SHIPZERO30

ZESTAs.
ZERO EMISSIONS SHIP TECHNOLOGY ASSOCIATION

HyWindships

At London International Shipping Week's ShipZERO30 Workshop, the IMO became a stage for innovators and disruptors to showcase the cutting-edge solutions that promise a healthy ocean and a profitable future. The day presented successful real-life vessels that only recently were dismissed by the industry mainstream as impossible, such as liquid hydrogen storage and bunkering, primarily wind-powered commercial ocean-going cargo ships, and hybrid battery-hydrogen fuel cell propulsion, yet each is built on decades of proven technology. The technologies showcased here will play a pivotal role in shipping's decarbonization journey and will spearhead the ambitions of the IMO's Net Zero Framework into reality. The message was clear: the transformation of maritime transport is not only feasible, it has begun, and the business case is real.

"These are challenging times but, as you all know, we all have a responsibility when it comes to reducing emissions in order to protect the planet for future generations. What you bring to the table is information and expertise. You're going to talk about electrification, hydrogen, wind propulsion"
-Arsenio Dominguez, Secretary General of the IMO

"We, the technology providers, the people in this room, will continue to push forward, to support all the work being done at the IMO. We understand the safety required for these technologies, and we will bring that into the IMO as well."
-Madadh MacLaine, Secretary General of ZESTAs

Five Reasons Why HyWindships Work

1. **Cost-effective and efficient use of renewable energy:** All proposed e-fuels (including methanol, ammonia and hydrogen) rely on hydrogen produced from renewable electricity. Hydrogen is the fuel that requires the least amount of renewable energy investment, due to the lower amount of total energy investment during production per unit of energy yield onboard[1]. Wind is abundant and low-OPEX.

2. **Efficient use of energy onboard:** Electric powertrains are 10-20% more efficient than combustion engines[2], and are fully compatible with hydrogen fuel cells and batteries to ensure minimal losses and excess energy storage. Using e-ammonia in a fuel cell requires energy- and space-intensive cracking[3]. Wind is directly used to propel the ship at high efficiency.

3. **Air pollution:** No emissions of SOx, NOx or PMs which cause millions of excess deaths per year and put strains on health systems around the world[4,5].

4. **Ocean health and climate change:** Marine life sequesters around 40% of total CO_2 but increases in dissolved CO_2 have caused the ocean to acidify by 38% between 1850 and 2022[6]. To stop the ocean acidifying and protect its power to sequester carbon, we must stop all forms of marine pollution harmful to marine life, including SOx, NOx and PM which cause eutrophication, changes to albedo, and biodiversity loss. Business as usual damages fisheries, agriculture, forestry and crucial ecosystem services, usually most adversely affecting emerging economies, Small-Island Developing States and Least Developed Countries.

5. **GHG emissions and climate change:** Hydrogen in electrical powertrains and wind are the only future proof maritime propulsion technologies because they do produce GHG emissions. Green hydrogen is a long-term, bankable fuel investment which avoids stranded assets.

What is a HyWindship?

HyWindships combine proven and scalable Absolute Zero emissions technology to transform shipping's impact on the climate and ocean health while leveraging policy and business model innovation to meet the highest shipowner demands. By combining hydrogen fuel cells, wind propulsion, electric powertrains and state-of-the-art energy efficiency measures, HyWindship newbuilds can achieve trans-oceanic commercial shipping today.

Absolute Zero emission technologies produce zero GHG emissions onboard from Tank-to-Wake (TTW), are nearly silent and do not pollute water or air. On a lifecycle, Well-to-Wake basis, the ensuring of renewable electricity as the basis ensures that the overall GHG emissions are as close to zero as possible by avoiding differing quantifications and climate metrics for balancing GHG emissions with removals that may or may not be within the marine fuel lifecycle.

