Natural Resources PC

How Zero and Near-Zero Fuels Can Take Off in the Maritime Sector

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The shipping industry is responsible for between 2 and 3% of all global emissions. In recognition of this, the International Maritime Organization's 2023 GHG Strategy set net-zero by around 2050 and calls for at least 5% [striving for 10%] of ship energy from zero/near-zero fuels by 2030. Hitting this target will require a wide-scale transition from today's high-emission fossil fuels to zero-emission alternatives.

As with almost all sectors -- in addition to efficiency measures [in this case CII/EEXI compliance, wind-assist, routing] -- the instruments that can make early projects in green fuels bankable in the maritime sector are *technological advancements* and *regulatory plus fiscal incentives*.

Lower-GHG fuels to cut both fuel bill and compliance penalties is often what closes IRR.

1. Technology pathways, by fuel/tech

Following the move to LNG that is reducing GHG emissions compared to Bunker C or diesel, Zero and Near-Zero solutions include the use of Hydrogen, Methanol, Ammonia and Fuel Cells. Methanol and Ammonia in particular have emerged as two of the most promising candidates among the options under consideration. Each has its own distinct advantages, challenges, and pathways to scale.

1.1 Hydrogen [H_2]

This source already fits Short-sea ferries, Ro-Pax, offshore support vessels and harbor craft—routes with fixed schedules and frequent bunkering. It appears harder for deep sea due to need for considerable Cryogenic LH_2 or 350–700 bar compressed storage that limits cargo space. Also supply is nascent outside a few corridors. Near-term configurations could include Direct H_2 to PEM fuel cells [highest tank-to-wake efficiency] or, for auxiliaries/peak shaving, H_2 ICEs as bridging tech.

1.2 Methanol [MeOH]

This option is available for ocean-going cargo now and is expanding bunkering, despite its lower energy density volume vs HFO for the same range. Supply is tight but ramping. Dual-fuel 2-stroke & 4-stroke engines are commercial, and retrofits are offered at scale. Other key advantages: Methanol is liquid at ambient conditions (simple tanks/piping), mature bunkering is operational in big ports such as Singapore, Rotterdam and other key EU ports, Shanghai, and a growing orderbook e.g., Maersk newbuilds already operating, while Greek-owned Danaos, Navios and others have placed orders. Clearly, Methanol's real climate benefit is maximized if the fuel is green ie biomethanol or e-methanol, with e-methanol engines being already available for Short-sea/point-to-point. Biomethane, the fuel produced from organic waste, like manure, contributes at least 90 per cent less carbon than conventional marine fuels to the atmosphere's carbon cycle. In short, 'methanol-ready' designs are to preserve option value when ammonia engines and bunkering mature around 2026–27+.

1.3 Ammonia [NH_3]

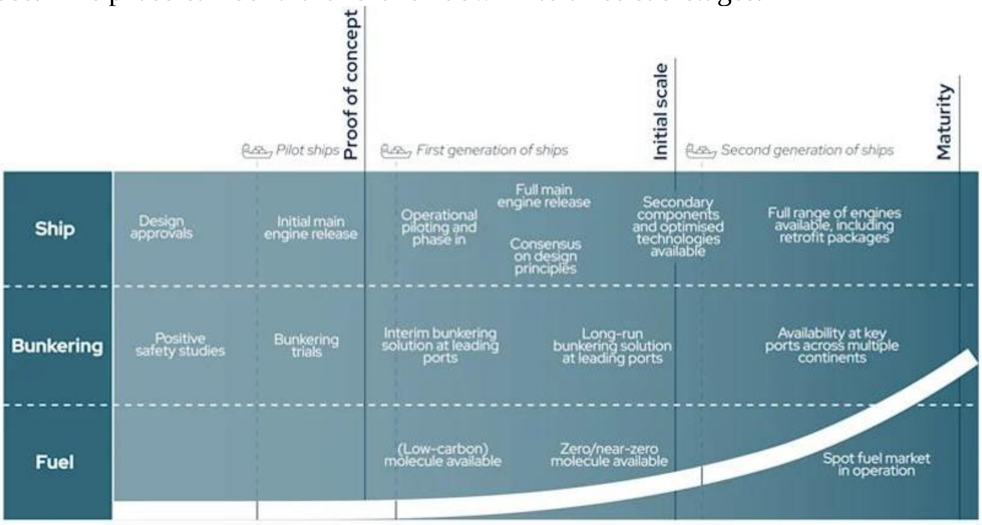
Deep-sea segments aiming for carbon-free tank-to-wake consider ammonia due to its best volumetric density among hydrogen-derived e-fuels; can ride existing ammonia logistics. Two-stroke ammonia engines have passed key test milestones; first deliveries are targeted for 2026–27. In a key step for class/flag approvals, Interim IMO safety guidelines for ammonia-fuelled ships were issued in 2025. However, toxicity demands tight designs, detection, ventilation and training; control of NO_x/N_2O is crucial. DNV and others have issued design/bunkering practices. All told, 'ammonia-ready' designs are near-commercial engines, with first operations expected mid-decade and broader uptake in 2026-27 as bunkering/standards mature.

