/2021/08/24/maersk-accelerates-fleet-decarbonisation

88. Maersk (2022). A.P. Moller - Maersk accelerates Net Zero emission targets to 2040 and sets milestone 2030 targets. Press Release. https://www.

maersk.com/news/articles/2022/01/12/apmm-accelerates-net-zero-emission-targets-to-2040-and-sets-milestone-2030-targets

89. Maersk (2023). Maersk orders six methanol powered vessels. Press Release. https://www.maersk.com/news/articles/2023/06/26/maersk-orders-six-methanol-powered-vessels

90. Maritime Executive (2022a). Containership Orders at Record Levels with New Order Linked to MSC. News. https://maritime-executive.com/article/containership-orders-at-record-levels-with-new-order-linked-to-msc

91. Maritime Executive (2022b). NGO Criticizes European Ports Calling for More Emissions Efforts. News. https://maritime-executive.com/article/ngo-criticizes-european-ports-calling-for-more-emissions-efforts

92. Maritime Singapore (2023). Decarbonisation Blueprint. https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/NAP/Maritime%20Singapore%20Decarbonisation%20Blueprint.pdf

93. Methanol Institute (2023). Methanol Projects. Accessed: 15th May, 2023.

94. Ministry of Oceans and Fisheries (2023). 2030 Greenship-K Promotion Strategy. https://www.mof.go.kr/page/en/selectPage.do?menuSeq=1588&pageSeq=1017

95. Norton Rose Fulbright (2019). Sustainable/green financing in the shipping and offshore sectors. Insights. https://www.nortonrosefulbright.com/en-gr/knowledge/publications/0e4486ae/sustainable-green-financing-in-the-shipping-and-offshore-sectors

96. NSA (2020). Norwegian shipping climate neutral by 2050. Norwegian Shipowners' Association. https://rederi.no/en/aktuelt/2020/norwegian-shipping-climate-neutral-by-2050/

97. NYK (2021). NYK Announces Target of Net-Zero Emissions by 2050 for Oceangoing Businesses. Press Release. https://www.nyk.com/english/news/2021/20210930_03.html

98. Oellingrath, E., & Ray, D. (2022). Sustainable finance propels shipping's green transition. Nordea. https://www.nordea.com/en/news/sustainable-finance-propels-shippings-green-transition

99. Offshore Energy (2021a). Port of Singapore eyes more clean fuel options. News. https://www.offshore-energy.biz/port-of-singapore-eyes-more-clean-fuel-options/

100. Offshore Energy (2021b). Germany wins EU funding for sustainable inland shipping program. News. https://www.offshore-energy.biz/germany-wins-eu-funding-for-sustainable-inland-shipping-program/

101. Oftedal, S. (2020). National Policy Frameworks: Green Shipping – The Norwegian Approach. Norwegian Ministry of Climate and Environment. https://www.nordicenergy.org/wp-content/uploads/2020/03/Sveinung-Oftedal.pdf

102. Osterkamp, P., Smith, T., & Søgaard, K. (2021). Five percent zero emission fuels by 2030 needed for Paris-aligned shipping decarbonization. GMF. https://www.globalmaritimeforum.org/news/five-percent-zero-emission-fuels-by-2030-needed-for-paris-aligned-shipping-

decarbonization

103. Our World in Data (2023). Levelised cost of energy by technology. https://ourworldindata.org/grapher/levelized-cost-of-energy

104. P4G (2022). Getting to Zero Coalition. Website. https://p4gpartnerships.org/pioneering-green-partnerships/all-p4g-partnerships/getting-zero-coalition

105. Pacific Environment (2022). Mobilizing People and Ports to End Ship Pollution. Ports for the People. https://www.pacificenvironment.org/ports/

106. Pacific Environment (2022). Ship It Zero Coalition & Medical Professionals Demand Target Address Shipping Pollution. Press Release. https://www.pacificenvironment.org/press-releases/ship-it-zero-coalition-medical-professionals-demand-target-address-shipping-pollution/

107. Palmer, K., Smith, T., Baresic, & D., Fahnestock, J. (2021). Getting to 5%: An action plan for delivering zero-emission fuels in shipping. GMF. https://www.globalmaritimeforum.org/news/getting-to-5-an-action-plan-for-delivering-zero-emission-fuels-in-shipping

108. Pandey, A., Søgaard, K., Blaxekjær, L., Spiegelenberg, F., & Montgomery, R. (2022). How EU Contracts for Difference can support zero-emission fuels. GMF. https://www.globalmaritimeforum.org/news/how-eu-contracts-for-difference-can-support-the-development-of-zero-emission-fuels

109. Petrofin Research (2021). Petrofin Global Bank Research and Petrofin Index of Global Ship Finance - End 2020. https://www.petrofin.gr/wp-content/uploads/2021/11/Petrofin-Global-Bank-Research-and-Petrofin-Index-of-Global-Ship-Finance-end2020.pdf

110. Petrofin Research (2022). Petrofin Global Bank Research and Petrofin Index of Global Ship Finance - End 2021. https://www.petrofin.gr/wp-content/uploads/2022/09/Petrofin-Global-Bank-Research-and-Petrofin-Index-of-Global-Ship-Finance-end2021.pdf

111. Petrofin Research (2023). Petrofin Global Bank Research and Petrofin Index of Global Ship Finance - End 2022. https://www.petrofin.gr/wp-content/uploads/2023/07/Petrofin-Global-Bank-Research-and-Petrofin-Index-of-Global-Ship-Finance-end-2022.pdf

112. Port of Melbourne (2023). Port of Melbourne seals $475mln sustainability-linked loan. https://www.offshore-energy.biz/port-of-melbourne-seals-475mln-sustainability-linked-loan/

113. Port of Rotterdam (2022). The port of Rotterdam, soon to be Europe's Hydrogen Hub. News Overview. https://www.portofrotterdam.com/en/news-and-press-releases/the-port-of-rotterdam-soon-to-be-europes-hydrogen-hub