Absolute Zero is Proven

Wind propulsion

Brands Hatch

- Union Maritime is positioning themselves to be the world's largest wind-assisted shipowner, with 34 vessels to use BAR and Norsepower technology.
- BAR Technologies' 37.5 m WindWings guarantee min. 1.5 tonnes fuel saved/wing/day, or about 5 tonnes CO_2 reduction.
- Norsepower Rotor Sails deliver 5-25% fuel and emission reduction on suitable routes.

Neoliner Origin

- Primarily wind-powered 136m Ro-Ro cargo vessel with estimated 80-90% fuel reduction, 83% GHG reduction.
- Competitive and stable freight rate due to consistent bunkering costs.
- Retractable sails compatible with ports.
- First voyage Bastia (IT) - Marseille (FR): 315 cars for Filpar completed 5th October.

Hydrogen fuel

Hydra

- World's first liquid hydrogen (LH_2)-powered vessel, in operation since 2023 with 98% uptime, best in Norled's fleet of electric and diesel-powered RoPax ferries.
- Deliberately over-engineered to enable scale-up to multi-MW fuel cell power and 30 tonnes/hour bunkering.
- 80 bunkers completed so far at 4 tonnes/hour, supplying 2 weeks of operations.

Suiso Frontier

- World's first LH_2 carrier vessel delivered in 2021 by KHI.
- Pilot demonstrates bulk LH_2 transport from Australia to Japan and terminal (un) loading.
- 116m vessel fitted with a 1250m³, 75 tonne capacity cryogenic IMO Type C tank.

Reliable and Scalable

Wind propulsion is rapidly commercialising and competition increasing. Many innovative systems are available including rotor sails, suction wings, wing sails and kites, offered by 20+ wind technology providers in the market.

Uptake growth shows installations doubling since 2023. Currently, 71 commercial ships with wind propulsion systems are operating globally across a range of ship types, and 60 more installations are on order.

Fuel saving performance is validated by real-time onboard data systems and independent holistic prediction studies, reinforcing trust and confidence and making investments both safe and attractive.

Investment payback from fuel savings alone is at 4 to 6 years, reducing to 2 to 3 years with IMO and regional GHG policies.

30 hydrogen fuel cell-powered vessels are currently in service, under construction or FID committed (100 kW power or higher). The largest power system on order is two 6.4 MW systems supplied by PowerCell for Torghatten Nord ferries, currently under construction.

Marinised storage of gaseous or liquid hydrogen (LH_2) storage is available from suppliers such as Hexagon Purus, eCap Marine, Kawasaki, Air Liquide and Chart Industries.

Smooth integration of fuel cells with battery-electric powertrains enables **highly efficient hydrogen usage.**

Energy-dense LH_2 can be bunkered at 4 tonnes/hour. Challenges such as boil-off gas have been eliminated during sailing by reusing evaporation as fuel.

Standards, Guidelines, Crew Safety and Training

Wind is recognised as a fuel pathway in the IMO 2024 LCA Guidelines (Pathway 128) with an additional submission to calculate GFI based on wind (MEPC 82/7/9).

Vessel stability is addressed through pre-assessment holistic effects on heeling. Visibility reductions from the bridge are met by "better than a human eye" camera systems under SOLAS.

Suppliers are integrating wind propulsion into training simulators to improve confidence at sea, while actively engaging with port authorities to open dialogue.

