LLOYD'S MARITIME ACADEMY

Report: Decarbonisation and the Latest IMO Expectations - Changing Landscape MPEC81

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Decarbonisation Overview – Navigating a Sustainable Future

2023 marked the warmest year on record, with global temperatures averaging 1.48°C above pre-industrial levels. This alarming climate shift has driven lawmakers and corporate leaders to prioritise reducing Green House Gas (GHG) emissions.

The maritime sector is a key focus for decarbonisation, handling 90% of global trade and contributing around 3% of worldwide GHG emissions. With shipping emissions projected to rise by up to 130% by 2050, urgent and equitable decarbonisation is essential.

In mid-2023, the International Maritime Organization (IMO) updated its GHG Strategy, aiming for net-zero emissions by 2050, in alignment with the Paris Agreement. In response, shipping companies are adopting low-emission fuels and complying with new IMO as well as EU regulations. Investments in modern fleets, operational measures like hull cleaning, and slower sailing speeds are projected to enhance fuel efficiency by 20% by 2030.

Despite the improvements, rising emissions persist due to increasing consumption. The next critical step is prioritising low and zero-carbon fuels, though cost as well as availability remains significant challenges.

Why Decarbonisation is the Need of the Hour

The maritime sector faces significant economic, geopolitical, and environmental challenges. **A staggering 98.8% of ships still rely on fossil fuels, yet there is a hopeful shift with 21% of new vessels expected to use cleaner alternatives like liquefied natural gas (LNG), methanol, and hybrid technologies. This transition is crucial as the sector fell 17% short of the IMO's climate targets in 2023, resulting in 165 million metric tonnes of carbondioxide (CO2) emissions**.

Dry bulk, general cargo, and tankers currently contribute around 400 million tonnes of CO2 emissions. With global commerce projected to double by 2050, emissions will escalate without urgent action. The Sea Cargo Charter (SCC) has called for immediate industry-wide measures to meet the ambitious targets.

The transition to green shipping standards demands accountability and initiative from ship owners, ports, as well as the energy sector. Despite new green standards enforced by major flag states like Liberia, Panama, and the Marshall Islands, economic constraints on alternative fuels, bunkering infrastructure, along with greener vessels hinder progress. Immediate and decisive action is essential to navigate towards a sustainable future in maritime transport.

Initiatives towards Decarbonisation

Decarbonisation in shipping requires financial incentives, investment in new technology, and sustainable maritime fuels (SMFs). Policy interventions, such as sanctions for non-compliance plus rewards for energy transitions, are crucial. The inclusion of shipping in the EU Emissions Trading System (EU ETS) and the FuelEU Maritime initiative are key regulations.

Green Shipping Corridors mandate decarbonisation technologies and regular reporting, benefiting stakeholders through environmental gains, enhanced biodiversity, and economic savings. Automation measures, like 'Just-in-Time' arrivals, reduce anchoring duration and carbon footprint, aligning with national emission reduction targets. The corridors support sustainable maritime practices as well as efficiency improvements.

Initiatives towards Decarbonisation

Strategies to Minimise GHG Emissions:

The IMO Marine Environment Protection Committee (MEPC) 80 and 81 meetings have accelerated decarbonisation efforts by implementing the Energy Efficiency Existing Ship Index (EEXI) along with the Carbon Intensity Indicator (CII). Key initiatives to reduce GHG emissions include optimising operational measures, enhancing hydrodynamic performance, negotiating better commercial agreements with charterers, and considering alternative fuels.

Speed optimisation is a cost-effective method to reduce fuel consumption without affecting charter rates, enhancing climate impact without sacrificing financial returns. However, a unified effort among stakeholders is still lacking.

Improving a ship's hydrodynamic performance, influenced by contracted speed, requires collaboration among shipyards, owners, charterers, and the IMO. This involves redesigning or improving propellers, optimising hull design, and implementing drag reduction measures.

Future technologies like carbon capture and alternative fuels are crucial for achieving net-zero emissions by 2050. **The number of dual-fuel ships has increased from 10% to 18% in 2023**. According to DNV study and DNV Alternative Fuel Insights (AFI) platform, around 20 to 25 ammonia-powered vessels have been ordered in the last 12 months, with deliveries scheduled for 2026-2027. However, it remains unclear if the vessels will operate on alternative fuels immediately or in the future.