114. Poseidon Principles (2022a). A global framework for responsible ship finance. https://www.poseidonprinciples.org/finance/

115. Poseidon Principles (2022b). Signatories. https://www.poseidonprinciples.org/finance/signatories/

116. Poseidon Principles (2022c). The Poseidon Principles provide a framework for integrating climate considerations into lending decisions to promote international shipping's decarbonization. About. https://www.poseidonprinciples.org/finance/about

117. Poseidon Principles (2022d). CaixaBank joins the Poseidon Principles as the first Spanish bank. News. https://www.poseidonprinciples.org/finance/news/caixabank-joins-the-poseidon-principles-as-the-first-spanish-bank/

118. RECHARGE (2020). World's first liquid hydrogen fuel cell cruise ship planned for Norway's fjords. News. https://www.rechargenews.com/transition/world-s-first-liquid-hydrogen-fuel-cell-cruise-ship-planned-for-norway-s-fjords/2-1-749070

119. Reuters (2022). Britain proposes to bring shipping sector into carbon market. Climate Change. https://www.reuters.com/business/sustainable-business/britain-proposes-bring-shipping-sector-into-carbon-market-2022-03-25/

120. RINA (2021). RINA and SDARI to develop ground-breaking methanol/ammonia fuelled tanker design. Press Release. https://www.rina.org/en/media/press/2021/02/12/sdari-ship-design

121. Sæternes, A., (2022). The green shift in the Norwegian ferry market. Statens vegvesen. https://www.electric-water-mobility.eu/upload/elmar/statens-vegvesen-governmental-actions-for-green-shift-on-norwegian-ferry-routes.pdf

122. Science Based Targets Initiative (SBTi, 2023). Targets and commitments database. https://sciencebasedtargets.org/target-dashboard

123. Smith, T., Baresic, D., Fahnestock, J., Galbraith, C., Velandia Perico, C., Rojon, I., & Shaw, A. (2021). A Strategy for the Transition to Zero-Emission Shipping: An analysis of transition pathways, scenarios, and levers for change. Getting to Zero Coalition. https://www.u-mas.co.uk/wp-content/uploads/2021/10/Transition-Strategy-Report.pdf

124. Smith, A., & Raven, R.P.J.M. (2012). What is protective space? Reconsidering niches in transitions to sustainability. Research Policy, 41, 1025-1036.

125. Sørensen, F.M. (2022). Shipbuilding Market Outlook. MAN Energy Solution.

126. Stena Bulk (2021). Stena Bulk unveils decarbonisation plan to become net zero emissions business by 2050. Press Releases. https://www.stenabulk.com/press-and-news/press-releases/stena-bulk-unveils-decarbonisation-plan-become-net-zero-business-2050

127. TCFD (2022). Task Force on Climate-related Financial Disclosures. https://www.fsb-tcfd.org/

128. Sandia National Laboratories (2022). Maritime Applications for Hydrogen Fuel Cells. Energy. https://energy.sandia.gov/programs/sustainable-transportation/hydrogen/fuel-cells/maritime-applications/

129. SEI (2022). Unique data platform brings transparency to global maritime trade, supports efforts to decarbonize sector. Press Release. https://www.sei.org/about-sei/press-room/unique-data-platform-brings-transparency-to-global-maritime-trade-supports-efforts-to-

decarbonize-the-sector/

130. SGMF (2022). Yara and SGMF team up to foster ammonia as a fuel. Blog Article. https://sgmf.info/posts/yara-and-sgmf-team-up-to-foster-ammonia-as-a-fuel

131. Shaw, A., & Smith, T. (2021). Outcomes and Implications of MEPC 77, expanded analysis. UMAS. https://www.u-mas.co.uk/wp-content/uploads/2021/11/Transition-Perspective_Outcomes-and-Implications-of-MEPC-77-expanded-analysis-1.pdf

132. Ship&Bunker (2022). ONE Orders Ten Ammonia-, Methanol- and Carbon Capture-Ready Boxships. News. https://shipandbunker.com/news/world/502548-one-orders-ten-ammonia-methanol-and-carbon-capture-ready-boxships

133. UK Government (2022). COP 26: Clydebank Declaration for green shipping corridors. Policy Paper. https://www.gov.uk/government/publications/cop-26-clydebank-declaration-for-green-shipping-corridors/cop-26-clydebank-declaration-for-green-shipping-corridors

134. UK Government (2023a). The UK Emissions Trading Scheme Authority has announced a package of reforms to tighten limits on industrial, power and aviation emissions from 2024. https://www.gov.uk/government/news/tighter-limit-on-industrial-power-and-aviation-emissions-as-uk-leads-the-way-to-net-zero

135. UK Government (2023b) Cleaner shipping gets £34 million boost with next round of innovative tech funding. https://www.gov.uk/government/news/cleaner-shipping-gets-34-million-boost-with-next-round-of-innovative-tech-funding

136. UKRI (2023) Minister announces investments to decarbonise maritime sector. https://shipandbunker.com/news/world/502548-one-orders-ten-ammonia-methanol-and-carbon-capture-ready-boxships /

137. UMAS (2022a). GloTram. UMAS. https://www.u-mas.co.uk/products/gloTram/

138. UMAS (2022b). Major progress at the IMO: After over a decade of stalemate, the IMO's latest meeting on GHG emissions achieves consensus on pricing GHG emissions. UMAS. https://www.u-mas.co.uk/major-progress-at-the-imo-after-over-a-decade-of-stalemate-the-imos-latest-meeting-on-ghg-emissions-achieves-consensus-on-pricing-ghg-emissions/

139. UMAS (2023). Implications of the Revised IMO GHG Strategy for national, regional and corporate action. https://www.u-mas.co.uk/ghg-targets-from-a-multilateral-decision-making-process-come-close-to-science-derived-targets-new-analysis-shows/

140. UN (2021a). Declaration on Zero Emission Shipping by 2050. UN Climate Change Conference 2021 (COP26). https://em.dk/media/14312/declaration-on-zero-emission-shipping-by-2050-cop26-glasgow-1-november-2021.pdf