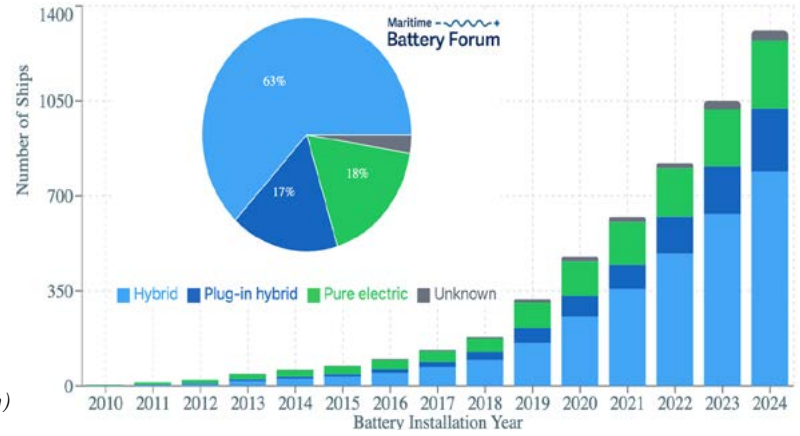
The IMO Interim Guidelines for the Safety of Ships Using Hydrogen as Fuel were completed at CCC 11 in September 2025, and will be published in May 2026. Guidelines in all maritime class societies acknowledge the relevant ISO standards developed onshore.

Crew training programs are not yet standardised but **ZESTAs and UHI Orkney are working to build on the draft interim generic guidelines agreed HTW 11** in February 2025. Successful training of crew and shoreside operators was shared by LH2 Shipping, Hexagon Purus and Future Proof Shipping at ShipZERO30.

Electrification

Underpinning all Absolute Zero emission technologies is the efficiency provided by electric powertrains and battery storage, optimising energy use and minimising losses. Electric and hybrid marine technology is mature and installations are growing quickly as shipowners recognise the stable OPEX case. Like cars, ships can be fully electric, hybrid, or plug-in hybrid.

The largest marine battery is 40 MWh capacity, installed on the 14000 GT fully-electric RoPax ferry China Zorilla, soon to enter service between Uruguay and Argentina.



Cumulative electrified vessel installations by type (Maritime Battery Forum)

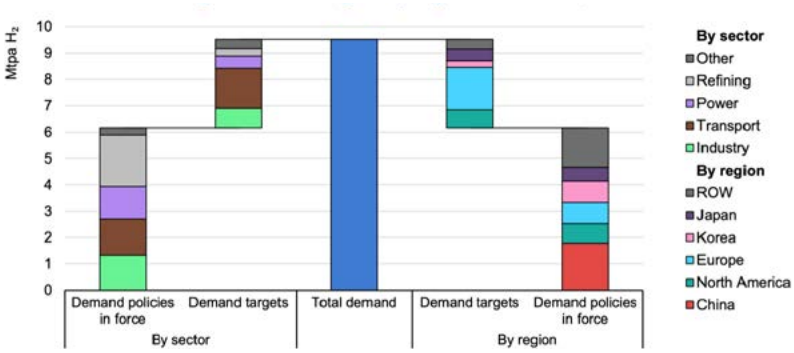
Building Maritime Hydrogen Supply Chains

Wind propulsion and electric powertrains greatly increase fuel efficiency onboard a HyWindship, ensuring minimal valuable green hydrogen fuel is required. Nonetheless, hydrogen is crucial for achieving the operational range demands of commercial shipping, and a global maritime supply chain is thus demanded by shipowners ready to transition today.

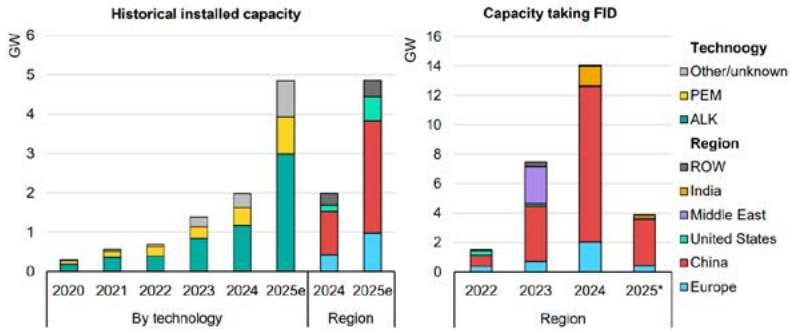
Global Trends:

Green hydrogen production has increased steadily each year, and will continue to increase despite some cancelled projects. Added electrolyser capacity has more than doubled so far between 2024 and 2025, mostly led by China and followed up by Europe. As of September 2025, 26 GW of electrolysis capacity had taken FID or was under construction with the target of being in operation by 2030, amounting to 3.8 million tonnes of green hydrogen supply[7].