Ship owners must consider availability, regulatory compliance, technical considerations, and business feasibility when ordering ships using alternative fuels. Currently, rules for ammonia and hydrogen are not fully established, while methanol has interim guidelines. **The IMO is developing comprehensive international standards for fuels other than LNG while the Cargoes and Containers (CCC) Committee is updating the IGC and IGF codes with new regulations**.

Initiatives towards Decarbonisation

IMO Measures

The IMO is committed to addressing climate change in line with UN Sustainable Development Goal 13 by reducing greenhouse gas emissions from international shipping and promoting an equitable transition.

At its 81st session, the Marine Environment Protection Committee (MEPC) approved the "IMO net-zero framework" to reduce GHG emissions. This includes the 2024 Guidelines on the Ship Energy Efficiency Management Plan (SEEMP) and 2022 fuel consumption data for ship energy efficiency. The session also tackled marine litter through better reporting procedures, implemented the Ballast Water Management Convention, and adopted the Hong Kong Convention on ship recycling. Additional measures included amending MARPOL Annex VI for marine diesel engine replacement and endorsing an underwater noise reduction action plan.

The IMO CARES project, funded by Saudi Arabia, helps developing countries meet IMO Energy Efficiency and GHG Strategy targets. Key activities include the Maritime Technology Global Challenge, Knowledge Network, CARES Connects Networking Event, and the IMO CARES Technology Report to accelerate maritime decarbonisation.

On February 23, 2024, UN member states adopted the Inland Transport Committee's (ITC) Strategy on Reducing Greenhouse Gas Emissions from Inland Transport. This strategy involves 61 UN inland transport legal instruments designed to improve transport sustainability and tackle climate change. It includes the European Agreement on Main International Railway Lines and Main Inland Waterways of International Importance. The strategy harmonises the measurement of vehicle fuel consumption and CO2 emissions, promoting alternative fuel sources.

Stage wise Progression – 2030 and 2050

There is a greater commitment to ensure the adoption of alternative zero plus near-zero GHG fuels by 2030. **Suggested milestones are at least 20% to 30% reduction in net-zero GHG emissions by 2030 and 70% to 80% by 2040**. The measures are expected to contribute to a more ambitious goal of achieving net-zero GHG emissions by or around 2050.

Comparison of the 2018 and 2023 IMO GHG Strategies

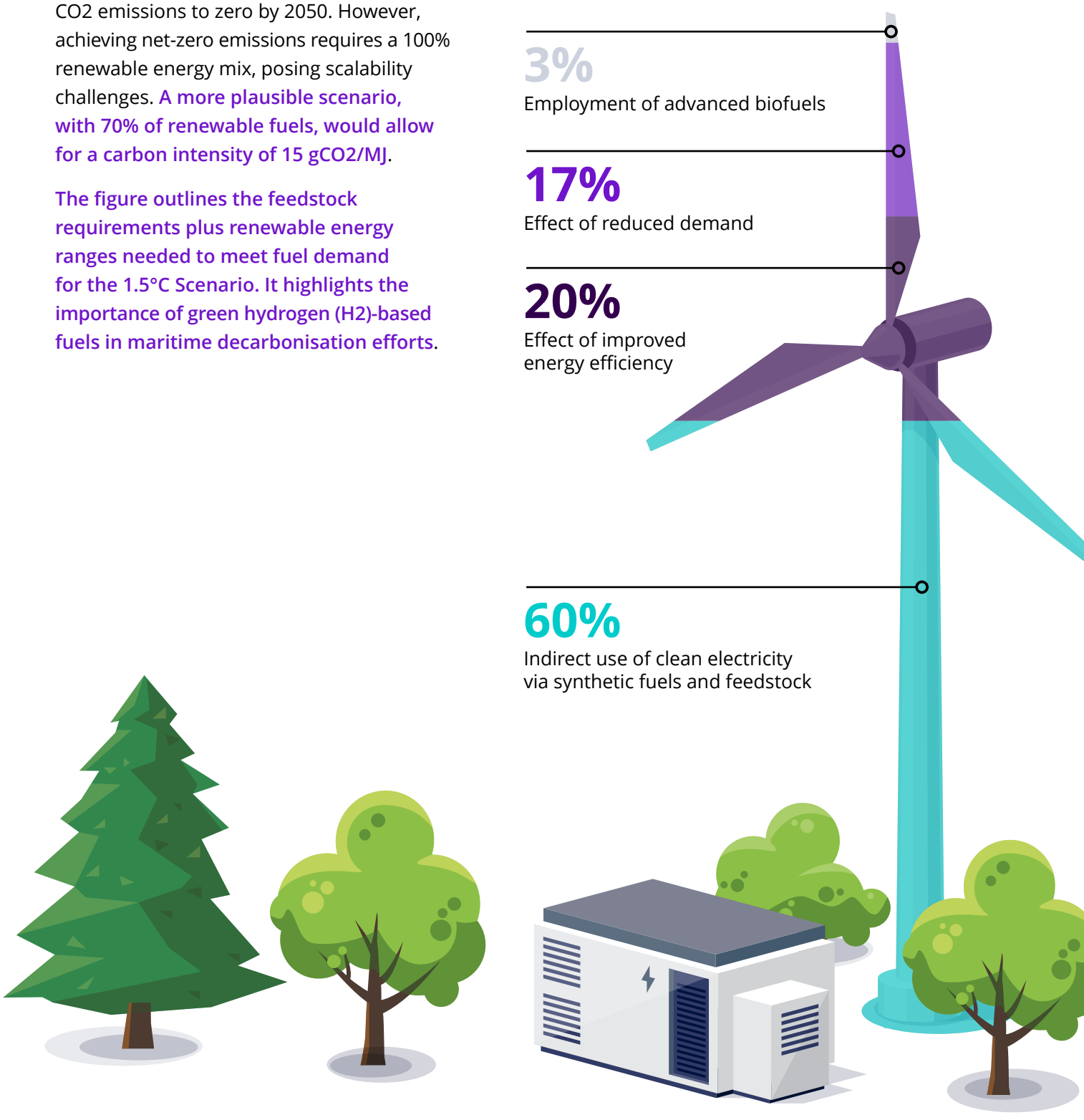
	2018 initial GHG Strategy	2023 revised GHG Strategy
Absolute emission reduction	2050: at least 50%	2030: 20%, striving for 30% 2040: 70%, striving for 80%
Emission intensity	2030: at least 40%	2030: at least 40%
Fuel uptake target	_____ _____	2030: 5% striving for 10%
Just and equitable transition	_____ _____	Measures included
Policy measures	List potential short-term, medium- term and long-term measures	Commits to the adoption of mid-term measures by 2025, including technical and economic measures
Scope	Tank-to wake carbon emissions	Well to wake GHG emissions