141. UN (2021b). Decarbonizing All Means of Transport Key for Sustainable Growth, Achieving Net-Zero Emissions by 2050, Secretary-General Tells Beijing Conference. Press Release. https://press.un.org/en/2021/sgsm20971.doc.htm

142. UNCTAD (2022). Merchant Fleet. https://hbs.unctad.org/merchant-fleet/

143. UNEP (2022). Net-Zero Banking Alliance. Finance Initiative. https://www.unepfi.org/net-zero-banking/

144. UNHLCC (2021). Upgrading out system together. A global challenge to accelerate sector breakthroughs for COP26 and beyond. RaceToZero. https://racetozero.unfccc.int/wp-content/uploads/2021/09/2030-breakthroughs-upgrading-our-systems-together.pdf

145. VesselsValue (2021). Newbuild Report 2021. https://container-news.com/vesselsvalue-newbuild-report-2021/

146. Wartsila (2023). Wärtsilä to supply methanol-fuelled auxiliary engines for six CMA CGM newbuild container vessels. https://www.wartsila.com/media/news/01-08-2023-wartsila-to-supply-methanol-fuelled-auxiliary-engines-for-six-cma-cgm-newbuild-container-vessels-3302313

147. WEF (2022). First Movers Coalition. https://www.weforum.org/first-movers-coalition

148. World Bank (2023). Container port traffic (TEU: 20-foot equivalent unit). https://data.worldbank.org/indicator/IS.SHP.GOOD.TU?locations=XL

# 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

**EJ** – exajoule

**EU** – European Union

**ETS** – emissions trading scheme

**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

**GCMD** – Global Centre for Maritime Decarbonisation

**GW** – gigawatt

**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

**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

**mn** – million

**Mt** – million tons

**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

**PV** – photovoltaic

**R&D** – research and development

**RD&D** – research, development, and deployment

**RINA** – Registro Italiano Navale

**SBTi** – Science Based Targets Initiative

**SGMF** – Society for Gas as a Marine Fuel

**SIDs** – Small Island Developing States

**SZEF** – Scalable Zero Emission Fuel

**TCFD** – Climate-Related Financial Disclosures

**TEU** – Twenty-foot equivalent unit

**TWh** – terawatt-hour

**UK** – United Kingdom

**UN** – United Nations

**UNEP** – United Nations Environment Programme

**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

# 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 number of pilot and demonstration projects dedicated to fuel production and bunkering and infrastructure has continued to increase year-on-year, with an increasing number of technologies progressing towards full commercialisation. |
| Cross-industry collaboration on SZEF ship projects | ON TRACK | The GMF Pilot Mapping Database (GMF, 2023) has indicated a consistent and increasing trend of cross-industry collaboration. |
| Key technological developments | NOT ON TRACK | Fuel-cell and battery-electric propulsion systems for short-sea shipping are well technologically developed, whilst ICE-based propulsion methods using methanol and ammonia for longer-range voyages are technologically progressing. However, there are substantial concerns regarding the capacity to manufacture SZEF-based engines at a rate consistent with reaching the 2030 breakthrough target. |
| Government-energy industry collaboration | ON TRACK | There are a large number of GW-scale, government-led targets for developing green hydrogen capacity across all regions of the world; the aggregate of which will continue to grow throughout the rest of the decade. In addition, the GMF pilot database (GMF, 2023) indicates an increasing number of maritime pilot and demonstration projects receiving direct public funding. |
| Decrease in green hydrogen production costs | PARTIALLY ON TRACK | Electrolyser capacity announcements and projected falls in the price of renewable energy look set to unlock a green hydrogen production cost of US$2/kg in the 2020s. However, projected price falls look unlikely to narrow the cost competitiveness gap with fossil-based incumbent fuels based on their current price. |
| Increase in electrolyser and green hydrogen production capacity | PARTIALLY ON TRACK | Based on the current pipeline of green hydrogen projects, the 5% shipping breakthrough would require at least 15% of electrolyser capacity and more than 20% of the green hydrogen produced in 2030 in the most optimistic scenario. New announcements to 2030 can be expected, however, the degree to which they will align with what is required in 2030, in terms of their scale and the proportion that reach the final investment decision stage, is highly uncertain. |

| | | |
|---|---|---|
| Scale-up of SZEF production | PARTIALLY ON TRACK | Based on the current pipeline of capacity announcements, there is a good likelihood of there being sufficient green ammonia supply to facilitate the 5% goal/ However, given likely competition from other sectors, there is uncertainty of what proportion n of produced green ammonia will be available for shipping. Regarding e-methanol the current likely projections of supply will not be sufficient to meet the 5% goal without at least part of the SZEF fleet using green ammonia. New e-methanol and green ammonia announcements to 2030 can be expected, however the degree to which they will align with what's required in 2030, in terms of their scale and the proportion that reach final investment decision remains uncertain. |
| **DEMAND** | | |
| Key industry actors commit to net zero by 2050 based on SBTi requirements and actions | ON TRACK | Based on the more stringent criteria set by SBTi and the requirements for defining actions as well as ambitions, progress seems to be growing. More than five owners or operators meet these criteria, as do a few ports and shipyards. Translation of the committed actions into practice, however, remains to be seen, but for the moment progress continues to be on track. |
| Zero-emissions freight becomes increasingly commonplace | NOT ON TRACK | To reach the 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 and/or about 20-30 15,000 TEU. Announcements to date appear to fall well short of this threshold. |
| Owners, freight purchasers, fuel producers, ports, finance, and other stakeholders take part in pilots and demonstrations to unlock SZEF potential | ON TRACK | A growing number of projects or pilots related to fuel production, bunkering, and infrastructure/systems are now in place, indicative of both the interest and a number of challenges being evaluated and addressed to allow SZEF to scale. Together with the increase in cross-stakeholder collaboration, for now, this indicator remains on track. Towards 2025 and 2030, this may need to be renamed or adjusted to reflect projects turning into scale-ups. |
| "Dark green" corridors for zero-emission shipping start to materialise | PARTIALLY ON TRACK | Green corridors announced, in planning, or due have grown rapidly in the last few years. Whilst there is still insufficient involvement from potential fuel producers or suppliers, corridors that begin to materialise ought to create demand to encourage greater participation from the missing parts of the value chain. Public sector engagement, however, in more than half of the initiatives is very encouraging and allows this indicator to be on track. A focus now needs to be on "dark green" corridors. |

