Outcomes Report:

Charting Our Journey

A Word from the Secretary General

Dear Reader,

We, the shipping industry, are embarking on a journey together led by a common goal: eliminating shipping's negative impacts on our fragile climate. The collective voice of the IMO has set a strong ambition for zero emissions by 2050, with intermediary targets for 2030 and 2040. It is our shared responsibility to not only meet, but to exceed these objectives, ensuring that our oceans are protected and that our technology does no harm.

Absolute zero emission technologies produce zero GHG emissions, are nearly silent, with no pollutants to water or air. The solutions are here today: batteries, hydrogen fuel cells, wind propulsion, all in combination, using highly efficient technologies and measures to reduce costs.

Throughout this report and in all ZESTAs material, zero emissions (or ZE) means absolute zero. The World Shipping Council defines “absolute zero” GHG emission fuels in the submission to the IMO (ISWG-GHG 13/3/9).

Equally important is a fair and equitable transition for all, leaving no-one behind in the accelerated change of the Fourth Shipping Revolution.

I’d like to give a special thanks to the ShipZERO28 sponsors, as well as speakers, panellists and moderators, without whom this workshop would not have been possible. Finally, I would like to extend my sincere gratitude to the ZESTAs Secretariat and the motivated researchers who worked diligently to deliver this informative report ahead of COP28.

Please take the time to read it thoroughly as I believe it will give you both hope and inspiration.

Thank you for your continued support on our Voyage to Zero.

Madadh MacLaine
Secretary General
Zero Emission Ship Technology Association (ZESTAs)

ShipZERO28 Sponsors

Table of Contents

Executive Summary

The IMO Revised GHG Strategy, adopted at MEPC 80 in July 2023, represents a significant leap forward in ambition. This means a fundamental transformation in the industry: a Fourth Shipping Revolution and the end of fossil-fuelled shipping by 2050.

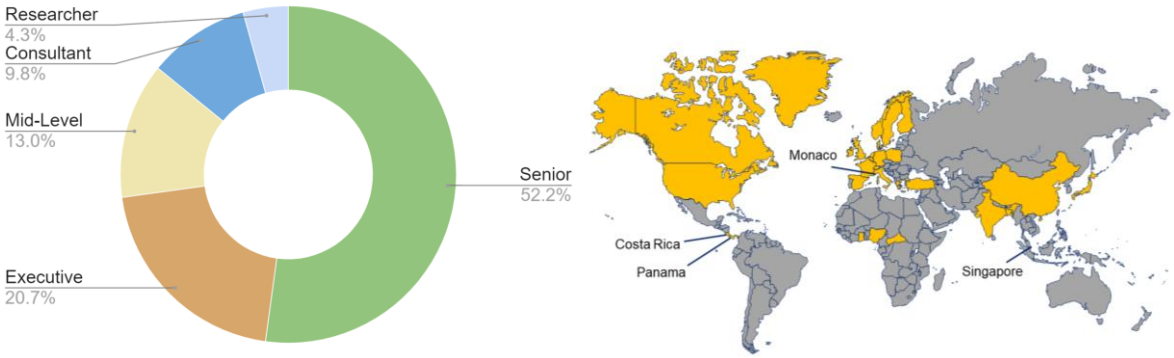
Shipping's impact is more crucial than most sectors - both in its ability to harm and our ability to protect the environment. Marine life sequesters around 40% of total CO_2 yearly and produces over half of our oxygen. Additionally, the oceans absorb fast rates of warming, capturing 90 percent of the additional heat generated from CO_2 emissions. However, business as usual will cause irreversible tipping points due to phytoplankton die-off due to ocean acidification and marine pollution of the Surface Microlayer (SML) by oil, heavy metals, scrubber wash water and plastics by 2045-2050.

"Getting to zero GHG emissions is only one part of healing our planet."
- Nick Brown, Global Brand and Communications Director, Marine & Offshore at Bureau Veritas.

Ocean life has an extremely fast recovery time and is our greatest ally in combating climate change. Correct stewardship of our oceans will ensure that we mitigate the worst effects of climate change, in line with the Paris Agreement, and "do no harm".

Absolute zero emission technologies are the solution for shipping: producing zero GHG emissions, minimal underwater radiated noise (URN) and no pollution to water or air. The solutions are here today: batteries, hydrogen fuel cells, wind propulsion all in combination using highly efficient technologies and measures to reduce costs.

ShipZERO28 brought together a wide and diverse audience from the shipping and energy sectors to brainstorm solutions to creating global zero emission ecosystems, with a focus on addressing shipowner challenges.



Distribution of ShipZERO attendees by position (left) and country (right).

Shipowners **Wah Kwong** and **Veer** presented their unique challenges in reducing and eliminating GHG emissions on their fleets, followed by technical presentations, the finance panel, brainstorming sessions and the visionary panel. **The full agenda can be accessed here.**

Three principles guided all discussions:

- Only absolute zero emissions solutions
- Leave no one behind
- Do no harm

Industry experts presented their solutions, specifically addressing shipowner challenges. One theme was clear throughout: **collaboration is key**. None of the projects discussed would have achieved success without collaboration with a wide range of industry partners. The most successful projects to date have been **Joint Ventures**. **Videos of all presentations and panel discussions are available here.**

Since the first ZESTAs event at COP26, zero emissions shipping has become more tangible. Photos of zero emission vessels and infrastructure are much more common than at ShipZERO26, in 2021 at COP26. We are seeing more and more real, operational vessels and systems at larger and larger scales.

Currently, the main challenge of transitioning away from fossil fuels is the lack of renewable electricity to create green hydrogen. This is a supply chain problem, so ShipZERO28 took a whole supply chain perspective to understand the strengths and weaknesses of zero emission shipping. A series of technical presentations across Day 1 and Day 2 looked at the supply chain in order:

Energy → Storage → Delivering to ships → Vessel propulsion

To kick off the technical presentations, front-running innovators **Lhyfe** and **Drift Energy** presented a rethinking of absolute zero emissions energy production, harnessing the vast renewable resources available at sea. Naturally, the shipping industry is best equipped to build offshore energy projects, giving developers a solid offtake business model. Industrial-scale rollout of green hydrogen production and infrastructure was presented by **Air Liquide, Chart Industries** and **Howden**.

The focus then moved to port and quayside infrastructure. **Port of Trelleborg**, **Unitrove Innovation**, **MJR Power and Automation** and **Shift Clean Energy** brought their knowledge and experience to address the question: how do we deliver green energy to ships? The takeaways here are to learn from scaled up land-based systems for proven technology and work collaboratively with ports to start small and modular infrastructure demonstrators which can then scale up as demand grows.

Finally, leading technical experts **ABB**, **SEAM**, **Nedstack**, **PowerCell**, **Future Proof Shipping** and **LH2 Shipping AS**, presented their learnings and results from delivering groundbreaking zero emission vessel projects. We learnt that the vessels on the water today have set the groundwork for all components required for a zero emission fleet: design, integration, safety, training and operations. Scaling up onboard power for larger ships is straightforward, especially when combined with state-of-the-art wind propulsion and energy efficiency technologies as presented by **Bureau Veritas**, **Dealfeng**, **Bound4Blue**, **NAPA, Howden** and **Propelwind/UPS**.

Shipowner recommendations resulting from technical presentations and discussions were:

- Explore partnerships with renewable energy providers and innovative offshore hydrogen and electricity suppliers to access abundant renewable resources available at sea, bypassing slow rollout of grid infrastructure by accessing offshore power directly at source.
- Sign offtake agreements with hydrogen suppliers, building a flexible business model that fits your operations.
- Form Joint Ventures with ports to access a strong network and share data.
- Form Joint Ventures with zero emission technology suppliers to define bespoke and flexible business models to fit your operations e.g. leasing modular batteries, hydrogen fuel cells, or containerized hydrogen storage.
- Share energy consumption and voyage data with ports and technology suppliers to increase performance.
- Combat range anxiety and asset risk by collaborating with ports and technology providers to create custom solutions such as swappable zero emissions energy refuelling - either electricity or hydrogen.
- Convert existing vessels to electric propulsion to attract investment, reduce GHG emissions and increase efficiency. Electrification is low risk because all zero emission vessels are electric.
- Fully modular systems are available today, ideal for tackling fuel uncertainty, retrofit on older vessels and enabling innovative leasing or pay-as-you-save business models to eliminate high CAPEX.
- Partner with banks to create innovative financing agreements for total modularity of the propulsion system and to lease fuel saving technologies.
- Utilise proven design and implementation work successfully executed on existing hydrogen-electric propulsion systems. Design, implementation, operational support, certification and crew training is available today based on existing vessels.
- On existing vessels, retrofit wind propulsion with voyage optimisation and hull air lubrication to improve EEDI and CII scores and avoid ETS costs
- On new builds, design for maximum efficiency to reduce fuel consumption over the vessel's lifetime and design for modular electric propulsion systems to enable zero emissions solutions.
- Use verified data to sign long-term Joint Ventures with cargo owners and ports who are serious about zero emissions. Analyse cargo owners' business cases to determine the additional cost per unit of cargo of zero emissions transport.

The Finance Panel moderated by Effie Datson, Asset & Wealth Management Executive and NED Board Member and comprised of an expert roundtable, followed by Q&A:

- Paul Taylor, Global Head of Maritime Industries, Société Générale Corporate & Investment Bank and Vice Chair of the Poseidon Principles
- Louisa Cilenti, Managing Principal and Co-founder, pH3 Capitol
- Marc Ostwald, Chief Economist & Global Strategist at ADM Investor Services International

Finance presentations were delivered by Michael Adams, Founder & CEO of Ocean Assets Group and Frederic Bouthillier, Carbon Emissions Trader, Head of Shipping at Vertis Environmental Finance.

The key takeaways from the Finance Presentations and Panel Discussion were:

- Collaboration between West and East is critical to unlocking transition capital. Strategic, holistic thinking must replace linear ideologies
- Institutional funding is crucial to the climate transition, especially in the Global South and should be allocated principally to Small and Medium Enterprises (SMEs) which provide 90% of economic activity and over 70% of jobs in developing countries
- Avoid investments in fossil fuel systems
- Blended finance models accelerate the transition by unlocking private capital using catalytic finance from institutions or funds. Catalytic finance impacts can be measured using ESG ratings or certificates and verified with digitalisation. Zero emission corridors can anchor catalytic finance.
- Successful zero emission corridors in the Global South must incorporate ships, jobs, training and resources and meet developing countries where they are today
- Hydrogen fuel cells and electrolysers are the most promising early-stage innovations needing funding today and attracting investor interest
- Low hanging fruit such as wind propulsion, sustainable antifouling and electrification are fully commercialised growing rapidly
- Hydrogen allows renewable energy to be stored and traded as a commodity, giving finance more accurate cost estimates to inform business cases.
- Digitalisation for energy efficiency using smart data is also attracting interest and growing at a high rate.
- Data transparency is a ‘win-win’ situation because of the cost savings experienced

The Finance Presentations and Panel Discussion shipowner recommendations were:

- Seek blended finance models: use catalytic funding from institutions, foundations, or development banks to de-risk your business case and attract private impact finance.
- Front-runner shipowners and technology suppliers should share their technology and training with the Global South through catalytic funding verified by ESG, for example through IMO CARES and zero emission corridors.
- Prepare for increasing EU ETS costs and planned ETS in other countries by retrofitting wind propulsion, hull air lubrication and other energy efficiency technologies for absolute fuel reduction across the entire fleet.
- Seek collaboration with finance to build consortia for innovative financing models with verified emissions reduction methodologies to generate in-sector onsets as an additional revenue stream.
- Partner with technology suppliers, ports, cargo owners and catalytic or institutional finance to fund retrofit solutions and explore modular future-proof design on newbuilds.

Attendees split into six random groups and were instructed to identify the key mechanisms and links between policy, markets, finance and technology that can unlock actionable solutions to creating zero emission ecosystems in shipping. Each group then explained their conclusions to the room. Finally, the Visionary Panel convened to deliver their thoughts on the day's discussions, followed by a participative SWOT Analysis (Strengths, Weaknesses, Opportunities, Threats), covering the entire shipping industry from all perspectives.

The Visionary Panel was moderated by Carleen Walker, Founder & CEO of North American Marine Environment Protection Association (NAMEPA), and comprised:

- Cargo – Elisabeth Fauvelle Munck af Rosenschöld, Sustainability director, IKEA Supply AG
- Cargo – Richard Hixson, Co-founder HealthCare Ocean
- Banking – Michael Parker, Global Shipping, Logistics & Offshore at Citi Group and Chair of Poseidon Principles
- Classification – Nick Brown, Global Brand and Communications Director, Marine & Offshore at Bureau Veritas
- Shipowner - Danielle Southcott, Founder, CEO Veer Group zero Emissions container vessels, (Bahamas)
- Shipowner - William Fairclough, Managing Director at Wah Kwong Maritime Transport Holdings Limited (Hong Kong)

Brainstorming, Visionary Panel and SWOT Analysis outcomes:

- Survivability is increasingly a driver of policies and markets due to the worsening effects of climate change, their impact (especially on developing countries) and public desire and willingness to pay (especially in developed countries) for action
- As market pull for urgent climate action increases, shipping industry actors closest to the consumer (cargo owners, cruise companies) have the opportunity to leverage willingness to pay for a "green button" for zero emissions shipping at a premium. In many cases, the additional cost passed onto the consumer is negligible, as shown in existing Joint Ventures between cargo owners, shipowners and zero emission technology suppliers.
- Policies can ensure developing countries do not pay increased prices for zero emissions shipping
- Policy mechanisms delivering direct financial and legal support (e.g. tax credits, direct funding, price caps, legal agreements such as Contracts for Difference) are preferred by the shipping industry over institutional market-based measures (e.g. EU ETS, IMO EEDI & CII) because of their faster impact, better ability of the industry to allocate resources compared with institutions, and concerns of greenwashing and lack of transparency in institutional market-based measures.
- Voices from the shipping industry stressed the urgency of policies to bring the levelized costs of renewable electricity (LCOE) and green hydrogen much closer to those of fossil fuels, as enacted in the US Inflation Reduction Act.
- Making the IMO Data Collection System (DCS) transparent would unlock the opportunity to create obligatory independent, objective, digitalised third-party emissions verification (e.g. certification label, peer rating), eliminating greenwashing.
- Data transparency is win-win for shipowners, ports, cargo owners, policy makers and technology suppliers. For a shipowner, the gains in efficiency (e.g. less time in port) far outweigh any concerns about competition.