IRENA's 1.5°C Scenario

The International Renewable Energy Agency's (IREA) 1.5°C Scenario aims to limit global temperature rise to 1.5°C and bring CO2 emissions to zero by 2050. However, achieving net-zero emissions requires a 100% renewable energy mix, posing scalability challenges. **A more plausible scenario, with 70% of renewable fuels, would allow for a carbon intensity of 15 gCO2/MJ**.

The figure outlines the feedstock requirements plus renewable energy ranges needed to meet fuel demand for the 1.5°C Scenario. It highlights the importance of green hydrogen (H2)-based fuels in maritime decarbonisation efforts.

Estimated role of key C02 emission reduction measures associated with IRENA's 1.5°C Scenario

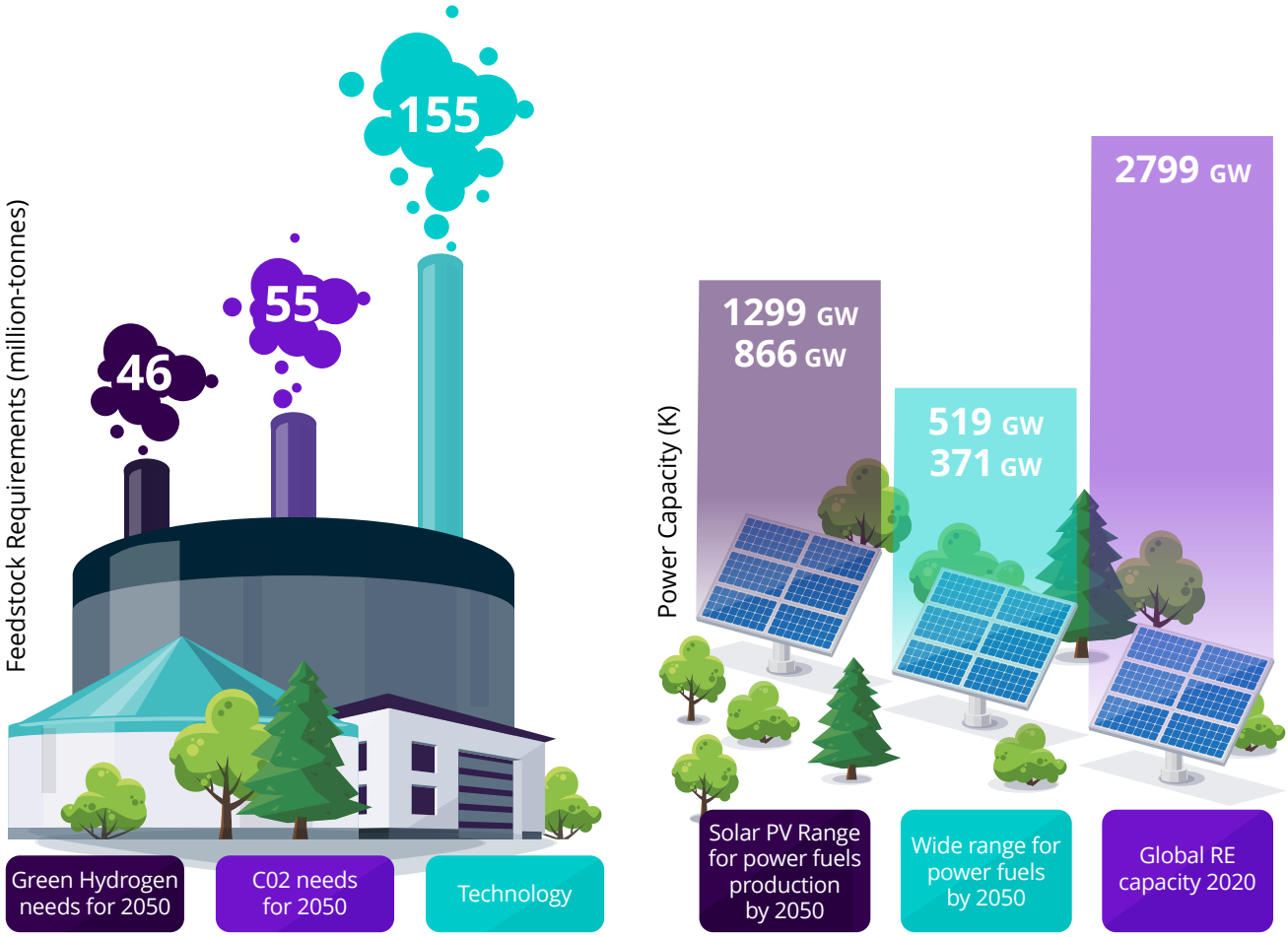


IRENA's 1.5°C Scenario

Green H2 demand is projected to be 46 metric tonnes by 2050. About 74% of the amount will be used to produce ammonia, 16% for methanol, along with 10% for green hydrogen.

The graph depicts the expected ranges of solar and wind power required to meet the requisite amounts of green hydrogen. However, various factors will determine the actual capacity of renewable energy to be deployed until 2050. The final energy capacity will be influenced by the renewable power technology used and the average capacity factors associated with each renewable energy plant.

Feedstock requirements and range of renewable energy deployment associated with the inclusion of powerfuels in the 1.5°C Scenario by 2050



Regional Approach to Decarbonisation in the Maritime Industry

European Union (EU):