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| Growth in the share of SZEF-capable vessels in the active fleet | NOT ON TRACK | With or without LNG-capable vessels, the current fleet and projected growth does not indicate there will be sufficient demand for SZEF in 2025 or 2030 to reach the 5% goal. Whilst both LNG-capable and methanol-capable vessels have seen strong growth in the last five years or so, they still form a very small proportion of the total global GT. Conventionally-fuelled vessels without alternative fuel capability or alternative fuel readiness have continued to enter the fleet, whilst conversions have seldom occurred for legacy tonnage. Projections based on the trends seen would put the global fleet short of the 0.1 EJ in SZEF needed in 2025 (equivalent to about 100 15,000 TEU ships running e-methanol) and that needed in 2030 (600 15,000 TEU ships equivalent). Current projects put us close to 30%-50% of the 0.1 EJ goal for 2025. |
| Growth in the share of SZEF-ready vessels in the active fleet | NOT ON TRACK | Vessels capable of being retrofitted to run on alternative fuels have not increased substantially, when compared to 2015 or even 2020: LNG-ready being the most common, albeit at 0.1% of total global gross tonnage, and the second closest being ammonia-ready vessels at 0.01% of total GT. Although these numbers will likely look much better in the next couple of years, as many of the alternative fuel ready vessels were only ordered in the last year or two, they remain a very small part of the requirement towards 2025. Readiness is not an indicator of conversion and must be looked at with caution as various definitions exist of what is required to be classed as ready for something like ammonia, methanol, or LNG. Nevertheless, it is an indicator that the optionality is being valued and paid for (to some unknown extent), contrary to the large ambivalence in the past few decades. |
| Share of orderbook with SZEF-fuel capable vessels | NOT ON TRACK | About 50% of the orderbook (in GT) in 2022 was LNG or LNG dual-fuelled, compared to 45% in 2020 and 15% in 2015. The other biggest mover is a rapid rise in methanol or methanol dual-fuelled vessels, increasing from 0.5% in 2020 to 4.5% in 2022. The orderbook, however, is such a small proportion of the existing GT, even if the orderbook only had ammonia or methanol dual-fuel vessels going forward, it will take a significant amount of time for new vessels to supplant legacy tonnage. |
| Share of orderbook with SZEF-ready vessels | NOT ON TRACK | Although the most popular choice for readiness appears to be ammonia, making up 5-7% of the orderbook GT between 2020 and 2022, this remains a very insignificant contribution to move towards 2025, let alone 2030, as it would only make up about 2% of the required SZEF demand even if we doubled the ammonia ready GT by 2025. |
| **FINANCE** | | |
| Increase the share of shipping debt aligned to trajectories needed to meet 2030/50 targets | PARTIALLY ON TRACK | Of the significant amount of total shipping finance now tied to Poseidon Principles trajectories, a large and growing set of those portfolios (compared to 2021) appear to be aligned within 5% of the required trajectory — even when weighted for each portfolio's size. Whilst not indicative of whether this translates directly or indirectly towards SZEF, continued alignment should eventually help facilitate that switch. |

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| Increase in willingness to report financing attached to shipping and its alignment to climate targets | PARTIALLY ON TRACK | There was an 8% increase in the total debt tied to Poseidon Principles between end-2021 and end-2022, even whilst total ship finance was estimated to have risen by 5%. Continued increases in transparency would be necessary to keep this lever on track, especially from APAC and Greek lenders who appear to be increasing their ship portfolios whilst others have been divesting. |
| Increase or maintain sufficient issuances of sustainability-linked loans and bonds to ship owners and operators | PARTIALLY ON TRACK | Stable appetite observed (in relative terms) to issue sustainability-linked bonds and other instruments to ship owners and operators, despite a slowdown in the overall GSS+ market, allows this indicator to be partially on track. The amount issued may still be too little compared to expectations for 2025 and 2030. |
| Mobilise industry funding for SZEF bunkering and production investment | PARTIALLY ON TRACK | Sustainability-linked loans and bonds of US$195 mn were issued to ports in 2021, and about US$500 mn to shipyards in 2020. Whilst short of the US$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 US$24 bn would bring us closer to the targets set for 2030. |
| Increase public finance (i.e., grants, loans) for SZEF-related activities | PARTIALLY ON TRACK | About US$8.2 bn in government-driven investments have gone into shipping activity, but challenges remain in increasing the geographical diversity of where these funds are available and allocated to. Most are, however, also not specifically attributed to SZEF, but could establish the surrounding context needed to facilitate SZEF. |
| **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 development in many classification societies with some announcements already made, such as the Lloyd's Register Zero Ready Framework (Lloyd's Register (2022d)) 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. |
| Classification societies research and set operational, bunkering, and safety standards for SZEF | PARTIALLY ON TRACK | Work on safety guidelines has continued at pace with several classification societies and others such as the Society for Gas as a Marine Fuel (SGMF) and the Global Canter for Maritime Decarbonization (GCMD) also being involved in such endeavours. However, additional announcements of more completed guidelines would be necessary to put this indicator fully on track. |
| Governments publish 1.5°C-aligned decarbonisation plans for domestic shipping | PARTIALLY ON TRACK | So far, eight NAPs published, and in four there is mention of 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 combining these aspirations, and general policies with actual visible progress in NAPs, there is some partial progress, but not enough to say we are on track. |