- Shipowners who abuse institutional market-based measures such as the EU ETS through greenwashing will be excluded by shipping finance using methodologies for emissions verification through digitalisation and obligatory target-based financing.

The ShipZERO Programme

ShipZERO is a series of events hosted by ZESTAs with the aim to collaborate across industry levels. Our mission is straightforward: to uncover and tackle the barriers to achieving **Absolute Zero Shipping** and to build the foundations of an operational and global zero emission shipping ecosystem.

There have been three ShipZERO events so far, kicking off with ShipZERO26 at COP26 in Glasgow, UK, in November 2021. **Two conclusions** were reached:

1. Technology required for zero emission shipping exists but that it must be better publicised, especially to decision makers.
2. Policy and regulation must increase ambition with concrete measures to accelerate zero emissions shipping.

Learning from this, ZESTAs achieved three major milestones:
→ Policy Brief delivered to over 2,000 transport ministers at COP26
→ International recognition at the world stage during COP26
→ Successful application for consultative status at the IMO

In short, **ZESTAs solidified its ability to inform policy and regulation at the highest level**, ensuring that top decision makers receive the most transformative, important, and up-to-date changes to reach absolute zero GHG emissions in the shipping industry.

What is absolute zero?
Zero emission fuels are essential in reaching deep reductions in emissions. The World Shipping Council defined "absolute zero" GHG emission fuels in a submission to the IMO based on the Well-to-Wake (WTW) model by the European Sustainable Shipping Forum and Marin[1]. The only demonstrated and commercialised zero emission fuels are renewable electricity and hydrogen produced from renewable electricity, as evidenced in a ZESTAs submission to the IMO[2] (ISWG-GHG 15/INF.2). The viability of these fuels are increased by using wind propulsion and energy efficiency technologies, because they reduce fuel demand. Throughout this report and in all ZESTAs material, zero emissions (or ZE) means absolute zero.

In June 2022, ZESTAs hosted the second event in the series, ShipZERO26.5 in Amsterdam, Netherlands. This event focused on the industry itself: how finance, law and shipowners can create the business cases for innovation to thrive. **Four solutions** were identified:

1. Pooling resources into multi-vessel projects with collaboration between competitors
2. Zero emission channels in green corridors → e.g. inland electric and hydrogen corridors in Benelux (Zero Emission Services, Future Proof Shipping, Condor H2)
3. Modular and retrofit-ready design to future-proof investments → e.g. containerised and swappable components (Shift, Future Proof Shipping, ABB, TrAM project)

[1] World Shipping Council (WSC), 2022; Understanding Net-Zero, Near-Zero, Absolute Zero, and Zero (ISWG-GHG 13/3/9): https://www.worldshipping.org/regulatory-filings/understanding-net-zero-near-zero-absolute-zero-and-zero-iswg-ghg-133x
[2] ZESTAs, 2023; Commercial Readiness of Absolute Zero GHG Technologies (ISWG-GHG 15/INF.2): https://zestas.org/wp-content/uploads/2023/06/ZESTAs-ISWG-GHG-15-INF.2-Commercial-Readiness-of-Absolute-Zero-GHG-Technologies.pdf

4. Industry-led innovative contracts and agreements → e.g. Poseidon Principles, Sea Cargo Charter

Beginning in 2023, ZESTAs addressed the shipowner challenge, specifically: why are shipowners not building zero emission vessels?

At ShipZERO Online in March 2023, we worked directly with Dutch short-sea ship-owner Vertom to address their challenges. Zooming in on a specific shipowner allowed us to see the barriers in detail:

- Challenge: Vessels are not always dedicated to specific routes or customers: tramping. Contracts, spot market made ZE operations impossible currently and no long-term client could be found.
  → Solution: Enabling ZE vessels to operate flexibly (range, cargo, port), sharing costs across customers
- Challenge: Hesitance to pool resources due to the need to stay competitive.
  → Solution: Sharing resources while protecting or improving competition

For ShipZERO28 at IMO Headquarters during London International Shipping Week (LISW) in September 2023, we focussed on creating a global zero emission shipping ecosystem by:

- Identifying common ground between specific shipowners
- Examining modular standardised solutions that work for various vessel types, enhancing flexibility, simplifying certification, and minimising costs
- Developing strategies to achieve absolute zero for small vessels and facilitate direct emission reduction for large vessels

What's it like to be at a ShipZERO event?

All ZESTAs events take a hands-on approach and encourage heavy audience participation, holistic problem solving, networking and fun! Expert presentations are followed by detailed, frank Q&A sessions, and panel discussions. Brainstorming sessions bring together attendees into diverse groups working to solve shipping's most complex solutions through cross-pollination. Informal networking breaks and after event drinks provide the perfect occasions to meet with potential future collaborators, investors, industrial heads, and decision makers. Everyone in attendance is, like you, on board and focussed on changing the current course of the shipping industry, for the better!

ShipZERO28 continued by addressing specific shipowner challenges, this time of two very different companies: Veer and Wah Kwong. By building on all the learnings of the previous three events, we brought together a formidable array of delegates to workshop solutions to their challenges.

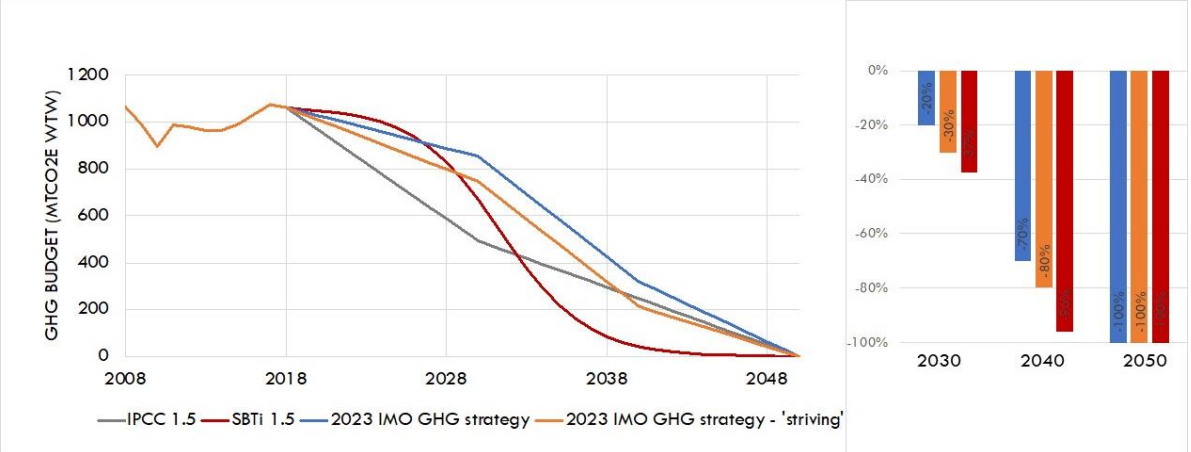
Three principles guided all discussions:

- Only absolute zero emissions solutions
- Leave no one behind
- Do no harm

Foreword: Oceans of Hope

The 2023 IMO Revised GHG Strategy sets clear ambitions for international shipping to reach net-zero GHG emissions by 2050 with indicative targets of 20-30% by 2030 and 70-80% by 2040, compared to 2008[3]. This means a fundamental transformation in the industry: a Fourth Shipping Revolution.

Analysis by UMAS shows that the IMO's targets correspond to a path between 1.55°C and 1.6°C and are close to those of the IPCC and the Science Based Targets initiative (SBTi), based on the GHG budget defined in the IPCC 1.5° scenario. The implications to existing and new ships and the energy industry are that the average ship's GHG intensity must reduce by 86% by 2040. This will end the era of fossil-fuelled shipping. Watch the full presentation by Dr Nishatabbas Rehmatulla here.



IMO GHG reduction targets and a 1.5°C pathway. Slide by UMAS presented by Dr Nishatabbas Rehmatulla, Principal Research Fellow - Shipping decarbonisation at UCL Energy Institute[4].

The urgency of combating climate change is extreme and at a choke point. The IPCC AR6 Synthesis Report[5] in March 2023 made three sobering conclusions clear:

- Climate change is a threat to human well-being and planetary health (very high confidence).
- There is a rapidly closing window of opportunity to secure a liveable and sustainable future for all (very high confidence).
- The choices and actions implemented in this decade will have impacts now and for thousands of years (high confidence).

We are at a crucial moment in our planet's history. Our actions today will have a critical impact on future generations. Click here to watch the presentation by Richard Hixson, Co-founder HealthCare Ocean.

Shipping's impact is more crucial than most sectors - both in its ability to harm and our ability to protect the environment. Research by the GOES Foundation and the University of Edinburgh shows the inseparable relationship between climate change and ocean health. All marine life sequesters around 40% of total CO_2 (2.5 Gigatonnes per year), compared to just 10% from terrestrial plants (0.6 Gigatonnes per year) and produces over half of our oxygen[6]. Additionally, the oceans absorb fast rates of warming, capturing 90 percent of the additional heat generated from CO_2 emissions. Phytoplankton are crucial to slowing climate change because they absorb a massive 25% of the Earth's CO_2.

[3] IMO, 2023: https://www.imo.org/en/MediaCentre/PressBriefings/pages/Revised-GHG-reduction-strategy-for-global-shipping-adopted-.aspx
[4] Slide presented by Dr Nishatabbas Rehmatulla at ShipZERO28
[5] IPCC, 2023: https://www.ipcc.ch/report/sixth-assessment-report-cycle/
[6] GOES Foundation, 2023: https://goesfoundation.com/about-goes/

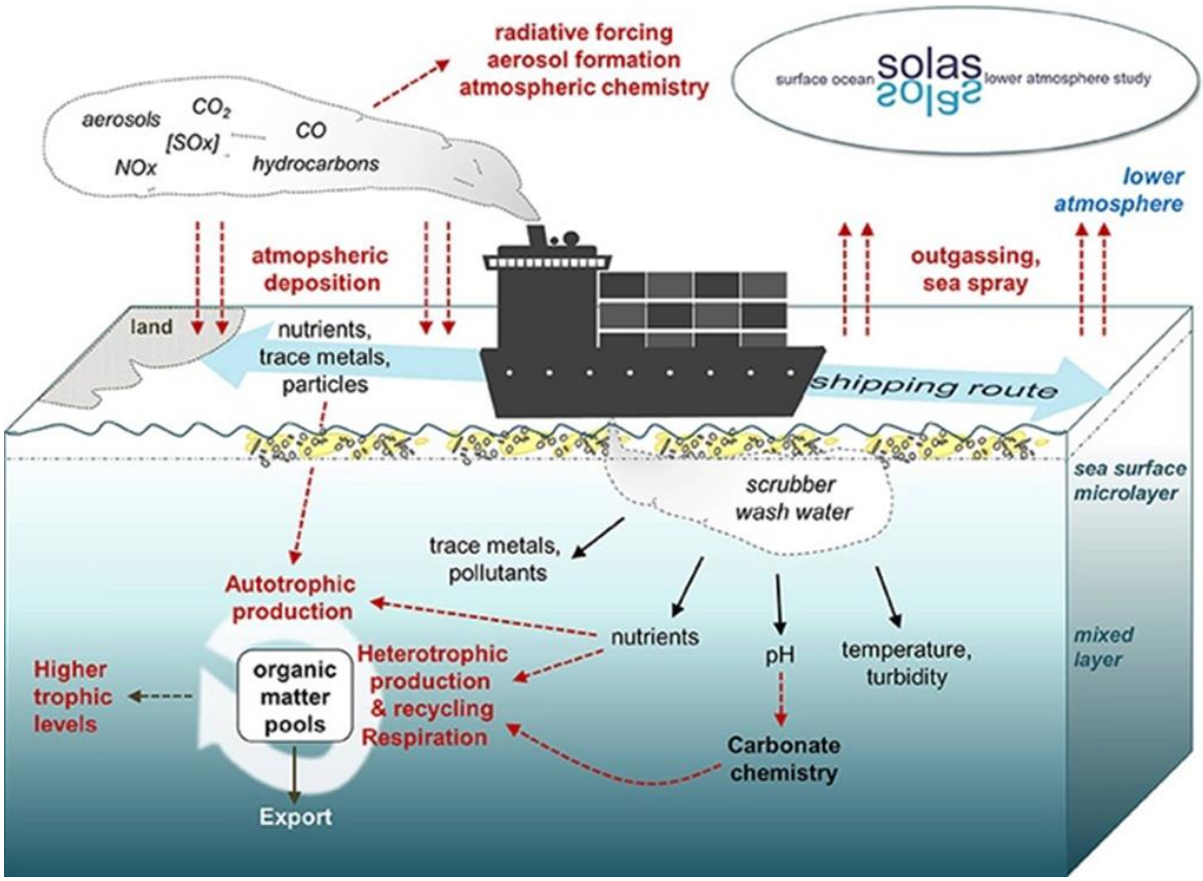
“By absorbing carbon, phytoplankton are our greatest ally in combating climate change” - Sir David Attenborough, 2021

The oceans have a powerful capacity to absorb fast rates of warming and CO_2 levels - but not unlimited. We are staggeringly close to reaching irreversible tipping points.

Increases in dissolved CO_2 have caused the ocean to acidify by 38% between 1850 and 2022, rising at a rate not seen in 55 million years[7,8]. Ocean acidification is reducing oxygen levels, dissolving coral habitats, creating dead zones and killing plankton. More than 50% of marine life has died off since the 1950s and it is dying off at a rate of more than 1% per year[5]. The acidity level is expected to reach pH 7.95 by 2045-2050, at which point carbonate-based lifeforms begin to dissolve and the food chain breaks down. The consequences of business as usual are catastrophic.

But there are oceans of hope.

Phytoplankton are the most abundant plants on Earth - there are 100 million microscopic phytoplankton in a litre seawater. They live almost exclusively in the ocean surface microlayer (SML) to access the sun’s energy. The surface microlayer is the boundary layer where all exchange occurs between the atmosphere and the ocean. Organisms living here face the brunt of pollution from oil spills, heavy metals, plastic and scrubber wash water.