Demand creation policies are driving production in Asia and Europe by going beyond just targets, such as the National Energy Law (Draft) in China[8], Contracts for Difference play a key part, such as India's SIGHT, the EU Hydrogen Bank Auction (EHBA), UK Hydrogen Allocation Rounds (HAR), the Hydrogen Society Promotion Act in Japan, and H2Global.



Comparison of potential annual demand for "low-emissions" hydrogen by 2030 created through forcing policies and targets[7]. Includes non-electrolytic hydrogen.



Installed electrolyser capacity by technology and region, 2020-2025e (expected), and capacity reaching Final Investment Decision (FID) by region, 2022-2025[7].

Hydrogen Maritime Supply: Gen2 Energy Case Study

At ShipZERO30, Norwegian renewable hydrogen producer Gen2 Energy presented their FID ready Nesbruket liquid hydrogen (LH_2) production plant. The EUHB awarded a 61.6€ million OPEX maritime grant to produce 30 tonnes per day of liquid hydrogen, with the condition that 60% of the production capacity is allocated to the maritime sector over the first 10 years of operation. This is enough to supply between 9 and 18 LH_2-powered vessels.

Gen2 Energy is working closely with Chart Industries, LH2 Shipping, Litra Gass and ASCO to create a complete LH_2 supply chain along the entire coast of Norway, by establishing several bunkering locations, and transport liquid hydrogen efficiently between the sites of production to the bunkering locations. With Chart they also have a collaboration agreement with Tata Steel, Ecolog and Port of Amsterdam to create a green hydrogen corridor between the Netherlands and Norway, for seaborn transportation and exportation of liquid hydrogen for industrial and maritime customers.

A Viable Future for Shipowners

Retrofits present great opportunities for shipowners to extend fleet lives and upgrade performance. 45% of the global fleet is estimated to be at risk of failing to meet tightening carbon intensity standards within a few years, representing about 50,000 vessels[9]. Around 35% of vessels older than 15 years are already undergoing retrofits, representing a global market valued at $5.24 billion in 2024 and estimated to be growing by 5.14% per year[10]. **Retrofitting is one of the fastest and most cost-effective ways to cut emissions at scale while preserving asset value.**

Kishan Muthu, Head of SeaLabs at Union Maritime, who are on track to have the largest global fleet of wind assisted ships with an estimated investment of $150 million across 34 vessels.

Wind-assisted propulsion retrofit payback times are around 5 years, shortening to 2 to 3 years with IMO and regional policy. Suppliers are racing to shorten payback with innovative business models and guarantees.

Deployment at scale delivers visible, bankable OPEX savings, creates demand signals for green financing, and buys time for port infrastructure.

Newbuilds can achieve very large GHG emissions reductions today while remaining compatible with future zero-carbon fuels. Wind propulsion, advanced hull coatings, hybrid-electric propulsion and energy-efficient design can deliver major fuel demand reductions, as demonstrated by Union Maritime's LR2 tanker design, with 31% lower estimated CO_2-eq emissions.

For even more ambitious reductions, HyWindships can deliver Absolute Zero emissions for short-sea and oceanic shipping, as shown by the primarily-wind powered Neoliner Origin now operating between Europe and North America, Samskip's 2 coastal container vessels under construction, and Veer Group's wind and hydrogen-propelled trans-oceanic container ship that is one charter signature away from the shipyard.

Any shipowner concerned about covering costs should look towards blue bonds as innovative financing mechanisms capable of covering OPEX and CAPEX, such as South Korea's recently issued 10-year $1 billion blue bonds[11]. **Danielle Southcott, CEO and Founder of Veer Group** is leading charge in cutting-edge business model innovations, such as the Physical Connectivity Guarantee enabling customer verification of clean shipping, to prove to competitors that HyWindships are bankable today.