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|---|---|---|
| Governments set production targets for zero carbon fuels (intermodal usage) | ON TRACK | Out of top 20 countries, 17 have some type of hydrogen strategy which is already published, with a 2030 target for hydrogen production or electrolyser capacity. When converted into potential green hydrogen production, this equates to a total of just under 55 Mt of annual hydrogen production by 2030. This, on its own, would be sufficient to meet around 5.83-5.46 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 the IEA database of actual planned projects in 2030 puts the 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 create policies targeting SZEF adoption | PARTIALLY ON TRACK | Out of 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. With these developments, domestic policies are considerably developed, but when looked into more detail it becomes evident that seven out of the carbon pricing countries, five are EU ETS members. |
| Submission to IMO of NAPs to address GHG emissions from international shipping | NOT ON TRACK | Eight NAPs have so far been submitted. This is below the current target and, when taking into consideration the number of the IMO member states (i.e., 175 members), as well as the scale of the decarbonisation challenge and the 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 (e.g., MBMs and non-MBMs) which are aligned with 5% SZEF and decarbonisation by 2050 | PARTIALLY ON TRACK | The IMO is currently working on a plan to continue the development of economic instruments and technical measures for shipping with plans to make significant progress by MEPC 81. Similarly, the IMO has agreed a 5% goal for “zero or near zero GHG emission technologies” by 2030, meaning that progress can be considered to be moving in the right direction. However, until exact measures are adopted, and there are indications that this is the case, this indicator cannot be considered as being fully on track. |
| IMO to require new ships to be zero-emission ready (e.g., GHG reduction plan with zero-emission (SZEF) propulsion capability) | NOT ON TRACK | There has been very limited progress at the IMO regarding these developments, based on an analysis of IMO materials. |
| IMO to adopt guidelines to estimate well-to-tank GHG emissions and regulation/ incentives for SZEF | PARTIALLY ON TRACK | The MEPC adopted guidelines on lifecycle GHG intensity of marine fuels (LCA guidelines) for consideration. Additionally, 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”, further supporting the correct progress which, combined with the expectation of adoption of “economic elements”, gives much hope for optimism. However, as the exact nature of these measures and the way in which well-to-wake emissions will be accounted for remains to be seen, and is uncertain, progress can be considered to be only partially 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, with increased participation in shipping decarbonisation negotiations | PARTIALLY ON TRACK | Progress has continued since last year and observed in multiple areas with increased presence in IMO debates during MEPC 80 and MEPC 79. However, further involvement in the submission process and co-authorship of submissions is necessary to show deeper involvement. |
| Observers at the IMO increase focus on climate | PARTIALLY ON TRACK | Multiple industry and NGO organisations are focusing more on climate change debates during MEPC meetings. Many NGOs present at MEPC have had a growing focus on climate on their websites, through the publication of white papers, and participation in debates. Most recently, new NGOs with a focus of climate change and alternative propulsion have gathered observer status at the IMO. However, on the IGO side and regarding industry associations, additional participation in cooperative endeavours would be welcomed. |
| Key labour organisations voice support for decarbonisation | ON TRACK | The International Transport Workers' Federation (ITF) has continued to be active during ISWG 14,15 and MEPC 80. Following on from the 2021 position paper on sustainable shipping (ITF, 2021), the ITF has published a position paper on a just transition for seafarers with calls for a 1.5°C-aligned decarbonisation pathway. In addition, the Just Transition Maritime Taskforce was launched at COP26, which has continued to develop. |
| Green skills saps identified and recommendations in place to address those gaps for both jobs at sea and across the supply chain | PARTIALLY ON TRACK | Work commenced under the Just Transition Maritime Taskforce has continued and resulted in the publication of a position paper in late 2022. |
| Local NGOs surrounding top 50 global ports calling for air pollution mitigation | ON TRACK | There has been growing NGO presence in several key international ports. Since 2022, there has been an increased pressure, especially on US and European ports by NGOs with regards to their shipping emissions. It seems highly likely that this trend will continue and through time become more visible in most global regions. |

# Annex B

## Technology and supply

### Ammonia and methanol supply estimate up to 2030 (Figure 4)

The ammonia and methanol supply estimates are based on data from announced projects obtained from the Ammonia Energy Association (AEA) (AEA, 2023) and the Methanol Institute (Methanol Institute, 2023). The data is used to develop three scenarios of future supply for ammonia and methanol as marine fuels. In both 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 the usage of bio-methanol) as these fuels are in line with the definition of SZEF used for the purposes of this report. The data is then used to develop three scenarios of future ammonia and methanol uptake. The scenarios are based on the following assumptions:

iv. **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 utilised for the supply of SZEF for international shipping.

v. **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 utilised for the supply of SZEF for international shipping. This scenario also assumes, in addition to existing planned announced projects, 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 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).

vi. **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 utilised for the supply of SZEF for international shipping. The scenario also assumes, in addition to existing planned announced projects, 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 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 versus 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.

### 2030 hydrogen price assessment and electrolyser capacity

The ability of SZEF to be produced at costs competitive with incumbent fossil-based fuels is core to the definition of SZEF used throughout this report. Given hydrogen-based fuels form the most likely solution set to power deep-sea shipping in the absence of fossil-based alternatives, the costs of producing green hydrogen can act as a catalyst to lower SZEF prices and expedite the transition to them.

However, the question of how much one kilogram of green hydrogen costs to produce is a difficult one, both to answer and provide forecasts for into the future. Two drivers tend to dominate: the prices of electrolyser capacity and those of renewable energy. Analysis from the Energy Transitions Commission (ETC, 2021) suggests that, should 20 GW of cumulative electrolyser capacity (and the implied subsequent price reductions) be realised, green hydrogen costs could approach US$2/kg in areas with "mid-cost" renewable electricity prices (defined as US$30/MWh) and US$1.5/kg in areas with "low-cost" renewable electricity prices (defined as US$10/MWh). These features are further explored here to understand the likelihood of achieving such green hydrogen production cost reductions throughout the course of the decade to 2030.