Over the past five years, the EU has strengthened its influence in international shipping through stringent environmental regulations. **The World Shipbuilding Council (WSC) aims for global agreements at the IMO by 2025, supported by EU member states at MEPC 83**. The EU is aligning its EU Emissions Trading System (EU ETS) and FuelEU Maritime regulations to cover emissions from well to wake, emphasising sustainability across the maritime sector.

United Kingdom:

The UK government has integrated international shipping emissions into its net-zero strategy, guided by the Climate Change Committee and included in the sixth carbon budget starting 2033. **Plans are underway to incorporate emission standards into the Nationally Determined Contribution for 2035, focusing on enhancing operational efficiency and reducing onboard fuel storage**. The Clean Maritime Plan, aligning with IMO decarbonisation goals, is set for release in September 2024.

Regional Initiatives:

- **EU ETS:** A pivotal driver for decarbonisation, recent reforms under the Fit for 55 packages aim for a 55% emissions reduction by 2030, marked by increased CO2 allowance prices to incentivise fossil fuel reduction.
- **UK's Carbon Border Tax Proposal:** Scheduled for implementation from 2027, this mechanism plans a 14-24% tax on imports from countries with less stringent environmental standards, currently in consultation phase for 2024.

Renewable Fuels and Technology Readiness

Alternative fuels like ammonia, methanol, LNG, hydrogen, and biofuels are key to long-term decarbonisation, leveraging renewable energy. Very Low Sulphur Fuel Oil (VLSFO), Ultra Low Sulphur Fuel Oil (ULSFO), marine diesel oil (MDO), and marine gas oil (MGO) can also reduce emissions as well as promote sustainability.