When it comes to understanding how emissions reductions are possible for your fleet, ZESTAs is here to help shipowners navigate the rocky seas of regulation and changing technology.

Absolute Zero is Bankable

"The funds collected by the Net Zero Framework will be invested into this sector, and that includes R&D, new technologies, and new fuels which will allow us to decarbonise." ***- Arsenio Dominguez, Secretary General of the IMO.*** *This is a crucial part of the mix of financial solutions for a just transition.*

Torsten Thiele, Senior Advisor, Blue Finance at Ocean Risk and Resilience Action Alliance (ORRAA), kicked off ShipZERO30 calling for a reorganization of the maritime industry to scale ocean investment vehicles. A collaborative "Ocean Asset Class" designed to scale zero emissions solutions can drive healthy oceans through infrastructure projects and innovation support.

Blue bonds, private capital, blended finance, are one side of investment. Another side of financing is policy, such as the remedial unit pricing in the IMO Net Zero Framework, which leverages a unique advantage of international shipping as the only industry with a global regulatory framework.

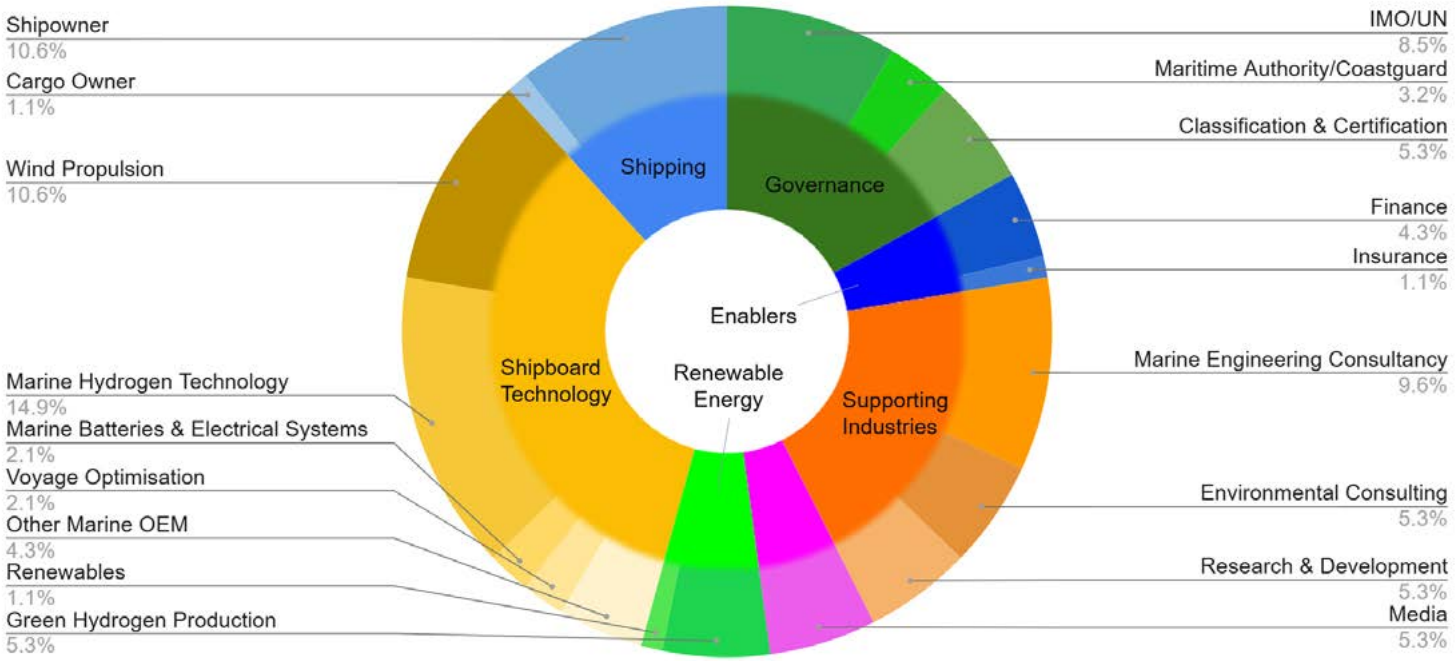
Existing regulations such as the Poseidon Principles and UNGC Ocean Investment Protocol guide financial institution investments, who receive certainty through insurance schemes and international legislation like the High Seas Treaty.