Marine sector impact on ocean pollution and global heating.[9]

[7] European Environment Agency, 2023: https://www.eea.europa.eu/en/analysis/indicators/ocean-acidification
[8] OSPAR Commission, 2023: https://oap.ospar.org/en/ospar-assessments/quality-status-reports/qsr-2023/other-assessments/ocean-acidification/#2-ocean-acidification
[9] Dryden, Howard & Duncan, Diane. (2022). Climate Disruption Caused by a Decline in Marine Biodiversity and Pollution. International Journal of Environment and Climate Change. 12. 3414-3436. 10.9734/IJECC/2022/v12i111392.

Ocean life is extremely resilient.

Marine life doubles in biomass every 3 days, whereas terrestrial life takes 60 years. That means ocean life has an extremely fast recovery time when pollution and CO_2 are removed. To eliminate shipping's climate impact, the industry must follow the IMO Revised GHG Strategy. To stop ocean acidification, we must stop all forms of marine pollution to prevent phytoplankton from dying out.

Carbon is only part of the problem. Ocean health is complex and interconnected and requires responsible stewardship from the shipping industry. We must protect and restore the chain of life from the tiniest bacteria to the largest mammals alive. The phytoplankton which give us our oxygen and capture our carbon rely on whales to fertilise the photic zone of the ocean with their excrement, who in turn rely on every creature beneath them in the food chain.

"Getting to zero GHG emissions is only one part of healing our planet" - Nick Brown, Global Brand and Communications Director, Marine & Offshore at Bureau Veritas.

"Do no Harm"

Absolute zero emission technologies produce zero GHG emissions, are nearly silent and no water or air pollutants. The solutions are here today: batteries, hydrogen fuel cells, wind propulsion all in combination using highly efficient technologies and measures to reduce costs.

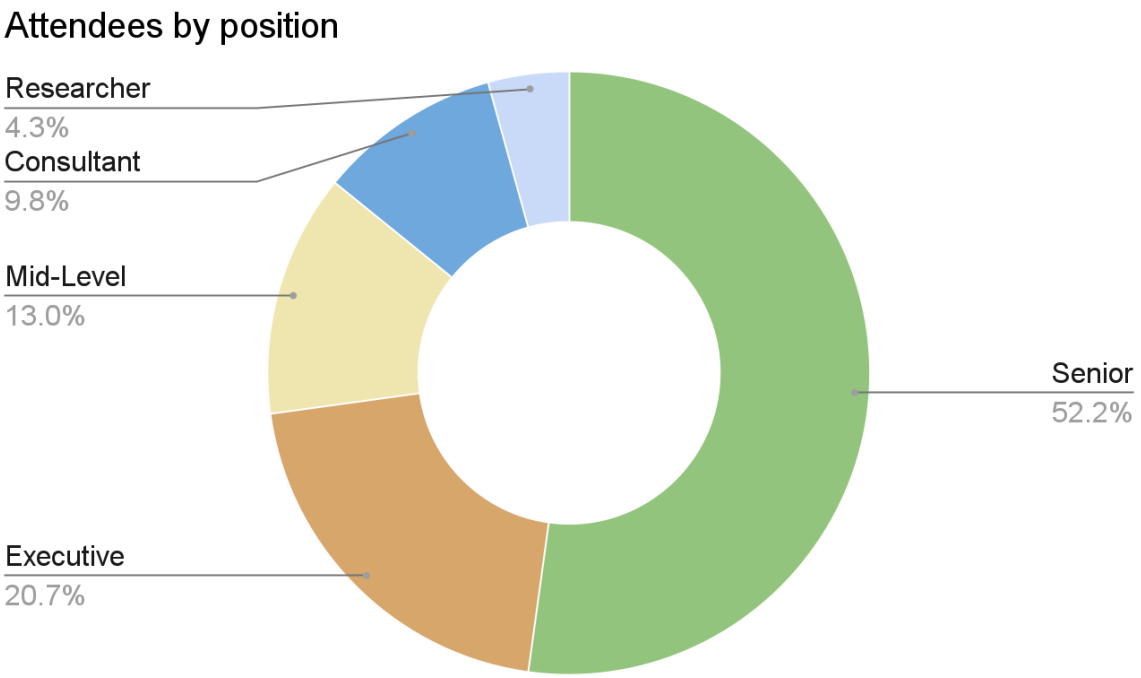
William Fairclough, Managing Director of third generation family owned Wah Kwong Maritime Transport Holdings Ltd., summed up shipping's unique position during the Visionaries' Panel on Day 1:

"Shipping capital is generational and that gives us a special perspective when it comes to the seismic scale of the problem we face. When you think in terms of your children and grandchildren, we have a different mindset instead of the typical 5-7 year business time frame. I think that enables us to say things that others are not comfortable in saying"

As we will see in this report, all of this technology is available today and the renewable energy required is ready to build - but it needs demand from industry to trigger investment. As an industry, shipping must grasp its duty to responsibly steward our oceans to prevent catastrophic climate change and ocean acidification. We can come together to eliminate the challenges. One person's challenge is another's opportunity.

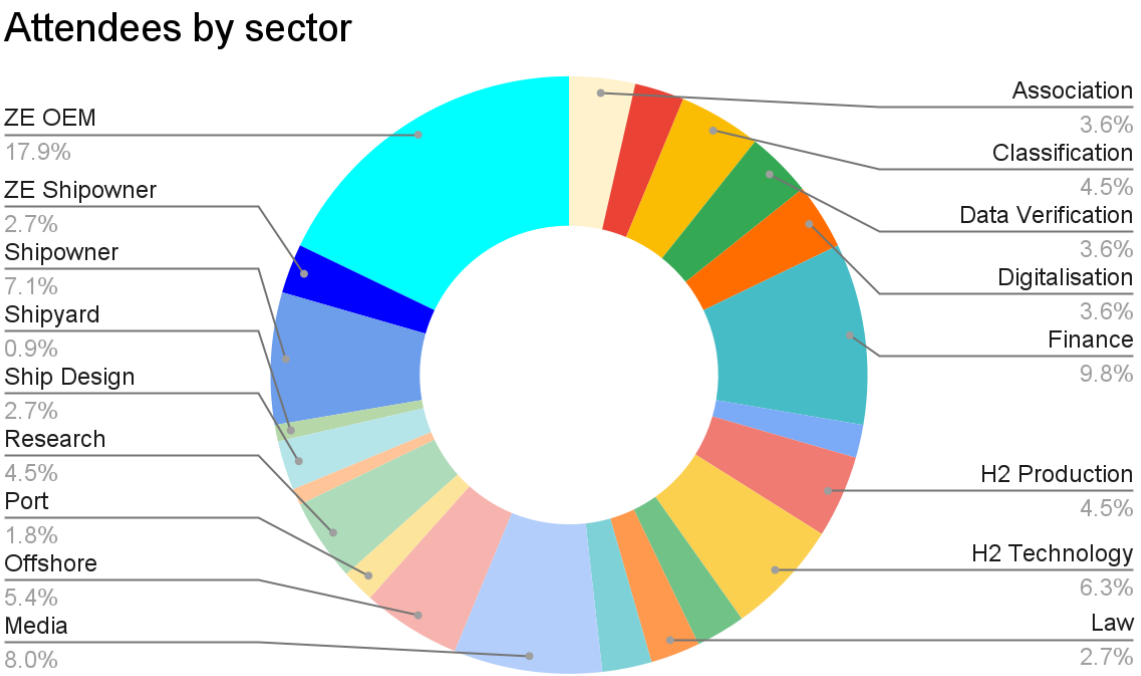
A Picture of the Room

Industry leaders were the clear majority at ShipZERO28, with over half of the attendees coming from senior positions. Compared to ShipZERO26, we saw a 24% rise in the number of Senior representatives attending ShipZERO28, echoing the recent news of our consultative status at the IMO in parallel with the IMO Revised Strategy on GHG Emissions.

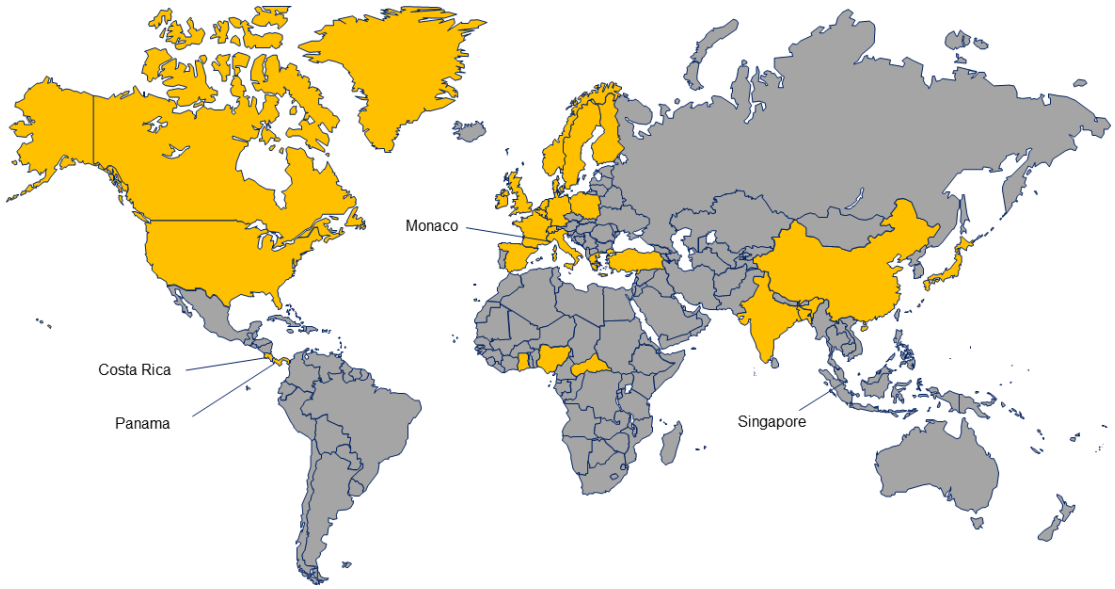


ShipZERO28 attendees by position.

In addition to our expert panellists and visionaries, senior and executive attendees were the clear majority, including key decision makers **IMO representative of the Canadian Delegation, US Head of Delegation and Director of the US Coastguard, Head of the UK Maritime and Port Authority, Deputy Director of UK Department for Transport and the Assistant Director of Maritime and Port Authority of Singapore and the Senior Project Manager at United Nations Global Compact**. Representatives from shipowners **Wah Kwong, Veer, Samskip**, **P&O Ferries**, **Simon Møkster Shipping**, **Thor Dahl Shipping** and zero emission shipowners **Future Proof Shipping** and **Zulu Associates** were in attendance, as well as cargo owners **IKEA Supply AG, UPS, Healthcare Ocean** and industry body the **World Shipping Council.**



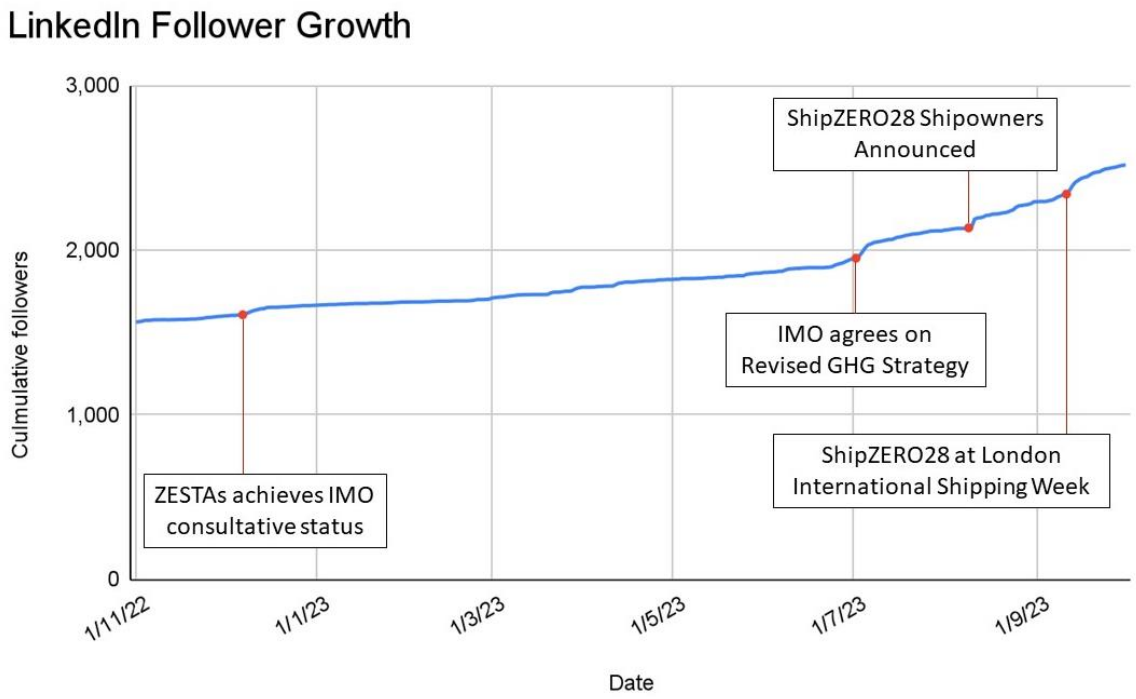
Diversity of ShipZERO28 attendee sector backgrounds.



Global distribution of ShipZERO attendees.

ShipZERO28 had a mix of old and new faces, and we attracted 59% new attendees while 41% of delegates had attended a previous ShipZERO event before.

ZESTAs events are not member-only. Our members made up 17% of attendees in the room, creating a space for networking and knowledge sharing outside of our association.



The ZESTAs social media following has been growing steadily, with increased pace since the announcement of the IMO Revised GHG Strategy.

Shipowner Challenges

Shipowners are beholden to market pull, regulations, and market viability. They face the risk of asset stranding if they lack the capital for long-term investments to future-proof their vessels.