Ethanol, especially bio-ethanol and Hydrotreated Vegetable Oil (HVO), shows promise in lowering GHG emissions with reduced toxicity. In 2023, **Raizen and Wartsila** partnered to advance maritime decarbonisation. Wärtsilä's tests with ethanol as a primary fuel and the use of cellulosic ethanol in its Sustainable Fuels labs highlight the integration of clean energy solutions in the maritime sector.

Pathways for Alternative Fuels

The marine fuel value chain involves two critical processes: Well-to-Tank (WtT) and Tank-to-Wake (TtW). TtW emissions are substantial due to vessel operations. WtT begins with feedstock exploration, processing, refining, and transport to port storage.

Three color-coded pathways in the marine fuel value chain are identified for studying safety, emissions, and cost-effectiveness of the WtT process of promising alternative fuels.

- Gray pathway or fossil fuel-based chain without carbon capture and storage (CCS)
- Blue pathway or fossil fuel-based chain with CCS
- Green pathway or renewable energy-based marine fuel value chain

Renewable Fuels and Technology Readiness

Gray Fuel Pathways dominate global marine fuel production despite rising efforts to reduce GHG emissions. Methanol, hydrogen, and ammonia notably emit more GHGs than VLSFO, underscoring the urgent need for an industry-wide energy transition to meet the IMO's 2030 decarbonisation targets.

By 2030, conventional fuel usage in the shipping fleet is projected to drop below 80%, though nearly half will still rely on conventional diesel by 2050. Achieving carbon net-zero by 2050 may involve introducing e-diesel or biodiesel alongside expanding onboard CCS systems. Energy Efficient Technologies (EETs) offer further potential for enhancing the efficiency of conventional fuel-powered vessels.

Blue Fuel Pathways, including blue fuels, e-fuels, and biofuels to meet well-to-wake (WtW) GHG emission targets 2050. The carbon neutral channels present viable long-term solutions to meet decarbonisation goals. The initiatives aim to decrease GHG to reach net zero in comparison to the emission levels in 2008. Blue hydrogen, blue methanol, and blue ammonia are identified as effective alternatives. Blue hydrogen and ammonia show more immediate promise while blue methanol faces significant challenges in meeting short-term decarbonisation goals. Addressing uncertainties in carbon offsetting and enhancing blue hydrogen's utilisation are crucial for advancing the pathways in the near term.

Furthermore, blue hydrogen is produced using fossil fuels signifying a carbon footprint in its manufacturing process. Biofuels are another viable alternative as part of the blue fuel category. However, the volume of biofuels needed by the maritime sector and the amount of biological resources required to produce a sustainable quality presents substantial problems. The bio-resouces channeled towards production of fuels is likely to impact food production in developing nations in Africa and Asia, presenting an ethical dilemma in its usage.

Renewable Fuels and Technology Readiness

Green Fuel Pathways: Maritime industries, specifically Marine e-fuels (or electrofuels), are renewable non-biological fuels produced through electrolysis using renewable energy. This includes energy carriers like e-diesel, e-methanol, and e-methane, prized for the fuels' potential to leverage renewable electricity in shipping applications.

Recognising the fuels' pivotal role, the IMO has endorsed e-fuel pathways to achieve its 2030 decarbonisation targets. However, significant variations in emission factors exist among e-ammonia, e-methanol, and e-diesel. The GHG emission intensities of e-fuels along the WtW marine fuel chain remain dynamic, benefiting from advancements in green technologies and infrastructure.

To maintain the integrity of carbon markets and alternative fuel pathways, challenges in carbon offsets for non-carbon-free fuel pathways can be addressed through improved measurement methodology. Additional factors include governance frameworks, enhanced standards, transparency, and third-party verification to prevent greenwashing to ensure decarbonisation initiatives are successful.

Black Carbon Emissions Effects on Global Warming Potential

Black carbon, a dark particulate matter from fossil fuel combustion, significantly amplifies global warming by absorbing solar radiation. The shipping industry employs EETs to reduce CO2 emissions and enhance energy performance. EETs optimise ship designs through improved propeller propulsion, reduced hull friction, and integration of solar or wind energy. Compatibility among EETs is critical during retrofitting to maximise benefits. The IMO's Green Voyage 2050 project highlights cost-effective EETs that align with the IMO GHG Strategy, emphasising sustainable advancements in maritime decarbonisation.