The sector is ready and capital is mobilised, but ports and shipping face $874 billion of Value at Risk from 2°C global warming[12]. These losses can be cut by 94% by aligning portfolios with the Paris Agreement to keep warming below 1.5°C. Suzanne Johnson made this clear, affirming that *"Shipping is making one of the clearest investment theses of our times with regards to the ocean industry"*. Absolute Zero technologies are crucial to ensure shipping accelerates reductions of GHG emissions and does no harm.

"Urgency is so crucial. We don't price in the cost of climate and certainly not nature, but there is a growing awareness within public markets." ***- Suzanne Johnson, Senior Advisor to the UN Global Compact Ocean Stewardship Coalition.*** The ocean needs decade-long perspectives, and large-scale collaborative action today.

A Picture of the Room

ShipZERO30 Attendees by Sector



As usual, our latest ShipZERO workshop attracted a diverse array of expert voices from across all aspects of the shipping industry and beyond - united by a shared vision and practical goal: to accelerate zero emissions shipping past the demonstration phase into commercial deployment across coastal and oceanic shipping.

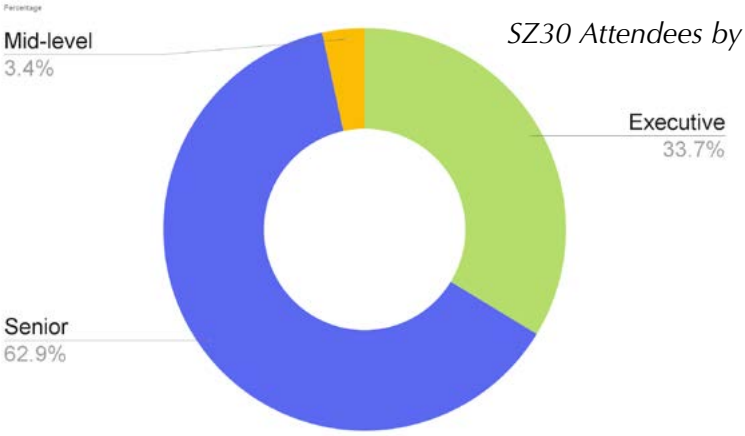
Executive decision-makers from shipowners Wah Kwong, Bahri, Union Maritime, Samskip, Scorpio Group, Maris Fiducia, Neoline, Future Proof Shipping and Veer Group brought their industry expertise to the table and their weight behind adoption of feasible, practical solutions to drastically cutting fleet emissions.

Danielle Southcott, CEO & Founder of Veer Group

A vast selection of shipboard technology providers and representatives from green hydrogen production, renewable energy, and supporting industries ensured that no solution was left unexplored in addressing the elimination of GHG emissions and pollution from ships: including 6 wind propulsion manufacturers, 11 hydrogen propulsion and storage providers, and 5 green hydrogen fuel suppliers.

Kim Nguyen, Project Manager at LH2 Shipping

ZESTAs welcomed the IMO Secretary General and the Head of Climate Action & Clean Air, the delegations of the Marshall Islands, Cayman Islands, Nigeria and United Kingdom, and industry bodies INTERCARGO, Cruise Lines International Association, SASHA Coalition, and PoliSea Group, as well as Bureau Veritas Marine & Offshore to contribute on behalf of international shipping governance.



SZ30 Attendees by Position

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