The IMO Revised GHG Strategy has raised shipping's global climate ambition and requirements are expected to mandate zero emission propulsion. Meeting all industry obligations while staying afloat is a challenging voyage for any shipowner during this period of accelerating change and uncertainty.

To actively plan for the coming transformation, shipowners must seek partnerships and collaborate across the industry. One company's challenge is another's opportunity. At ShipZERO28 we assembled the most diverse room of actors possible into one room, creating a healthy and holistic dialogue to brainstorm concrete solutions. As seen in the previous section, 10% of attendees represented shipowners and another 10% from finance.

Attendees representing shipowners included **Samskip**, **P&O Ferries**, **Simon Møkster Shipping**, **Thor Dahl Shipping**, **Future Proof Shipping**. Two very different but equally proactive shipowners, **Wah Kwong** and **Veer.Voyage,** took the stage to kick off ShipZERO28, presenting their challenges and opening the discussion for diverse industry voices to suggest solutions.

Click the links to watch the presentations by Danielle Southcott, CEO and Founder of Veer and William Fairclough, Managing Director Wah Kwong.

Shipowners at a glance	Wah Kwong	Veer
Routes/operating areas	Worldwide	North Atlantic
Average length of voyage	Single legs 7-40 days, average voyage 20-40 days	8-10 days
Average/range of power of engines/APUs in vessels	Engine power (propulsion) 8-16MW performing at 4,000-10,000 kw/hr (up to 14,000 kWh for larger vessels).	Wind as main propulsion allows 10,400 nautical miles (nm) range. In case of no wind, auxiliary hydrogen-electric fuel cells allow 1,200 nm autonomy.
Are long term charters for the same vessel or just any vessel owned?	Any vessel can be on long term charter.	Any vessel can be on long term charter.

Comparison of shipowners Wah Kwong and Veer.

Wah Kwong

Description

Wah Kwong Maritime Transport Holdings Limited is a family-owned private shipping company based in Hong Kong with a global outlook. Established in 1952, Wah Kwong owns and operates a diversified fleet of ships in addition to offering a full range of in-house services in new building supervision, technical and commercial management to our customers and partners in China, Asia and Europe.

Wah Kwong currently runs a diversified fleet of 79 vessels including oil tankers, gas tankers, bulk carriers, containerships and LNG bunkering through its three main business units – Shipowning, Chartering and Ship Management. Wah Kwong enjoys long-term relationships with major world commodity companies and has increasing presence through strategic partnerships with some of China's key shipowners, leasing and state-owned companies.

The 112,000 dwt crude oil tanker Unity Venture, owned by Wah Kwong[10].

Wah Kwong's Challenges

- On board energy requirements:
  - Fuel volumes: currently depending on vessel type/size, operating conditions, cargo is about 25 MT per ship per day of marine fuel/equivalent energy density fuel
  - CII/ EEOI/ AER measures
- Age and design of fleet:
  - Current average age of fleet is about 6 years
  - Vessel working life is about 25 years
  - EEDI/ EEXI measures

[10] Image courtesy of Wah Kwong Maritime Transport Holdings Limited.

- Charter contracts, locking in commitment:
    - Charters: mix of long and short terms charters, predominantly time charters
    - Cargo owner: cargo is generally owned by the shipper or head charterer.
- Business case:
    - Shipowners provide vessels to the charterers who are generally responsible for fuel purchases
    - Shipowners anticipate vessel specifications demanded from the chartering market – ie cargo, cost of operating (inc. bunker fuel)
    - Current cargoes predominantly oil, LPG, LNG, coal, iron ore, grain, minor bulk cargoes
- Existing methods to reduce operational emissions:
    - Based on propulsion and hull, auxiliary systems, operations
    - Require hardware and/or change in operations: Associated capex and scheduling of installations during dry dock
- Alternative fuels
    - Fuel availability - large ships require large volumes.
    - Port facilities for handling alternative fuels.
    - Carbon impact in producing the fuel itself (Well-to-Wake, all GHGs)
    - Commercial viability – all in cost (retrofit capex + all fuel cost vs. base case).
        1. Retrofit or newbuild ships?
        2. When zero carbon fuels are commercially viable as a fuel – the impact on cargo demand will be very different – i.e. no coal, no gas, less oil – i.e. the shipowner's fleet is likely to look very different.
- Human element
    - Crew availability: Shortage of specialist crew to handle new fuels.
    - Crew training: Wah Kwong provides crew training facilities in China which are adapted for changing needs.
    - Health and safety of the fuel itself.

Veer

Description

Veer Group has circulated tender packages for their Design N°1 to shipyards and is now receiving quotes from shipyards. The vessel is primarily wind-propelled using 3 DynaRig sails and an innovative hull shape, with auxiliary power from hydrogen fuel cells.

Veer's future-fit solution is a fleet of fast, clean, cost-competitive ships and bold business model decisions. Veer will deploy the first clean container ship to cross an ocean. Clients are increasingly willing to pay for clean energy and accountability; Veer.Voyage is filling a gap in the market by providing an alternative solution to the container shipping industry.

Veer's zero emission container carrier "Design N°1" has been submitted as a tender package to shipyards[11].

[11] Image courtesy of Veer.Voyage

Veer's Challenges

- Port relations
    - Forming relationships with ports
    - Finding ports who are open to pricing based on tonnage
- Securing long-term contracts with clients: construction finance depends on securing long-term contracts with clients and increases confidence.
- Crew training: ensuring sufficient numbers of skilled crew members.
- Hydrogen bunkering
    - Understanding the business model of hydrogen container providers and their relationship with the ship/end user and with hydrogen fuelling stations.
    - Guaranteeing that international hydrogen gas suppliers accept external containers, fill them and not repeat verification and testing of hydrogen quality.
    - Establishing protocols for hydrogen purity testing with ports: with bunker fuel, sampling and testing occurs prior to bunkering, meaning the ship physically has to wait for the test to be returned. This is not practical with compressed and containerised fuel tanks. To avoid this, ISO container-specific identified testing could be done well in advance of the ship coming to port.
- Funding: Banks and institutional investors capable and experienced in financing shipping and heavy assets are not commonly used to backing startups.
- Carbon credits
    - Monetisation of carbon credits
    - Difficulty with regulations on emissions improvements: as a ''non-fossil-fuel vessel'', Veer's design is unable to show improvements to emissions because they are zero from the start.
- Classification: Difficulties defining a ''primary wind'' vessel.
- Greenwashing: Major competitiveness within the emerging ''clean shipping'' sector and a challenge for shipowners and clients to verify claims and technologies.

What Did we Learn?

After the shipowners presented their unique challenges, industry experts presented their solutions. One theme was clear throughout: **collaboration is key**. None of the projects discussed would have gotten off the ground without collaboration with a wide range of industry partners.

Since the first ZESTAs event at COP26 in 2021, zero emissions shipping has become more tangible. Photos of zero emission vessels and infrastructure are much more common than at ShipZERO26, back in 2021. **We are seeing more and more real, operational vessels and systems at larger and larger scales.** The information submitted by ZESTAs to the IMO in April 2023 (ISWG-GHG 15/INF.2)[12] detailed the extent of vessels and systems currently available and on the water. ShipZERO28 built on this and made clear that the size and power of zero emission propulsion systems is growing.

[12] ZESTAs, 2023; Commercial Readiness of Absolute Zero GHG Technologies (ISWG-GHG 15/INF.2): https://zestas.org/wp-content/uploads/2023/06/ZESTAs-ISWG-GHG-15-INF.2-Commercial-Readiness-of-Absolute-Zero-GHG-Technologies.pdf

Many voices in the shipping industry (and indeed the wider energy industry) identify the main challenge of transitioning away from fossil fuels as the lack of renewable electricity to create green hydrogen.

This is a supply chain problem, so ShipZERO28 took a whole supply chain perspective to understand the strengths and weaknesses of zero emission shipping. A series of technical presentations across Day 1 and Day 2 looked at the supply chain in order:

Energy → Storage → Delivering to ships → Vessel propulsion

Oceans of Energy

To kick off the technical presentations, front-running innovators presented their projects that rethink Absolute Zero emissions energy production, harnessing the vast renewable resources available in the oceans. Naturally, the shipping industry is best equipped to build offshore energy projects and presents project developers with a solid offtake business model.

French designer, owner and operator of green hydrogen electrolysers **Lhyfe** presented their expansion into offshore hydrogen with a 1-MW demonstrator connected to offshore wind, operational since Q2 2023 (watch the presentation here). The HOPE Project off the coast of Belgium will scale up to 10 MW by 2026, currently in Front-End Engineering and Design (FEED) phase. A barge 1 km offshore will produce 4 tonnes of hydrogen per day and send it to shore in a subsea pipeline.

SeaLhyfe 1-MW offshore electrolyser, operational since Q2 2023[13].

[13] Image courtesy of Emiliano Arano, Tatiana Syrikova, Jan Kopřiva, Tiff Ng,Paul Langrock/LAIF-REA, Tomas Anunziata, Ideol BYTP Centrale Nantes, Anna Shvets,liliana Drew, Emma Bauso

ZESTAs members **Drift Energy** showcased their disruptive mobile green hydrogen production solution consisting of agile and robust fleets of autonomous decentralised hydrogen production vessels. Using wind routing technology, these ships search for the best wind conditions in the ocean to produce renewable hydrogen at 80% capacity factor (twice that of North Sea offshore wind turbines), without planning delays or need for grid infrastructure.

Drift Energy's demonstrated mobile green hydrogen production vessel prototype (left) and 2 MW full scale design (right)[14].

Drift Energy demonstrated hydrogen production on a prototype vessel in Q2 2022 and is developing scale up. The full-scale vessel design has an electrolyser capacity of 1-2 MW, corresponding to 150 tonnes/year of hydrogen production, stored on board in standard ISO 40-foot containers and delivered by sea directly to the point of use.

Next, the focus moved to the industrial hydrogen supply chain with **Air Liquide, Chart Industries**, and Chart subsidiary **Howden**. Speakers supported public policy to subsidise green hydrogen cost per kg and stressed the importance of partnerships to scale up demand.

Chart and Howden produce components vital to the hydrogen supply chain including water purification for electrolysis, liquefaction plants, cryogenic tanks, compressed gas tanks and tanks for carriage on land or at sea, explaining that:

- Liquefaction plants at 10-30 tonnes/day output are commercially available 'off the shelf' and can be built in about 12 months, with scale up to 100 tonnes/day feasible
- Cryogenic storage has been in use since the 1960s, with Chart having built 900 out of roughly 1100 of tanks built globally.

Chart Vice President Erik Langeteig explained that while key liquid hydrogen infrastructure is established and mature, the electricity supply required to produce green hydrogen (roughly 60-70 kWh/kg) is the largest cost driver and a major barrier to uptake. Current CAPEX for onshore electrolysis is roughly $1.5-2 million per MW.

Air Liquide is one of Europe's largest green hydrogen producers, with 1 GW of electrolysers under construction and plans for 3 GW by 2030. Anna Lenaerts, Director Marketing & Business Support, Hydrogen Energy World Business line, stressed the importance of industry collaboration in lowering cost per kg. Watch the full presentation here.

Air Liquide partnered with the maritime industry to deliver affordable zero emission fuel to ZESTAs members **Future Proof Shipping** and ZESTAs supporters **Energy Observer** and partnered with energy company **Siemens Energy** to construct an electrolyser stack 'gigafactory' in Germany expected Q4 2023. Along with scale up and the large potential of offshore energy for green hydrogen, large existing or planned electrolysis projects are located on all main shipping routes and major ports.

[14] Images courtesy of DRIFT Energy Ltd

Both speakers supported policies incentivising green hydrogen production, such as the US Inflation Reduction Act tax credit of $3/kg and the credits for green hydrogen currently piloted in Germany and the Netherlands.

Discussion brought up concerns that shipping will compete heavily with other industries for green hydrogen in the coming decades, especially from industrial heating. However, all green hydrogen must come from renewable electricity so, when the power generation increases (as current targets suggest), storage of hydrogen to improve efficiency through peak shaving will create an abundance of cheap hydrogen in smaller quantities near renewable generation sites. Shipping can bypass the slow rollout of grid infrastructure currently holding up renewable electricity generation by accessing offshore power directly at source. Additional purchase agreements can be made with hydrogen suppliers at large electrolyser sites when demand is low.

It will become clear in the following sections (and in ZESTAs submission to IMO (ISWG-GHG 15/INF.2) that small and medium vessels can be absolute zero emissions now using green hydrogen in combination with electric propulsion, wind propulsion and other energy efficiency technologies to ensure that demand for scarce green hydrogen is kept to a minimum.

Shipowner recommendations

- Explore partnerships with renewable energy providers and innovative offshore hydrogen and electricity suppliers to access abundant renewable resources available at sea, bypassing slow rollout of grid infrastructure by accessing offshore power directly at source.
- Sign offtake agreements with hydrogen suppliers, building a flexible business model that fits your operations.

Powering Up

Once we access Oceans of Energy, how do we get it onto ships? Front running expert innovators delivered their experience optimising their flexible solutions alongside ports. A clear trend in modular, mobile, small-scale charging or hydrogen bunkering systems is taking shape, customised to fit port and fleet requirements and backed by bespoke and novel business models. The key, as usual, is collaboration.

Three very different but equally disruptive zero emission technology providers presented their solutions to the audience. They discussed lessons learnt from working with ports, moderated by Jennie Folkunger, Sustainability Manager at **Port of Trelleborg**, Sweden.

Unitrove unveiled the world's first liquid hydrogen bunkering system at COP26 in 2021 and has developed this into a zero emission multi-fuel system (ZEMFS) capable of dispensing liquid or gaseous hydrogen and electricity produced by a fuel cell. The entire system is condensed enough to be forklifted onto the back of a truck and carried to areas that cannot be reached by standard infrastructure. It does not require grid connection and can be transported to wherever the vessel is moored. Watch the presentation here by Steven Lua, CEO of Unitrove.

Unitrove's zero emission multi-fuel system (ZEMFS) condenses bunkering infrastructure onto the back of a truck to enable flexible and low-risk refuelling[15].

Unitrove is part of the Innovate UK funded ZEMFS consortium including ZESTAs members **ACUA Ocean**, **ZEM Tech** and knowledge partner the **University of Strathclyde**. The partners received funding from Innovate UK to deploy a liquid hydrogen bunkering system at **Port of Aberdeen**, UK in 2025.