## Electrolyser capacity trend

More than 230 GW of electrolysis capacity has been announced to be operational by 2030, with 111 GW at feasibility assessment stage and 9 GW of electrolyser capacity having passed the final investment decision stage (Hydrogen Council, 2023), representing a near-doubling from the previous year (Hydrogen Council, 2022). Assuming a further doubling can be achieved by the end of 2024, and leaving a two-year period for the construction phase, it seems likely 20 GW installed electrolyser capacity will be realised by 2026.

## Renewable electricity price trend

A learning rate-based analysis is conducted here to explore the likelihood of reaching US$2/kg and US$1.5/kg production targets for green hydrogen across the 2020s. The learning rate of renewable energy technologies describes the average reduction in LCOE for a given increase in installed capacity of that technology. By understanding how aggregated capacity installations of each renewable energy technology are likely to evolve throughout the rest of the decade, an understanding of associated reductions in the LCOE for each technology can be derived.

IEA data suggests that 720 TWh and 1323 TWh of energy were produced from solar PV and onshore wind in 2019, with 67 TWh of energy produced from offshore wind in 2018 (IEA, 2020). In addition, the IEA's Sustainable Development Scenario projects that energy generation from these technologies will rise to 1940, 2400, and 308 TWh respectively in 2025 and 3268, 3749 and 606 TWh in 2030 (ibid.).

Baseline costs for each renewable energy technology are taken from Our World in Data, suggesting levelised costs of energy for utility-scale solar PV, and onshore and offshore wind of US$50, US$30, and US$80 respectively per MWh in 2021 (Our World in Data, 2023). Learning rates of 0.39, 0.32, and 0.15 for utility-scale solar PV, and onshore and offshore wind, representing the years 2010-2023, were obtained from IRENA (IRENA, 2021). Learning rates were subsequently applied to baseline costs of each renewable energy technology under two scenarios:

**Scenario A**: LCOEs for utility-scale solar PV, and onshore and offshore wind are taken from Our World in Data for the year 2021 and learning rates are applied annually from 2021 to 2030.

**Scenario B**: LCOEs for utility-scale solar PV, and onshore and offshore wind are taken from Our World in Data for the year 2021, which are assumed to hold until the end of 2023, before learning rates are applied annually from 2024 to 2030.

Scenario A is included here to represent the classical learning scenario in which the average learning rate for each technology observed between 2010 and 2020 is assumed to continue to 2030. However, given multiple geopolitical events (e.g., the COVID-19 pandemic and the conflict between Russia and Ukraine) occurring in the first years of the 2020s, Scenario B explores the case that typical learning rate trends were disrupted during these years, resulting in a suspension of the trend until the end of 2023 before resuming its historic rate from 2024 onwards. The results of the modelling exercise are presented in Table A.

**Table A. Projected renewable energy costs to 2030**

| | Utility-scale solar PV (LR 0.39) | | | Onshore wind (LR 0.32) | | | Offshore wind (LR 0.15) | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Solar PV (TWh) | Scenario A | Scenario B | Onshore wind (TWh) | Scenario A | Scenario B | Offshore wind (TWh) | Scenario A | Scenario B |
| 2018 | | | | | | | 67 | | |
| 2019 | 720 | | | 1323 | | | | | |
| 2020 | | | | | | | | | |
| 2021 | | 50 | 50 | | 30 | 30 | | 80 | 80 |
| 2022 | | 44 | 50 | | 29 | 30 | | 74 | 80 |
| 2023 | | 40 | 50 | | 27 | 30 | | 68 | 80 |
| 2024 | | 35 | 44 | | 26 | 29 | | 63 | 74 |
| 2025 | 1940 | 31 | 40 | 2400 | 25 | 27 | 308 | 58 | 68 |
| **2026** | | **27** | **34** | | **24** | **26** | | **54** | **63** |
| 2027 | | 23 | 29 | | 22 | 25 | | 46 | 54 |
| 2028 | | 20 | 25 | | 21 | 23 | | 40 | 47 |
| 2029 | | 17 | 21 | | 20 | 21 | | 35 | 41 |
| **2030** | **3268** | **14** | **18** | **3749** | **18** | **20** | **606** | **30** | **35** |

## To reach US$2/kg, are we on track to reach "mid-cost" renewable electricity of $30/MWh by 2026?

Assuming no disruption to typical learning rate trends (Scenario A), the analysis suggests that it is likely a LCOE of US$30/MWh by 2026, likely to unlock a US$2/kg green hydrogen price, will be achieved via low-carbon electricity produced by utility-scale solar PV and onshore wind technology, however, not by offshore wind. In the case of a delayed resumption of the learning trend (Scenario B), only onshore wind seems likely to surpass the US$30/MWh threshold by 2026. Despite its greater learning rate, solar PV remains at US$34/MWh due to its higher initial LCOE in 2021, with offshore

wind substantially higher. In a "worst case" scenario, therefore, it seems likely only green hydrogen produced via onshore wind will be able to be produced at costs below US$2/kg by 2026.

## To reach US$1.5/kg by 2030, are we on track for "low-cost" renewable electricity of US$10/MWh by 2030?

Based on the modelling undertaken here, there is no scenario in which any of the renewable electricity pathways achieve the "low-cost" US$10/MWh target required to unlock a US$1.5/kg green hydrogen cost by 2030. Under **Scenario A**, solar PV looks closest, reaching US$14/MWh by 2030, followed by onshore wind at US$18/MWh. Notably, offshore wind only then reaches the level required for sub-US$2/kg green hydrogen production cost. Under worst-case assumptions imposed by **Scenario B**, only solar PV appears likely to drop below US$20/MWh, with onshore wind slightly more expensive, but neither reaching the US$10/MWh threshold. Offshore wind remains above the threshold needed to produce green hydrogen at less than US$2/kg in 2030.

## Summary

It is expected the current scale-up of installed electrolyser capacity will be sufficient to enable green hydrogen production costs of less than US$2/kg by 2026. This supports the notion that green hydrogen production could begin to become cost-competitive with blue (and some grey) production methods in the 2020s (ETC, 2021), even under the assumption of continuing supply chain volatility through to late 2023. However, this will remain dependent on the price of natural gas. The learning rate analysis suggests production costs of green hydrogen in 2030 appear unlikely to reach US$1.5/kg by 2030, regardless of the renewable generation method employed.