1.4 Fuel cells [PEM, SOFC]

As with hydrogen, High-efficiency fuel cells are the electric prime movers for short-sea; auxiliary/hotel loads on larger ships; future SOFC with on-board reforming [e-methanol/LNG today, e-fuels tomorrow]. As with ammonia, IMO interim safety guidelines for marine fuel cells are in place, and class rules exist. Multi-MW fuel-cell stacks (PEM today; SOFC coming) are already ordered/installed for Norwegian ferries in the ~6 MW class.

1.5 A further note on methanol and ammonia

Shipping's transition to zero-emission fuels and technologies is expected[1] to follow an S-curve, in which an initial period of slow uptake (emergence) is followed by a rapid increase (diffusion), before eventually flattening out (reconfiguration). Both methanol and ammonia are still in the emergence phase. This phase can be further broken down into three sub-stages:



1.*Proof of concept*, reached once a fuel has been shown to be safe and effective in real-world demonstrations; 2.*Initial scale*, reflecting small-scale commercial adoption of the fuel on specific routes and ports; 3.*Maturity*, marking the fuel's development into a widely available solution, with limited barriers to uptake.

Ports as enablers: Singapore and North Sea ports are standardizing digital/mass-flow bunkering and running methanol and ammonia pilots—de-risking operations and permitting.

2. Regulatory and fiscal incentives that make zero and near-zero fuels scale

2.1 Global rules

It has been already mentioned that the IMO's 2023 GHG Strategy set *net-zero by around 2050* and calls for *at least 5% (striving for 10%)* of ship energy from zero/near-zero fuels by 2030.

As for mid-term measures, a goal-based marine fuel standard [life-cycle GHG intensity] plus a global pricing/economic element are being finalized, with adoption steps slated from October 2025 and expected entry into force in 2027 under MARPOL timelines. This will penalize fossil fuel use and reward low-carbon fuels globally.

However, the US has recently threatened to retaliate against IMO members that back net zero emissions plan

2.2 Regional 'sticks & carrots'

EU ETS for shipping aims at phased-in compliance for voyages touching the EU, with 40% of 2024 emissions payable in 2025, 70% of 2025 in 2026, 100% from 2027. This creates a real carbon cost that favors low-GHG fuels. In the same direction, FuelEU Maritime is in force since Jan 1, 2025 and Sets tightening GHG-intensity limits on energy used on board (well-to-wake), is tech-neutral, and doubles the compliance credit of RFNBOs (e-fuels) through 2034—speeding e-methanol/e-ammonia uptake. Non-compliance triggers hefty monetary penalties.

On the negative side, EU mulls 10-year tax holiday for jet and shipping fuels, as was announced September 1, 2025

2.3 Production subsidies aiming to lower green fuel prices

EU & Member States utilize Innovation Fund grants, IPCEIs, and Carbon Contracts for Difference (e.g., Germany's 15-year CCfDs) that cover the green premium for hydrogen and derivatives used in industry and potentially shipping supply chains. At the same time, Nordic programs are in place with Norway's Enova directly funding H_2/NH_3 vessels and bunkering pilots thus offering material CAPEX aid that closes first-of-a-kind gaps.

In the United States, IRA §45V offers up to \$3/kg for clean hydrogen for 10 years, with final rules clarifying life-cycle emissions ≤4 kg CO_2e/kg H_2 and eligibility for projects using new clean power. *Note: 2025 policy moves introduced uncertainty about long-term availability; still a major driver.*

2.4 Demand-side coalitions create bankable offtake

Cargo owners are beginning to pay the green premium: The ZEMBA alliance was formed to generate the necessary mass of customers willing collectively to pay extra for cleaner fuels and make it worthwhile for a shipping line to use the cleaner product. ZEMBA's first tender (Amazon, Patagonia, etc.) underwrites low-carbon container miles—exactly the mechanism that let early biomethane and e-methanol voyages launch.

Footnotes and References are available.

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