As we saw earlier, there are oceans of energy available at sea and **MJR Power and Automation** has developed offshore charging stations to deliver this energy to vessels. The system allows offshore vessels to charge directly at wind turbines or maintenance platforms without needing to moor. Tested in harbour in Q2 2023, MJR aims to validate in Q1 2024 and deploy a commercial 1.5 MW charger for CTVs in Q4 before scaling up to a 4-8 MW high voltage version for Service Operation Vessels (SOVs) in 2025. Watch the presentation here by Ryan Reilly, Sales & Business Development Manager at MJR.

MJR Power and Automation offshore charging point during harbour trials (left) and conceptualised at an offshore wind turbine (right). MJR expects to validate offshore charging in Q1 2024[16].

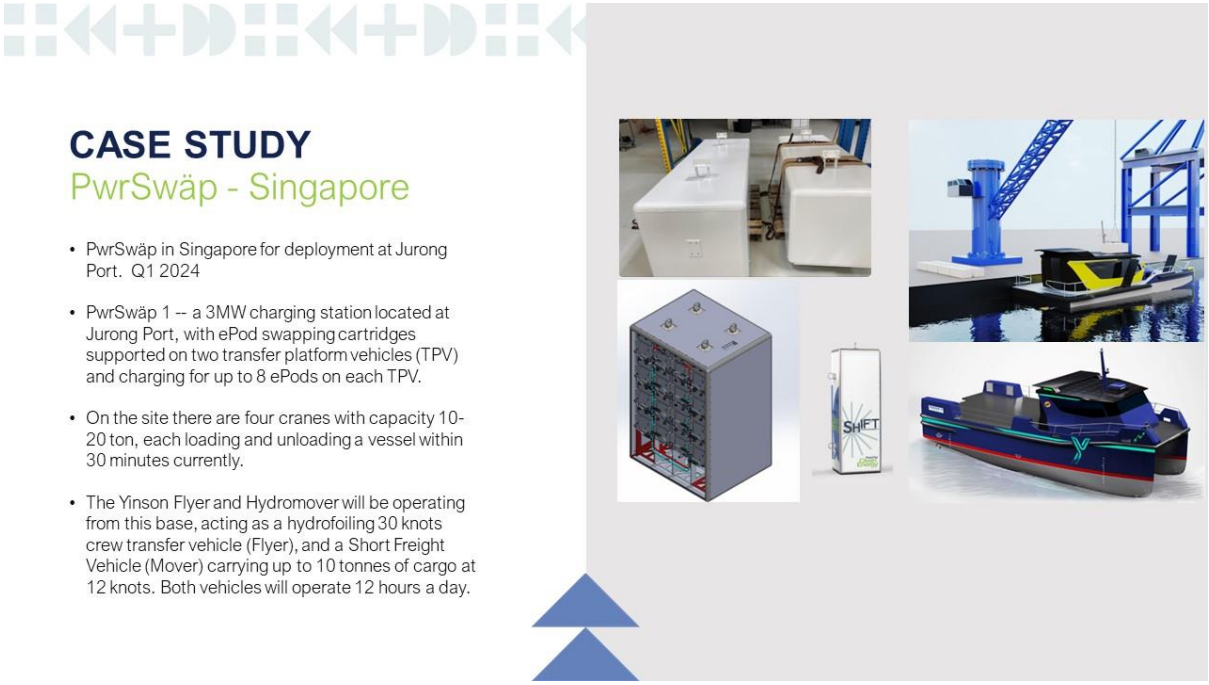
Shift Clean Energy is an established marine battery manufacturer with an outstanding safety record. They have developed swappable battery pods to bypass the slow deployment of shore charging infrastructure due to grid constraints and high costs. This has multiple benefits:

- Swapping depleted battery pods with fresh ones greatly reduces energy delivery time compared to charging depleted batteries on the vessel
- Centralised charging of battery pods optimises electricity (OPEX) costs, ensures longest asset lifetime and high rate of return through constant usage
- Modular and stackable design of pods means they are multi-use, used on ships and in port for vehicles, cranes and energy storage

Shift president, Paul Hughes, presented their collaboration in a Joint Venture with the **Port of Jurong in Singapore**. Shift has created an innovative business and legal model to de-risk and rapidly roll out their swappable battery recharging system. They offer the battery energy as a service to the port,

[15] Images courtesy of Unitrove Limited
[16] Images courtesy of MJR Power and Automation

eliminating CAPEX and ownership risk. Ownership and funding of the "PwrSwäp" battery assets is shared, playing to each's strengths: Port of Jurong knows best how to use the electricity and load batteries on and off vessels while Shift knows best how to safely maintain and charge the batteries.



Shift Clean Energy and Port of Jurong, Singapore, have created a Joint Venture to deploy swappable batteries for port electrification[17].

Each speaker agreed that the solution to risks in creating new infrastructure is to work collaboratively with ports, offering small and modular infrastructure demonstrators which can then scale up as demand grows. They agreed that ports are in an excellent position to bring together stakeholders to reduce risk, harmonise standards and gather data crucial to technology providers' business cases.

"Infrastructure has huge costs and risks but we can make it small, agile and manageable to quicken the build-and-learn cycles."

- Steven Lua, CEO of Unitrove.

Since every port is different, flexibility is a key requirement. Small building blocks reduce risk, lower CAPEX and make decision-making easier for ports. Both Unitrove and Shift have designed their systems using 20-foot container-sized building blocks, allowing ports to test small-scale and increase port and shipowner customer confidence before scaling up.

Swappable zero emissions energy refuelling - either electricity or hydrogen - can **solve shipowner range anxiety and asset risk challenges**. Ports and technology providers can collaborate to create custom solutions.

Danielle Southcott, CEO of Veer, underlined that regulatory details must still be clarified, specifically for the carriage of containerised hydrogen fuel tanks between ports. Purity testing of hydrogen in sealed

[17] Slide presented by Paul Hughes at ShipZERO28

compressed tanks must be carried out prior to swapping to ensure viable bunkering times. She suggested the development of an ISO container-specific advance testing protocol to assure containers were ready to load upon a vessel's arrival in port. Dialogue with ports is key to creating workable solutions.

Shipowner recommendations

- Form Joint Ventures with ports to access a strong network and share data.
- Form Joint Ventures with zero emission technology suppliers to define bespoke and flexible business models to fit your operations e.g. leasing modular batteries or fuel cells.
- Share energy consumption and voyage data with ports and technology suppliers to increase performance.
- Combat range anxiety and asset risk by collaborating with ports and technology providers to create custom solutions such as swappable zero emissions energy refuelling - either electricity or hydrogen.

Zero Emission Ships Have Set Sail

Finally, leading technical experts presented their learnings and results from delivering groundbreaking zero emission vessel projects. We learnt that the vessels on the water today have set the groundwork for all components required for a zero emission fleet: design, integration, safety, training and operations. **Scaling up onboard power for larger ships is straightforward.**

Zero emission vessels are electric

As explained in ZESTAs submission to the IMO (ISWG-GHG 15/INF.2), electrification is the foundation of absolute zero emission technologies because it enables maximum efficiency, optimisation of wind propulsion and is required for hydrogen-electric fuel cells. Renewably produced electricity and hydrogen produced from renewable electricity being the only absolute zero emissions fuels. All internal combustion engines (ICE) produce emissions. Expert speakers from two leading marine electrification suppliers - **ABB** and **SEAM** - shared their lessons learned from tangible zero emission vessels at ShipZERO28.

Fully electric systems are zero emission, but only feasible on certain vessels - either with short voyage times or small power demands. A 40-foot container can hold enough batteries for only 2 MWh of energy, corresponding to just 2 hours of operations. Zero emission fuel is therefore required for larger ships or longer voyages. The same container can hold enough gaseous hydrogen to provide 33 MWh, or 8 hours operations, or enough liquid hydrogen for 80-120 MWh, or 1-3 days depending on sea state. For reference, an equivalent volume of diesel is enough for 700 MWh, or 6.5 days.

Modularity tackles uncertainty and enables retrofit

Vice President of Marine Market Development at ABB, Jorulf Nergård, explained that a fixed electrical distribution system is the common point for any energy converter and modular propulsion and energy storage systems can be built around it. This way, shipowners have the option to upgrade or retrofit the propulsion system at a later date or transfer the propulsion system to a new vessel when the original vessel reaches the end of its life.

Containerised batteries, fuel cells, ICE or generators can easily be swapped out at a later date, for example replacing ICE with hydrogen fuel cells depending on fuel supply. Alongside swappable electric or hydrogen fuel recharging explored in the previous section, **fully modular zero emission propulsion**

and energy storage systems are available today, ideal for tackling fuel uncertainty, retrofit on older vessels and enabling innovative leasing or pay-as-you-save business models to eliminate high CAPEX.

Jorulf Nergård and Shift president Paul Hughes stressed that partnering with banks is crucial to create innovative financing agreements for modular propulsion systems because they are used to financing ships and fixed propulsion systems together.

A modular hydrogen-electric propulsion system by **ABB** (batteries, 800 kW fuel cells and hydrogen ICE) with wind propulsion and efficient hull design will be demonstrated on the 5500 GT coastal bulk carrier *With Orca*, which has Approval in Principle (AiP) from **Lloyd's Register** and is expected to be operational by 2024. Also under construction is the 820 TEU *SeaShuttle* container carrier powered by 3.2 MW hydrogen fuel cells and a superyacht with 3 MW **PowerCell** fuel cells.

Pioneering the retrofit of containerised solutions are zero emissions shipowner **Future Proof Shipping (FPS)** and fuel cell supplier **Nedstack**. In May 2023, FPS launched the world's first inland hydrogen cargo carrier, *H2 Barge 1*, after replacing an old diesel ICE with 825 kW Nedstack containerised fuel cells, 550 kWh batteries and 1 tonne of gaseous hydrogen storage provided by **Air Liquide**. Nedstack has also retrofitted 120 kW fuel cells for auxiliary power on the cruise ship *Viking Neptune* and 600 kW on the **Port of Rotterdam** dredger *Medusa 2*.

Two operational vessels equipped with hydrogen fuel cells: H2 Barge 1 *(left) and* Medusa 2 *(right)*[18].

The speed of class approval is increasing greatly with more lessons learnt by project deliverers. Approval by Lloyds Register for the first FPS ship took 2 years, but the second (*H2 Barge 2*) took just 6 months. Nedstack's entire *Medusa 2* dredger retrofit project took only 3 months. Now that partners know the barriers, rollout time from concept to launch is decreasing.

Click here to watch the presentations by Oscar Felix, Sales Manager at Future Proof Shipping and Jogchum Bruinsma, ZESTAs Chair and COO of Nedstack.

Scaling up with hydrogen

The 2700 GT RoPax ship *MF Hydra* is the world's first liquid hydrogen powered vessel, operated by **Norled** since May 2023 carrying up to 300 passengers and 80 cars in Norway. The vessel refuels 3 tonnes of liquid hydrogen in 1 hour, enough for 3 weeks operation - **the same operational viability as conventional fuel**.

[18] Images courtesy of Future Proof Shipping (left) and Boskalis Nederland (right)

Two more Norwegian ferries operated by **Torghatten Nord** are currently under construction, with the largest fuel cell systems to date built by **PowerCell** and with electrical system integration and off-the-shelf batteries by **SEAM**. The long-distance ships will be powered by **6.5 MW fuel cells each** and feature compressed gaseous hydrogen storage, which demands more frequent bunkering and more space than liquid hydrogen but is currently less expensive and more readily available. Watch the presentation by John Roger Nesje, Sales Director Europe for SEAM here.

On top of this, **PowerCell** is currently fitting a mystery superyacht with 3 MW fuel cells and 4.4 tonnes liquid hydrogen stored beneath the deck - enough for 3 weeks hotel load. **Nedstack** is scaling up to meet shipping's demand with a new Gigawatt-sized fuel cell factory in the Netherlands due to open in 2027, increasing production capacity by 100 times in 4 years.

Ivan Østvik, former Project Manager at Norled and CEO and Founder of **LH2 Shipping AS** oversaw the entire design (approved by **DNV**), build and delivery of the *MF Hydra*. At ShipZERO28, he explained that, by using the same technology proven on that vessel, **liquid hydrogen can power short sea shipping vessels for 3 weeks operation with existing technology** and presented detailed designs for each shipowner. Watch the full presentation here.

Veer's expected hydrogen fuel consumption of 3.9 kg/nm at 10 knots and 4.9 kg/nm at 11 knots could be supplied by:

- 5 tonne liquid hydrogen tank in stern, 10m length, 4m diameter, 165 MWh energy content (10 tonne tank available at marginally higher CAPEX)
- Range (without sails) of 1020-1280 nm
- Fuel cells under deck with up to 2 MW capacity
- Batteries with up to 4 MWh capacity
- Bunkering time 2 hours, with 25m safety radius in port

Ships in **Wah Kwong**'s slower size segment (8MW engine, 4MW/hour energy consumption and 20-day voyages) can be installed with the following hydrogen propulsion system:

- Six 20-tonne liquid hydrogen tanks on top deck, 12m long, 8m diameter, each storing 660 MWh energy content each (3960 MWh total)
- Fuel cells located with 8-10 MW capacity, located at each tank (1.5 MW each)
- Bunkering time 7-8 hours, with 25m safety radius in port
- Retrofit possible depending on deck strength and Explosion Hazardous Areas (Ex Zones)

After the presentations, the speakers joined a panel moderated by Julien Boulland, Global Market Leader for Sustainable Shipping at Bureau Veritas Marine & Offshore, before taking audience questions. Watch the discussions here.

The main challenge is currently liquid hydrogen supply in ports, as explored in the "Oceans of Energy" section. Shipowners must secure an offtake agreement with a hydrogen producer, which is difficult but possible, as proven by FPS and Norled. Hydrogen supply is improving and Ivan Østvik estimates that liquid hydrogen should be available in the US and Europe by 2027, enabling contracts for fuel supply to be made today.