Nonetheless, production costs will continue to be heavily differentiated by region with no single number able to represent the complex evolving landscape of environmental, economic, and political factors that determine production cost. However, the overall results published here are generally supported by IEA projections who note that, "should the planned pipeline of electrolyser projects be realised" and, combined with expected drops in renewable energy, the cost of green hydrogen could be reduced to "within the range of US$1.3-4.5/kg" (IEA, 2022 - Global Hydrogen Review 2022).

Finally, there are unavoidable downstream processes that will be necessary to enable green hydrogen to be consumed as a maritime fuel, all raising final bunkering and operational costs. Recent modelling has sought to investigate the impact of renewable electricity price on total costs of ownership for a SZEF-powered bulk carrier against a reference MDO baseline (LR/UMAS, 2020). The analysis assumes electricity prices of US$40/MWh in 2030, US$30/MWh in 2040, and US$20/MWh in 2050. A scenario with no carbon price is then contrasted with an alternative scenario in which a carbon price of US$101/t in 2030, US$194/t in 2040, and US$288/t in 2050 is assumed. The modelling finds that, without a carbon price, SZEF are unlikely to reach cost parity with conventional fuels, whilst with a carbon price, SZEF only become competitive in the late 2040s. The modelling supports the notion that renewable electricity prices may need to approach US$10/MWh (the "low-cost" threshold that ETC modelling suggests could result in a US$1.5/kg green hydrogen production price) for SZEF to be competitive at an operational level.

# 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 (Faber et al., 2020) for an average vessel of this size and type, and then comparing those estimates 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.[57]

## 2025 and 2030 required TEU estimate

Using data from the 4th IMO GHG Study (Faber et al, 2020) 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 containership. 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 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 over the last three years (2020-2022) in GT for fleets with different fuel capability is calculated based on Clarksons WFR (2023) data, combined with the average GT ordered based on the same source, and then extrapolated to get to 2025 and 2030 estimates of total SZEF-capable GT. The average values for the various fuel types are shown in Table B below.

**Table B. Approximate growth rates used for SZEF-capable tonnage.[58]**

| | Fleet growth rate, GT/y | Orderbook growth, GT/y |
|---|---|---|
| **Hydrogen and hydrogen dual-fuel** | 16,000 | 40,000 |
| **LNG and LNG dual-fuel** | 6,200,000 | 24,000,000 |
| **Methanol and methanol dual-fuel** | 110,000 | 1,800,000 |
| **Nuclear and nuclear dual-fuel** | 0 | 0 |
| **Other** | 9,700 | 65,000 |
| **Other gas dual-fuel** | 790,000 | 1,600,000 |

57 Utilising figures used by UMAS which are based on a literature review of several sources of conversion factors for SZEF fuels

58 Clarksons WFR (2023)

A ship type and size weighted average fuel consumption estimate for the whole fleet based on the 4th IMO GHG Study (Faber et al., 2020) is used to approximate 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 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.

**Table C. Shipping portfolios and alignment to[59]**

| | 2022 | | | | | |
|---|---|---|---|---|---|---|
| **Poseidon signatory** | **Shipping portfolio (US$ bn)** | **Portfolio size estimated** | **Reported alignment score (%)** | **Below 5%** | **Below 10%** | **Weighted score** |
| ABN Amro | 7 | No | 2.6% | 7 | 7 | 0.00114 |
| BNP Paribas | 20 | Yes | 12.2% | 0 | 0 | 0.01535 |
| Bpifrance | | | 42.8% | 0 | 0 | 0.00000 |
| CaixaBank | | | | 0 | 0 | 0.00000 |
| Citi | 9 | No | 12.2% | 0 | 0 | 0.00691 |
| CIC | | | -1.0% | 0 | 0 | 0.00000 |
| Crédit Agricole | 13 | Yes | 13.9% | 0 | 0 | 0.01136 |
| Credit Suisse | 8 | Yes | -1.3% | 8 | 8 | -0.00065 |
| Danish Ship Finance | 5 | No | 5.7% | 0 | 5 | 0.00179 |
| Danske Bank | 5 | No | 9.6% | 0 | 5 | 0.00302 |
| DekaBank | | | 5.2% | 0 | 0 | 0.00000 |
| DBJ | 4 | Yes | 3.8% | 4 | 4 | 0.00096 |
| DNB | 5 | Yes | 13.8% | 0 | 0 | 0.00434 |
| Eksfin | | | 31.2% | 0 | 0 | 0.00000 |
| Finnvera | | | 57.3% | 0 | 0 | 0.00000 |

59 Source: Petrofin Research (2023)

| | | | | | | |
|---|---|---|---|---|---|---|
| ING | 13 | Yes | -2.8% | 13 | 13 | -0.00229 |
| KfW IPEX-Bank | 13 | No | | 0 | 0 | 0.00000 |
| MUFG | 5 | Yes | 0.6% | 5 | 5 | 0.00019 |
| Nordea | 7 | Yes | 6.6% | 0 | 7 | 0.00291 |
| OCBC | 4 | Yes | 4.5% | 4 | 4 | 0.00113 |
| SACE | | | 51.0% | 0 | 0 | 0.00000 |
| SEB | 5 | No | 3.7% | 5 | 5 | 0.00116 |
| SBI Shinsei Bank | | | 7.4% | 0 | 0 | 0.00000 |
| Société Générale | 8 | Yes | 15.4% | 0 | 0 | 0.00775 |
| SpareBank 1 SR-Bank | | | -10.7% | 0 | 0 | 0.00000 |
| Sparebanken Vest | | | -12.5% | 0 | 0 | 0.00000 |
| Standard Chartered | 7 | No | 2.6% | 7 | 7 | 0.00114 |
| SMBC | 10 | Yes | 2.5% | 10 | 10 | 0.00157 |
| SMFL | | | -5.0% | 0 | 0 | 0.00000 |
| SMTB | 11 | Yes | -0.4% | 11 | 11 | -0.00028 |
| **Weighted alignment** | **6%** | | | | | |
| **Total accountable (US$ bn)** | **159** | | | | | |
| **Total ship finance (US$ bn)** | **525** | | | | | |
| **% Visible** | **30%** | | | | | |
| **Total under 5% (US$ bn)** | **74** | | | | | |
| **As share of all debt** | **14%** | | | | | |
| **Total under 10% (US$ bn)** | **91** | | | | | |
| **As share of all debt** | **17%** | | | | | |