The large size of hydrogen propulsion systems in development such as the two 6.5-MW Torghatten Nord vessels will pave the way for even larger capacities. **Speakers stressed the need for shipowners not to repeat design and implementation work that has already been done. The operational support, certification and crew training is available today based on existing vessels.**

"You have to wade through the quagmire of soft sustainability reports and find the real doers" - Oscar Felix, Sales Manager at Future Proof Shipping

For shipowner FPS, like Veer, a long-term partnership with a cargo owner was crucial in realising a zero emission vessel. FPS discussed with many cargo owners who were aligned with their vision on paper but could not commit to an agreement in practice. Finally, **Nike signed a Joint Venture with FPS** for container carriage between Rotterdam and Meerhout, Belgium. More than being just a shipowner, FPS created a 'Zero Emission Advisory', supporting their collaborative partners with technical aspects, regulations, and project management.

A key breakthrough for FPS in securing a long-term cargo agreement was achieved by analysing the additional cost per unit of switching to a zero emissions vessel. In the case of Nike it was about 0.04€ per item. LH2 Shipping AS has calculated the added cost of short-sea hydrogen powered vessels is around 2.2€ per tonne cargo. The additional cost of hydrogen propulsion is negligible to the cargo owner.

Bridging the gap

The additional cost of zero emission fuels means that any fuel consumption reduction improves the shipowner's business case. On older vessels, retrofitting such technologies improves financial viability and reduces GHG emissions. Wind propulsion, voyage optimisation and hull air lubrication are commercially available today for newbuilds and retrofits.

Wind propulsion is a fast-growing market with strong investment to reduce emissions and improve energy efficiency. Vessels with wind propulsion installed increased from 25 in 2022 to 49 in 2023[19], excluding traditional rigs which provide zero emission propulsion on thousands of vessels in developing countries, especially Small-Island Developing States (SIDS).

A large variety of modern wind propulsion systems are commercially available and installed on vessels today, with independently verified fuel and emissions reductions of up to 20%. Installations cover a wide range of ship types, with the different types of wind propulsion fitting different ship configurations and operational requirements. The diversity of technologies available mean that almost all ship types are suitable.

Type	Installations (rigs) 2023	Installations (vessels) 2023	Ship types
Rotor sails	44	16	Bulk, RoPax, RoRo, tanker, general cargo
Suction wings	31	16	Bulk, RoPax, RoRo, tanker, general cargo, fishing
Wing sails	17	8	Bulk, RoPax, RoRo, tanker, general cargo, yacht
Kite sails	6	6	Car carrier, general cargo

Installations of wind propulsion devices by type and vessels[20].

[19] International Windship Association (IWSA), 2023: https://www.wind-ship.org/en/news-media-4/
[20] Adapted from slide presented by Jullien Boulland at ShipZERO28

Bureau Veritas have led the classification and approval of wind propulsion technology for decades. Watch the presentation here by Julien Boulland, Global Market Leader for Sustainable Shipping at Bureau Veritas Marine & Offshore. The first ever rule note dedicated to wind propulsion plants onboard ships (NR206) was published by Bureau Veritas in 1987 and was overhauled in 2021 to reflect the fast-paced modernisation of the technology and its capability to reduce GHG emissions. The note includes risk analysis, manuals, product certificates and technical data. Two notations (WPS1 and WPS2) cover systems with fixed and moving parts and Bureau Veritas is planning a third (WPS3) to cover wind propulsion integration in the vessel's energy management system.

Container ships are one of the more difficult ship types to install wind propulsion on but Bureau Veritas have worked to change this, awarding AiP to the **Zéphyr & Borée** 1800 TEU design with 4 wing sails[21]. Zéphyr & Borée are believed to have placed an order for 5 of these vessels, to enter operation in 2026[22].

Dealfeng New Energy Technology Ltd. CEO and Founder Li Zhi presented their rotor sail solution, available for retrofit or newbuild at a range of sizes and 3 platform types for different operations (fixed, sliding, foldable). Dealfeng is to install the first rotor sail on a Chinese vessel, the newbuild coastal product oil tanker *MV Zhong Ran 36*, followed by a retrofit of two 4x18m rotor sails on **China National Offshore Oil Corporation** vessel *HYSY 226*. **China Classification Society (CCS)** has a wind propulsion guidance classification and rotors meet 5% SOLAS visibility requirements.

Bound4Blue supplies suction sails, which use a turbine inside a wing-shaped sail to generate 6-7 times more lift than a standard wing. COO and Co-founder Cristina Aleixendri presented their experience from 3 installations (1 fishing vessel and 2 general cargo). Similarly to Dealfeng, the sails can be retrofitted or installed on newbuilds, are foldable and come in different sizes. Retrofits have been installed on vessels at the quay in 4 hours.

Bound4Blue retrofit installations from left to right: fishing, general cargo, and 21,500 GT Ville de Bordeaux[23].

Payback time is more important than percentage savings for assessing energy efficiency and calculating business cases. Bound4Blue modelled 4 cases and found 3.5-4.5 years payback and 14-26% fuel savings (2856 tonnes fuel and 9052 tonnes of CO2 emissions annually for high case). Dealfeng the calculates a 3-4 year payback for shipowners, based on a model by Lloyd's Register for a 82,000 dwt bulk carrier travelling from Shanghai to Rotterdam with four 24m x 4m rotor sails achieving 8.8% average net fuel savings (739 tonnes fuel and 2330 tonnes of CO2 emissions annually).

Modelling using weather data is important for wind propulsion for two reasons: firstly to model, measure and verify fuel savings and emissions; and secondly, for realtime voyage optimisation to get

[21] Environment+Energy Leader, 2023: https://www.environmentenergyleader.com/2021/12/zephyr-boree-receives-approval-for-wind-propelled-shipping-vessel/
[22] The Maritime Executive, LLC., 2023: https://maritime-executive.com/article/five-methanol-fueled-containerships-with-wingsails-ordered-in-korea
[23] Images courtest of Bound4Blue S.L.

the highest performance out of wind propulsion systems. **NAPA** is a software, services and data analysis provider for ship design and operation. Jori Poikola, Sales Director Shipping Solutions at NAPA presented their experience in voyage optimisation. Alongside **Norsepower** and **Sumitomo**, they analysed 48 voyages between Amsterdam and New York and found that voyage optimisation increases fuel savings by 12% average annually on top of wind propulsion savings, leading to 28% total savings.

Hull air lubrication is another tool available to shipowners to significantly reduce GHG emissions and fuel consumption. **Howden**, as well as providing equipment vital to hydrogen production and storage explained in the "Oceans of Energy" section, install hull air lubrication to decrease drag. The retrofittable technology pumps small bubbles along the bottom of the hull. The 'bubble' lubrication method is preferred by Howden because it has negligible drag when not used, has lower installation costs than other methods and can be installed on a range of hull shapes. Of the 20 vessel installations to date, Howden has proven performance of 8-10% fuel savings, mostly installed on cruise ships but now scaling up commercialisation across many ship types. Watch the presentation here by Alasdair Carlaw, Commercial Leader - Energy (EMEA) & Marine (Global) at Howden.

Propelwind, like Veer, is a far front runner, seeking to redefine ship propulsion based primarily on wind power. By rethinking the vessel putting wind propulsion first, they have designed a series of cargo vessels with very low fuel requirements. On four routes analysed, the fuel required on board is up to 12.9 tonnes for 5,660 Nm distance at 12 kn with a displacement of 6,000 tonnes, corresponding to less than one 20-foot ISO container of hydrogen.

Propelwind is responding to a market pull for zero emission cargo. Three sizes of vessels (250, 600 and 2000 TEU) have been designed with modularity in mind, the design able to accommodate a range of cargo types such as containers, vehicles, project cargo and light bulk as well as featuring and self-loading and unloading to increase agility.

Multinational shipping company, **UPS**, supports Propelwind's future proof and zero emissions solution due to sustainability and logistical benefits. They identified global trade lanes suitable from a commercial perspective for primary wind propulsion (transatlantic, transpacific and Europe to South America) which provide a consistent year-long transit time. The multi-use design of the vessel gives flexibility for cargo unloading, enabling agility and additional competitiveness. Watch the joint presentation by Patrick Englebert, General Manager of Propelwind and Richard Hill, Product Development Manager – Ocean at UPS.

Shipowner recommendations

- Convert existing vessels to electric propulsion to attract investment, reduce GHG emissions and increase efficiency. Electrification is low risk because all zero emission vessels are electric.
- Fully modular systems are available today, ideal for tackling fuel uncertainty, retrofit on older vessels and enabling innovative leasing or pay-as-you-save business models to eliminate high CAPEX.
- Partner with banks to create innovative financing agreements for total modularity of the propulsion system and to lease fuel saving technologies.
- Utilise proven work successfully executed on existing hydrogen-electric propulsion systems. Design, implementation, operational support, certification and crew training is available today based on existing vessels.
- Retrofit wind propulsion with voyage optimisation and hull air lubrication on older vessels to improve EEDI and CII scores, and on new builds to reduce fuel consumption over the vessel's lifetime and enable zero emissions solutions.

- Use verified data to sign long-term Joint Ventures with cargo owners and ports who are serious about zero emissions. Analyse their business case to determine the additional cost per unit of cargo of zero emissions fuel.

Finance ¥$€£

The Finance Expert Roundtable and Q&A was moderated by Effie Datson, Asset & Wealth Management Executive and NED Board Member. Click here to watch the full Roundtable.

Finance Experts:

- Paul Taylor, Global Head of Maritime Industries, Societe Generale Corporate & Investment Bank and Vice Chair of the Poseidon Principles
- Louisa Cilenti, Managing Principal and Co-founder, pH3 Capitol
- Marc Ostwald, Chief Economist & Global Strategist at ADM Investor Services International

Finance presentations were delivered by Michael Adams, Founder & CEO of Ocean Assets Group (watch here) and Frederic Bouthillier, Carbon Emissions Trader, Head of Shipping at Vertis Environmental Finance (watch here).

Global threats require global collaboration

The world economy is in a grim and urgent situation, threatened by spiralling debt and a climate emergency. Finance and policy must move from linear ideology to strategic thinking. Fortunately, the resources are there to solve both challenges simultaneously if this is achieved and ideas, capital and assets are pooled together.

While the resources exist, there is a large funding gap in the transition. Recent years have seen capital flow away from the West to the Middle East and Asia, where developed countries with large sovereign wealth, pension and insurance funds are pouring hundreds of billions of dollars into renewable energy projects. In Western-centric circles there is too much distrust of other regions which is hindering the ability to access the transition capital required. **Collaboration between West and East is critical to unlocking transition capital**.

A suggestion by Marc Ostwald, Chief Economist & Global Strategist at **ADM Investor Services International**, would be to use government legislation to unlock some of the $20 trillion plus of quantitative easing (QE) and repurpose this as seed funding for 'national energy transition and infrastructure banks', using an updated KfW-type model (originally created by German state-owned investment and development bank KfW) to provide core capital to fund and develop infrastructure and related innovative technologies, and by extension incentivize private capital participation. Development banks and central banks can provide support and leverage for the private sector to deploy capital quicker. This requires government legislation in consultation with shipping, energy and other industries, and is especially necessary to upgrade power distribution grids.

There is not really anything specific that the shipping industry can do to push for this, it needs to be a broad coalition of business groups which above all includes manufacturing, energy producers and

distributors, and the whole of the transport sector, to apply maximum pressure on governments, in what might call a classic case of being to become rule makers, not rule takers.

Emissions Trading Schemes

The inclusion of maritime shipping in the EU Emissions Trading Scheme (ETS) creates a radical overhaul of shipping finance. The objective is to reduce GHG emissions 62% by 2030, compared to 2005. From 2024, cargo and passenger ships above 5000 GT must use European Emission Allowances (EUA) for CO2 emissions and cannot generate more greenhouse gas emissions than their allowances can cover. Carbon credits or certificates cannot be used for EU ETS compliance. From 2026, methane (CH4) and nitrous oxide (N2O) will be included and the scheme expanded to include offshore vessels above 5000 GT in 2027. Emissions for voyages between EU ports and 50% of emissions between EU and other ports are covered.

	SYSTEM	CURRENT	2024	2025	2026	2027	2028	2029	2030
VESSELS TYPES	MRV	cargo/passengers			cargo/passengers + offshore vessels				
	ETS	-		cargo/passengers		cargo/passengers + offshore vessels*			
VESSELS SIZES	MRV	+5000 GT			+5000 GT + 400 GT				
	ETS	-		+5000 GT		+ 5000 GT + 400 GT*			
GHGS	MRV	CO2			Co2 + CH4 + N20				
	ETS	-		CO2		Co2 + CH4 + N20			
EMISSION COVERAGE	MRV	100 % within and in/out of the EU/EEA							
	ETS	-		100% within the EU/EEA 50% in/out of the EU/EEA.				100% within and in/out the EU/EEA**	
PHASE- IN	MRV	100%							
	ETS	-	40%	70%		100%			

* to be decided by Q4 2026 with another trialogue discussion.

** depends on IMO decarbonisation actions and an EU review before 2028.

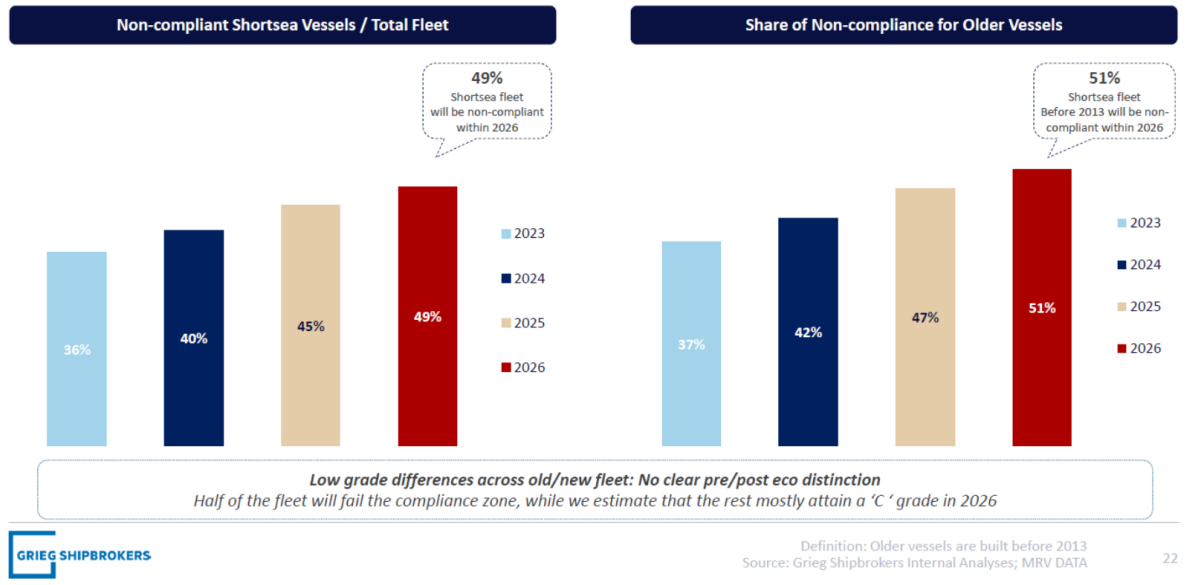
ENVIRONMENTAL FINANCE

VERTIS

EU ETS summary and timeline[24].

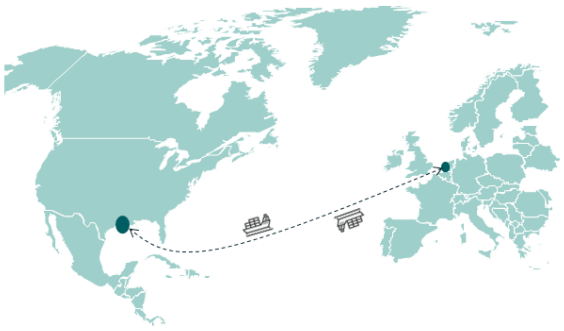
Analysis by **Grieg Shipbrokers** presented by Ivan Østvik of **LH2 Shipping AS** at ShipZERO28 shows that **by 2026, 49% of shortsea shipping will be non-compliant with EU regulations** (51% for vessels built before 2013). The ETS will add cost on top of fossil fuel, meaning the price difference between conventional fuel and zero emissions fuel will decrease and they become more competitive. The urgency of the situation means that updates and retrofits are crucial for shipowners to be compliant, such as wind propulsion, hull air lubrication and energy efficiency measures.

[24] Slide presented by Frederic Bouthillier at ShipZERO28



Non-compliance risk for EU short sea fleet 2023-2026[25].

ETS systems for shipping are launched in the EU and UK and are expected in China and Korea. The European Emission Allowance price is trending up, from 30€/EUA in Q1 2021 to 80€/EUA in Q2 2023. It is expected to rise to 120-130€/EUA in the coming years, dramatically increasing the financial impact of the ETS on shipowners. A case study of the financial impact of the ETS on international shipping is shown in the case study below by **Vertis Environmental Finance**, with 131,699€ of financial exposure for a Panamax dry bulk round voyage from the EU to the USA.



	VESSEL DESCRIPTION
DWT	82,500 MT
AGE	12 yrs
LOAD	229m, beam 32.25m, TPC 70.5
CARGO	97,000 cbm grain
SPEED	Laden: 13.5 kts Ballast: 14 kts
FUEL	Laden: 33mt fuel oil (380cs t) Ballast: 31mt fuel oil (380cs t)
SCRUBBER FITTED	NO

	ROUTE DESCRIPTION
FROM / TO	EU / US GULF (round trip)
DURATION	40 DAYS
TOTAL CO2 EMISSIONS	3 181 tonnes (round trip)
CO2 EMISSIONS IN EU ETS	1 590 tonnes (50%* - extra EU)
FINANCIAL EXPOSURE	131,699 €

ENVIRONMENTAL FINANCE

* Disregarding phase-in period
** At current market price : EUA = 82.83 €

VERTIS

Financial impact of the EU ETS: Case study of Panamax dry bulk round voyage.[26]

Carbon Emissions Trader, Head of Shipping at Vertis, Frederic Bouthillier proposed the idea of creating a consortium bringing together commercial technology suppliers, financing, verifying and commercialising in-sector shipping onsets for use in the environmental commodity market. **Retrofit funds such as those created by Eurazeo and Société Générale are leasing retrofit technologies to reduce shipowner's upfront investment** and can enable shipowners to quickly upgrade and transition their fleets.

[25] Grieg Shipbrokers Internal Analyses MRV Data. Slide presented by Frederic Bouthillier at ShipZERO28
[26] Slide presented by Frederic Bouthillier at ShipZERO28

Shipping has successfully avoided the global protest faced by the incorporation of aviation into the ETS by applying to only 50% of routes from EU ports to non-EU ports. The ETS will only apply to vessels choosing to serve EU ports.

There is some uncertainty as to the destination of ETS funds, with inconsistency between member state legislation. A potential solution is for a Development Fund to provide funding to get risky technologies off the ground with large expected write-off value.

The Brainstorming Session and Visionary Panel identified the risk of abuse of institutional market-based measures such as the EU ETS, creating the opportunity for climate fraud - or 'greenwashing'. Solutions to this challenge are explored in the section "Eliminating greenwashing with data and transparency".

Leave no-one behind

An estimated $1.9 trillion is required to decarbonise shipping fully, of which 87% should go to land-based infrastructure, according to **UMAS Advisory Services**. Roughly 40-60% of emissions reductions will come from energy efficiency and the remainder from zero emission technologies. $40 billion per year until 2030 is required for zero emission fuels and bunkering. If these targets are overshot, 90% of targets must be met by 2040.

Institutional funding is crucial to the climate transition, especially in the Global South. Michael Adams, Founder & CEO of **Ocean Assets Group**, presented the results of a report completed for **UNEP** focussed on the Blue Economy (maritime, ports, marine energy, coastal economies such as fishing, tourism, aquaculture). In developing countries, ports are economic lifelines (especially SIDS) with Small and Medium Enterprises (SMEs) making up 90% of economic activity and over 70% of jobs.

The report, Turning the Tide: How to Finance a Sustainable Ocean Recovery[27], advised on how to spend the remaining $2 billion of the **Asian Development Bank** Blue Economy loan (of which $3 billion has been spent) in the ASEAN (Association of Southeast Asian Nations) region. So far, there has been a failure to finance SMEs.

The key conclusions were as follows:

- Avoid: Investments in fossil fuel systems
- Challenge: Transition plans not aligned with IMO 2023 Revised GHG Strategy
- Seek out: Zero Emission systems for shipping and ports

Just like in technical projects, collaboration is key. Co-financing is crucial to reducing risk; bring together shipowners, charterers, technology providers and both public and private finance in a mix of catalytic and impact finance.

Catalytic finance is willing to take lower returns or provide capital guarantees to de-risk projects, opening the door for impact investment. This can come from funds by regional and development banks and corporations or loans from institutional banks and foundations. This is called **blended finance: using catalytic funding to de-risk and attract private impact finance**. In the ASEAN region, only 10% of capital required for transition must come from public catalytic funders and 90% from capital markets.

Measuring success of catalytic financing requires looking beyond just financial results. In shipping, initiatives such as the **Poseidon Principles** and the **Sea Cargo Charter** supported by the **Global**

[27] United Nations Environment Programme (UNEP) - Finance Initiative, 2023: https://www.unepfi.org/publications/turning-the-tide/

Maritime Forum (GMF) use an Environmental & Social Governance (ESG) rating for all clients, taking into account their long-term corporate strategy and assets. Paul Taylor, Global Head of Maritime Industries at **Société Générale** and Vice Chair of the Poseidon Principles believes this will cause a change in lending behaviour and innovative banks will outlast those with a "herd mentality".

Traditionally, catalytic funding is institutional, but the shipping investor space has changed dramatically in the last 5-10 years; there is a much larger mix of investors, different types of funds and capital, non-bank lenders. Available capital is slow but promising. Institutional funds such as the **IMO Finsmart** roundtable engages with development banks and the **World Bank** to push for solutions and collaboration.

Certificates to issue ESG bonds are hugely time consuming and of a very high standard. Anything linked to hydrocarbons will not get a green or blue bond. Credit quality 'wrappers' can be used to link investments with an insurance policy to protect investors from market volatility or unforeseen events. Investors want to see consistent and sensible timelines with milestones, progress and validation to lock in stable investment.

Zero emission corridors can anchor catalytic finance in the Global South. The Silk Corridor between Singapore and China initiated by **Lloyd's Register** has identified 340 vessels which are optimal for energy efficiency technology or zero emission propulsion retrofits. The Caribbean Corridor initiated by **NAMEPA** has access to shipbuilding in the Bahamas, leverage of the active trade between the United States and Caribbean ports, crewing from countries such as Jamaica and Trinidad and the critical global supply route at Panama.

Successful zero emission corridors in the Global South must incorporate ships, jobs, training and resources and meet developing countries where they are today, building on existing economies and capacities to get to zero emissions by 2050 at the latest. Both the environmental and social aspects of ESG are incorporated through the zero emission technology and land-side renewable energy supply (E) and support of local industries and crew training (S). Training and crewing is core in transferring zero emissions technology to the Global South, ensuring skilled jobs are created so that developing countries can be self-sufficient with new technology.

Anton Rhodes, Manager for Climate Mitigation Projects at the IMO, invited all attendees to participate in the **IMO CARES** project, trialling technology solutions produced in developed countries in the Global South. Working with member states, donors, international finance and technology providers they trial and upscale zero emission solutions in developing countries.

Scaling up

Start-up consultancies find seeking funding from banks difficult due to their minimal asset base to back a loan against. Sometimes industries can create security for banks by creating debt products that pool together cash flow generating products to back a loan against. No or minimal such mechanisms exist for start-ups. For now, they are reliant on industry specific funds that are higher risk takers but offer lower capital investments. Capital is hard to unlock unless projects are at a large scale.

Hydrogen fuel cells and electrolysers are the most promising early-stage innovations needing funding today and are attracting investor interest, according to Louisa Cilenti, Managing Principal and Co-founder at pH3 Capital Ventures. Low hanging fruit such as wind propulsion, sustainable antifouling and electrification are fully commercialised and growing rapidly, with the latter helping existing vessels

reduce 15-20% of ICE emissions through optimisation while also making zero emission solutions, such as hydrogen fuel cells and wind propulsion, more viable.

Digitalisation for energy efficiency using smart data is also attracting interest and growing at a high rate. Digitalisation requires data, in turn requiring greater cooperation. Front runners have found that greater transparency is a win-win situation because of the cost savings experienced, for example from reduced time in port.

“Some shipowners don’t like transparency but it is unavoidable because there is an economic interest.” - Michael Parker, Global Shipping, Logistics & Offshore at **Citi Group** and Chair of **Poseidon Principles**.

Financing older vessels is an issue for shipowners like Wah Kwong. Even relatively new vessels may become environmentally obsolete due to their long lifetimes. It is urgent for shipowners to partner with technology suppliers, ports, cargo owners and catalytic or institutional finance to fund retrofit solutions and explore modular future-proof design on newbuilds.

Shipowner recommendations

- Seek blended finance models: use catalytic funding from institutions, foundations, or development banks to de-risk your business case and attract private impact finance.
- Front-runner shipowners and technology suppliers should share their technology and training with the Global South through catalytic funding verified by ESG, for example through IMO CARES and zero emission corridors.
- Prepare for increasing EU ETS costs and planned ETS in other countries by retrofitting wind propulsion, hull air lubrication and other energy efficiency technologies for absolute fuel reduction across the entire fleet.
- Seek collaboration with finance to build consortia for innovative financing models with verified emissions reduction methodologies to generate in-sector onsets as an additional revenue stream.
- Partner with technology suppliers, ports, cargo owners and catalytic or institutional finance to fund retrofit solutions and explore modular future-proof design on newbuilds.

Brainstorming & Visionaries Panel Outcomes

All attendees were split into six random groups and were instructed to identify the key mechanisms and links between policy, markets, finance and technology that can unlock actionable solutions to creating zero emission ecosystems in shipping. The groups each explained their conclusions to the room, which you can watch here. Finally, the Visionary Panel convened to deliver their thoughts on the day’s discussions, followed by a participative SWOT Analysis (Strengths, Weaknesses, Opportunities, Threats), covering the entire shipping industry from all perspectives. The outcomes are discussed in detail below.

The Visionary Panel was moderated by Carleen Walker, Founder & CEO of North American Marine Environment Protection Association (NAMEPA) and CEO of SHIPPINGInsight, and comprised:

- Cargo – Elisabeth Fauvelle Munck af Rosenschöld, Sustainability director, IKEA Supply AG

- Cargo – Richard Hixson, Co-founder HealthCare Ocean
- Banking – Michael Parker, Global Shipping, Logistics & Offshore at Citi Group and Chair of Poseidon Principles
- Classification – Nick Brown, Global Brand and Communications Director, Marine & Offshore at Bureau Veritas
- Shipowner - Danielle Southcott, Founder, CEO Veer Group zero Emissions container vessels, (Bahamas)
- Shipowner - William Fairclough, Managing Director at Wah Kwong Maritime Transport Holdings Limited (Hong Kong)

Click here to watch the full Visionary Panel.

Survivability

The climate crisis has evolved to such an uncontrolled extent that survivability is now a key driver of policy and markets, and arguably currently the fastest driver of change. People see the effects of climate change accelerate each year and are motivated to take action. Participants discussed the possibility that, as the climate emergency worsens, so does the strength of this mechanism.

In developing countries, which feel the brunt of climate impacts, survivability is its most urgent, in some cases an existential threat. Survivability is influencing governments and industry decision making in the shipping sector. For example, the Bahamas Flag State agreed to back Veer's zero emission cargo solutions partly because it faces an existential threat from climate change, much of the country lying below 1 metre above sea level. Crucial infrastructure like the Panama Canal faces challenges since summer 2023 from severe drought[28], causing plans to strengthen resilience and climate mitigation. On a global level, the unanimous agreement of the 2023 IMO Revised GHG Strategy demonstrated a common acceptance that urgent action is required.

In developed countries, survivability is manifested most acutely in the market - both by customers and employees. Employers in the brainstorming sessions reported an ongoing "war on talent" in the job market, with younger generations especially unwilling to work for companies related to unsustainable practices such as hydrocarbon extraction. The public are increasingly asking for greener supply chains and some are willing to pay more. However, it is currently difficult to exploit this in shipping because of the separation from the customer.