**Annex B**

**Table D. Shipping portfolios and alignment to Poseidon Principles [60]**

| | 2021 | | | | | |
|---|---|---|---|---|---|---|
| Poseidon signatory | Shipping portfolio (US$ bn) | Portfolio size estimated | Reported alignment score (%) | Below 5% | Below 10% | Weighted score |
| ABN Amro | 7.45 | No | -3% | 7.45 | 7.45 | -0.00151 |
| BNP Paribas | 19.8 | Yes | 8% | 0 | 19.8 | 0.00909 |
| Bpifrance | | | 72% | 0 | 0 | 0.00000 |
| CaixaBank | | | | 0 | 0 | 0.00000 |
| Citi | 7.9 | No | 12% | 0 | 0 | 0.00566 |
| CIC | 2.5 | Yes | -7% | 2.5 | 2.5 | -0.00107 |
| Crédit Agricole | 13.5 | Yes | 16% | 0 | 0 | 0.01339 |
| Credit Suisse | 10 | Yes | -2% | 10 | 10 | -0.00147 |
| Danish Ship Finance | 5.74 | No | 6% | 0 | 5.74 | 0.00197 |
| Danske Bank | 5 | Yes | 3% | 5 | 5 | 0.00101 |
| DekaBank | | | | 0 | 0 | 0.00000 |
| DBJ | | | 1% | 0 | 0 | 0.00000 |
| DNB | 6.7 | No | 10% | 0 | 6.7 | 0.00390 |
| Eksfin | | | 64% | 0 | 0 | 0.00000 |
| Finnvera | | | -7% | 0 | 0 | 0.00000 |
| ING | 12.5 | Yes | -6% | 12.5 | 12.5 | -0.00459 |
| KfW IPEX-Bank | 17.15 | No | | 0 | 0 | 0.00000 |
| MUFG | 4.6 | Yes | | 0 | 0 | 0.00000 |
| Nordea | 7.5 | Yes | -1% | 7.5 | 7.5 | -0.00051 |
| OCBC | | | -2% | 0 | 0 | 0.00000 |
| SACE | | | | 0 | 0 | 0.00000 |
| SEB | 6 | Yes | 3% | 6 | 6 | 0.00092 |
| SBI Shinsei Bank | | | | 0 | 0 | 0.00000 |
| Société Générale | 7.5 | Yes | 24% | 0 | 0 | 0.01088 |
| SpareBank 1 SR-Bank | | | -16% | 0 | 0 | 0.00000 |
| Sparebanken Vest | | | -15% | 0 | 0 | 0.00000 |
| Standard Chartered | 6 | Yes | | 0 | 0 | 0.00000 |
| SMBC | 10.5 | Yes | 7% | 0 | 10.5 | 0.00424 |
| SMFL | | | -4% | 0 | 0 | 0.00000 |
| SMTB | | | -1% | 0 | 0 | 0.00000 |
| Amsterdam Trade Bank | | | | 0 | 0 | 0.00000 |
| DVB | | | | 0 | 0 | 0.00000 |
| Sumi Trust | 13 | Yes | | 0 | 0 | 0.00000 |

60 Source: Petrofin Research (2022)

| | |
|---|---|
| Weighted alignment | 4% |
| Total accountable (US$ bn) | 163 |
| Total ship finance (US$ bn) | 500 |
| % Visible | 33% |
| Total under 5% (US$ bn) | 50.95 |
| As share of all debt | 10% |
| Total under 10% (US$ bn) | 93.69 |
| As share of all debt | 19% |

**Public finance estimate (Figure 9)**

This is based on an analysis of the top 20 countries by TEU traffic through literature research of announced demonstration and pilot projects, the announced EU ETS inclusion into shipping (European Commission, 2023b), and the announced US Clean Ports Program (EPA, 2023). 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:

iv. **Direct** – this figure includes US$753 mn of funding which is condensed as being directly available for maritime shipping decarbonisation and, as such, can directly facilitate SZEF adoption. It is based on a literature review of grey literature, news reports, government papers, and other related publicly-available information from the top 20 TEU countries, with the bulk of this funding being identified in several sources, these being: several UK decarbonisation projects, such as Zero Emission Vessel and Infrastructure (ZEVI) competition, the UK National Clean Maritime Research Hub (URI, 2023), and CMDC (UK Government, 2023b); the German announcement of ZEV funding (Federal Ministry of Finance, 2021); various EU funding schemes; and Japanese funding in carbon neutral ships (Government of Japan, 2023).

v. **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% goal remains to be seen due to certain funding timelines coming into force and/or any remaining ambiguity of when and how these announcements will be implemented. The main bulk of this funding is the announced usage of an estimated US$1.6 bn of EU ETS revenue from shipping for maritime decarbonisation (European Commission, 2023b).

vi. **Potential** – this is funding which is generally available for a range of projects which can include SZEF activities as one possible beneficiary, alongside other target initiatives such as port infrastructure improvements, improvements in vessel energy efficiency, air pollution activities, and similar. The bulk of this funding comes from the US Clean Ports Program (EPA, 2023), Singapore (Maritime Singapore, 2022), Republic of Korea (Ministry of Oceans and Fisheries, 2023), and others.

RACE TO ZERO

2030 BREAKTHROUGHS

UMAS

GETTING TO ZERO COALITION