Participants concluded that this, as a mechanism, has the ability to directly influence, above all, 3 aspects of the shipping industry - policy, markets, finance:

- Policy by pressure from voters on governments to take action (especially in developed countries) or by existential threat to key infrastructure causing governments to take action (especially in developing countries)
- Markets by impacting consumer choices and the jobs market (especially in developed countries)
- Finance by adding risk to long-term fossil fuel investments.

A "green button" for shipping

As explored in under "Survivability", shipping is somewhat separated from the consumer, making it difficult to publicise emissions reductions or make use of consumers' willingness to pay for zero emission shipping. Participants imagined that shipping companies could feature a "green button" on

[28] The New York Times Company, 2023: https://www.nytimes.com/2023/08/25/climate/panama-canal-drought-global-trade.html

their websites to close the gap between shipping and the consumer, enabling the public to choose a zero emission shipping method at a premium.

Creating a green button would require cooperation between shipping companies, cargo owners and technology providers to set up a framework. Digitalisation will be required to measure and verify emissions and sources of zero emission fuel across the entire supply chain.

Exceptions to shipping's neglect by the general public arise in certain cases, such as wind propulsion and cruise vessels. Capturing the public's imagination with modern sails and zero emission cruises is a proven way of creating a sensational media buzz around shipping technology. Recent crises such as the Covid Pandemic and the 2021 Suez Canal obstruction have brought attention to the importance of maritime shipping to a wider audience.

Cargo owners and retailers such as the **NHS**, **IKEA** and **UPS** are the shipping stakeholders with the most direct access to consumers and are becoming increasingly aware of their potential for accelerating the transition. For example, **Elisabeth Fauvelle Munck af Rosenschöld, Sustainability Director at IKEA Supply AG explained during the Visionary Panel their ambitious targets - zero emissions by 2040 and 70% emissions reduction by 2030, compared to 2017.** Initiatives such **Ship It Zero** rate retailers by their supply emissions, incentivising cargo owners to outdo competitors and informing the public.

Shipping faces a challenge of who will pay for the climate transition as there are so many actors in the supply chain. Shipowners and retailers closer to consumers might be first movers as consumers can be the ones that pay more with negligible price increases, as shown by Joint Ventures between cargo owners and zero emission technology providers. This is more difficult for transport of feedstock or raw materials. Policies must mitigate increased commodity prices for developing countries to leave no country behind.

Richard Hixson, Co-founder of **HealthCare Ocean** suggested a sectorial shipowner's association to create a strong global consortium which can leverage finance and public awareness to drive down emissions:

"We need a Healthcare Cargo Shipowners' Association. Collaboration is key. We cross the line together, or none of us cross it at all. There are no winners or losers in climate change, we are all in this together. So let's break down the barriers, let's get talking and collaborating and drive this change."

Carrots, sticks, chickens or eggs?

Two policy mechanisms were identified during the brainstorming sessions:

1. Market iterative: policy → markets → finance → technology
2. Acceleration: policy → finance → technology → markets

Mechanism 1 aims to change the market to incentivise greater financial resources being allocated to technology. Examples are the EU ETS or the IMO EEDI and CII. Brainstorming participants from industry

expressed frustration with the slow pace of this policy mechanism due to its iterative nature and reliance on institutional rule making and concern of loopholes and fraud.

To improve this mechanism, cargo owner performance could be quantified using long-term viability indicators enforced by Class, giving a clear path to eliminating emissions as long as there is proof of earning stability. UK Procurement Policy Note 06/20 (taking account of social value in the award of central government contracts) is effective in the NHS as a "stick" according to Richard Hixson but is not necessarily engaged with tangibly or quantifiably. This model could be expanded to the international level through the IMO that goes further than the inadequate current performance indicators only focussed on efficiency (EEDI, CII) but not absolute emissions reduction. Quantifying environmental and social value becomes possible with digitalisation, as explored in the following section.

Mechanism 2 gives financial support to zero emission technologies, through:

- tax credits, for example the US Inflation Reduction Act's $3 tax credit for green hydrogen[29]
- directly allocating funding, for example the UK CMDC[30] and ZEVI[31] competitions for zero emission vessels and infrastructure demonstrations
- price caps
- changes to legal agreements to protect emerging markets, for example Contracts for Difference used in the UK renewable energy sector

In the brainstorming groups, Mechanism 2 was preferred by industry due to the speed of impact and the ability for finance to better allocate resources to solve "chicken and egg" infrastructure problems than institutions. Voices from the shipping industry stressed the urgent need for policies to bring the levelized costs of renewable electricity (LCOE) and green hydrogen much closer to those of fossil fuels and praised the US Inflation Reduction Act.

Eliminating climate fraud with data and transparency

Some brainstorming participants expressed concern that large institutional market-based measures such as the EU ETS can create the opportunity for climate fraud - or 'greenwashing'. This is a major challenge for both shipowners and clients. Corporate values have a large impact on the success of policies, enabling abuse. Shipowners, finance and technology suppliers must spend valuable resources understanding the ethical values of other parties to ensure successful relationships.

For example, if a shipowner installs wind propulsion technology (either retrofit or newbuild) onto a primarily fossil fuel driven vessel, they generate fuel savings and reduce their carbon footprint, improving their ETS, CII and EEDI rating. However, having a greener rating can open the opportunity for that shipowner to now burn a more harmful and cheaper fuel than they would have otherwise been permitted to burn. So, only corporate values will determine whether the shipowner avoids using more harmful fuel.

[29] US Government, Office of Energy Efficiency & Renewable Energy, 2023: https://www.energy.gov/eere/fuelcells/financial-incentives-hydrogen-and-fuel-cell-projects
[30] UK Government, Department for Transport, 2022: https://www.gov.uk/government/news/dft-launches-uk-shore-to-take-maritime-back-to-the-future-with-green-investment
[31] SAFETY4SEA, 2023: https://safety4sea.com/uk-77-million-boost-to-decarbonize-maritime/

An independent, objective, digitalised third-party verification system, perhaps in the form of a certification label similar to renewable energy guarantees of origin or peer rating would help in this situation. Transparent data and digitalisation enable everyone to see where cargo is going and its climate footprint. Data is already collected globally using the **IMO Data Collection System (DCS)** but is currently not made public.

Methodologies have been approved for antifouling and retrofit for dual fuel ICE that generate in-sector onsets with commercial value due to proof of emissions reduction. Challenges are still to be overcome such as the high costs of financing methodologies (18 months and $100,000 for antifouling proof) and accounting for double counting by additionality. **Veer** has a complete proposal for an app for absolute zero shipping created specifically for this purpose (combining clients, the carbon market, peer rating and verification) and are seeking support to launch it. The **Poseidon Principles** sets obligatory emissions targets to litigate against greenwashing. Banks will not finance abusers of the system, only those with a long-term strategy for the future.

SWOT analysis: De-emissioning shipping

The Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis was moderated by Carleen Walker during the Visionary Panel.

STRENGTHS

- ➔ Significant technology is available today
- ➔ Supply chains & infrastructure: people want to invest, changes in perception and flows of money
- ➔ Solution oriented mindset – people make change
- ➔ Economic necessity: Essential service, the world cannot survive without ships, unlike aviation – there is no alternative for transporting goods
- ➔ Everyone gets it – easy concept
- ➔ Global regulator, IMO is a strength if channelled correctly
- ➔ We don't need to wait – so much innovation is already out there, we can slice the problem into different parts
- ➔ Shipping is the only industry with accurate emissions data – no other industry has this – can be measured and improved on – people will believe you
- ➔ Centuries of experience of zero emissions shipping – in our blood
- ➔ Climate pressure increasing, younger generation are pushing market and putting pressure on employers
- ➔ Industry built on relationships – global family.
- ➔ Ambition – slow to start but we'll be first to finish
- ➔ Like-minded people across whole value chain – finance, shipowners, tech, end users/cargo owners (eg NHS), legal
- ➔ Accessibility of C-suite – willingness to do trials compared to aviation
- ➔ Large baseload of potential decarbonisation because ships are so emitting – 10 large vessels can make a huge difference
- ➔ Industry is on board and part of dialogue, engaging in discussions – support and examples saying we can do this

➔ Seafarers – unique people working on assets who understand technology and the ocean

WEAKNESSES

- Resistance from vested interests in fossil fuels
- Derived demand – the industry serves what's going on
- Industry overcapacity, belief that change will happen slowly. Ticking the box: ESG – risk of compliance without belief
- We exclude other pollutants – we have to consider wider damage to oceans
- Getting financing – capital is hard to unlock unless at large scale
- Renewable energy can be classified as a non-commodifiable energy source: complexity in incorporating into existing business models
- Shipping is a dirty word for financial regulators (this will change soon)
- Shipping has to compete with other industries for zero emission fuels
- Harmonisation of efforts is complex across wide geographic areas and operations
- Legacy asset owners don't want to stop using ships with long lifetimes which may become environmentally obsolete
- Shipping is split into siloes
- The physical time to develop solutions and prove viability is long – takes years, difficult to accept by finance or user – impatience
- Geopolitical vulnerability: rogue nations, competition between nations, damage to shipping from war, cost of global trade – can we afford to decarbonize?
- Primary energy source is not sufficient – speed of renewable energy rollout
- Not easy for start-ups to continue innovation, hard to attract talent
- Low margin business
- Complexity of maritime law – diffusion of responsibility
- Opaque industry – public does not see it, not a vote winner for government investment
- Fair and just transition for global south – majority of world is left out of this debate

OPPORTUNITIES

➔ Disclose vessel emissions data
➔ Large emissions reductions possible
➔ Build and harmonise coalitions
➔ Global south: large renewable energy potential, transfer authority and autonomy
➔ Power to save lives by transporting critical materials and improve health of millions of people
➔ Wide range of ships are part of decarbonisation including small ships and passenger ships
➔ Biodiversity protection: large impact possible – underwater noise reduction, truly sustainable industry, global industry
➔ Better regulation – building on IMO – align with Paris Agreement in 2028, simplify regulation, designate seafarers as essential workers
➔ A lot of data – visibility and transparency of scope 3 emissions details & magnitude, important to engage everyone, targets, demonstrate value proposition, create new jobs
➔ Regulate to stop oil dumping through MARPOL
➔ Address holistic impacts – GHGs are driving the conversation but IMO is also looking at wider impacts & co-benefits for marine environment, environmental protection silos can broken down

➔ Expansion of Marine Protected Areas (MPAs) – target for 30% of ocean by 2030, encourage zero emission ships
➔ Start ups – innovate, new companies taking over legacy operations
➔ Blue economy – includes shipping but also wider ocean industries - links with climate change, finance by governments, innovations and blue finance

THREATS

Threats → Opportunities

- Resistance from vested economic interests in fossil fuels → War on talent: the new generation won't work for companies associated fossil fuels
- Will we be fast enough? How do we scale up quickly? Innovation in collaboration needed → put more pressure on cargo owners, shipping in demand
- Time pressure: as available data improves, people will feel more pressure to de-emission but waiting too long for data could stop action now, collaboration → IMO CARES: roundtables with donors, companies, tech original equipment manufacturers (OEMs), publicity of eye-catching projects e.g. wind propulsion
- Misinformation: the status quo of fossil fuels kills people, but public perception does not match this → more data, better comms, continue changing industry image, global maritime industry resource – centralised message
- Geopolitics: countries might delay IMO policy if they feel they don't get a fair deal
- Fossil fuels are embedded into the global economy: fuels, petrochemicals, plastics. by-products and others
- Populist politicians: changing the world costs votes for them
    - Younger generation will not tolerate business as usual (BAU), they are emerging into taxpayers and voters (in democracies) but transformation cannot be overnight due to longterm investments such as pension funds.
    - Share wealth, industries and knowledge with developing countries.
    - Hold accountable countries and companies for ecocide – accountability
- Absolute zero by 2050 presents a threat if an equitable transition not achieved: power game in oil & gas, exploitation of global south for fossil fuels
- Disconnect between industry and crews → make sure they are not forgotten
- Just and equitable transition meaning being misused – legal use – can also protect fossil fuels
- Supply chains for zero emissions fuels are missing, prices are not known, offtake agreements are difficult, selecting fuel uncertain → modular "swap-out" propulsion designs, novel business models e.g. energy as a service, small steps in infrastructure for flexible & mobile solutions
- Lack of political will & greenwashing → better emissions data, transparency

Brainstorming conclusions

- Survivability is increasingly a driver of policies and markets due to the worsening effects of climate change, their impact (especially on developing countries) and public desire and willingness to pay (especially in developed countries) for action
- As market pull for urgent climate action increases, shipping industry actors closest to the consumer (cargo owners, cruise companies) have the opportunity to leverage willingness to pay for a "green button" for zero emissions shipping at a premium. In many cases, the

additional cost passed onto the consumer is negligible, as shown in existing Joint Ventures between cargo owners, shipowners and zero emission technology suppliers.

- Policies can ensure developing countries do not pay increased prices for zero emissions shipping
- Policy mechanisms delivering direct financial and legal support (e.g. tax credits, direct funding, price caps, legal agreements such as Contracts for Difference) are preferred by the shipping industry over institutional market-based measures (e.g. EU ETS, IMO EEDI & CII) because of their faster impact, better ability of the industry to allocate resources compared with institutions, and concerns of greenwashing and lack of transparency in institutional market-based measures.
- Voices from the shipping industry stressed the urgency of policies to bring the levelized costs of renewable electricity (LCOE) and green hydrogen much closer to those of fossil fuels, as enacted in the US Inflation Reduction Act.
- Making the IMO Data Collection System (DCS) transparent would unlock the opportunity to create obligatory independent, objective, digitalised third-party emissions verification (e.g. certification label, peer rating), eliminating climate fraud.
- Data transparency is win-win for shipowners, ports, cargo owners, policy makers and technology suppliers. For a shipowner, the gains in efficiency (e.g. less time in port) far outweigh any concerns about competition.
- Shipowners who abuse institutional market-based measures such as the EU ETS through climate fraud will be excluded by shipping finance using methodologies for emissions verification through digitalisation and obligatory target-based financing.