Key Transformational Technologies

The shipping industry is advancing towards net-zero goals with innovations like Onboard Carbon Capture and Storage (OCCS) and Wind Assisted Propulsion Systems (WAPS). OCCS captures and stores CO2 onboard through various combustion processes, enhancing energy efficiency plus reducing nitrogen oxide emissions. WAPS, including rotor, wing, suction, as well as kite sails, improve vessel efficiency while cutting fuel consumption and emissions. These technologies represent crucial steps towards sustainable shipping practices.

The maritime industry is exploring shore power to decarbonise, allowing vessels to shut down engines temporarily and reduce fuel consumption and emissions by up to 10%. Hybrid engines can save 17% more fuel than diesel engines, though shore power infrastructure is still underdeveloped. Cruise ships significantly contribute to greenhouse gas emissions, with hotel systems using 40% of onboard energy. Solar panels offer a viable solution, meeting energy needs sustainably. Focus is now on alternative energy sources, regulatory frameworks, financial incentives, and waste heat recovery technologies to achieve the IMO's decarbonisation targets.

To achieve significant emission reductions, ships must minimise total energy usage. Measures like increased insulation, improved windows, PCM layers, and efficient heating plus ventilation can save substantial energy. Air lubrication technology reduces frictional resistance, enhancing fuel efficiency and compliance. Digitalisation is transforming the marine industry, with IoT sensors and machine learning enabling remote monitoring along with predictive analytics for speed optimisation. Digital twin technology and AI-driven systems support the use of alternative fuels. Operators use these tools for regulatory compliance in addition to identifying improvements in fuel use and emissions.

Big Data weather routing is vital for decarbonising shipping. The Wayfinder platform optimises voyages by analysing weather forecasts, business metrics, and strategic initiatives, enhancing safety and efficiency. Real-time recommendations help operators dynamically adjust voyages. Similarly, the ZeroNorth platform integrates weather routing into voyage planning, ensuring routes consider meteorological factors for safety, sustainability, and commercial success. It transparently calculates CO2 and cost impacts, transforming commercial aspects and improving decarbonisation efforts.

Alternative Fuels - Beyond the Engine

Alternative fuels represent a pivotal pathway towards decarbonising the shipping industry beyond conventional engines. Key drivers include electrification, nuclear energy, and advanced digital technologies. Lithium-ion batteries and fuel cells, for instance, facilitate a shift from fossil fuels, offering higher energy density as well as lower emissions. Complemented by carbon capture systems, the technology marks a significant stride towards sustainability.

Lithium-ion batteries, employing technologies like lithium-polymer and metal halide, enhance energy storage capabilities. Fuel cells, meanwhile, convert fuel into electricity efficiently, albeit using costly materials and facing transient load challenges. Nuclear and renewable energy integration presents another promising avenue, aiming for net-zero emissions by 2050. Nuclear power uniquely supports clean fuel production, hydrogen generation, and serves as a primary power source.

Moreover, advanced reactors show promise in producing e-fuels such as e-ammonia and e-methanol, vital for sustainable shipping. Rapid digitalisation further bolsters this transformative journey towards zero emissions in maritime operations. The innovations underscore a multifaceted approach crucial for a sustainable future at sea.

Offshore Industry Insights

Sectors currently contribute 16% to the global energy mix but face mounting regulatory pressure to transition towards cleaner energy solutions. Companies are striving for near-zero methane emissions and zero greenhouse gas emissions.

Global offshore wind power capacity is projected to increase tenfold to 350 gigawatts by 2030. Analysis of global energy sources includes oil, gas, as well as wind under two scenarios: gradual transition and rapid decarbonisation.

Offshore hydrogen production is promising but hindered by high costs. **CCUS deployment has surged, with over 500 projects in development stages, set to capture an estimated total of 6040 million tonnes of CO2 by 2050**.

Offshore sustainability initiatives also address critical issues such as the carbon market's role in emission reduction, stringent methane emissions monitoring, and biodiversity preservation. The efforts aim to mitigate environmental impacts from offshore activities, spanning oil and gas operations, offshore wind farms, along with CCUS projects.

Key Takeaways

The IMO strives for a sustainable maritime future with low-carbon fuels like green hydrogen, ammonia, biofuels, and LNG. A 50/50 mix of heavy fuel oil and hydrogen can cut CO2 emissions by up to 43% per unit of distance traveled. Hydrogen-based fuels, including ammonia, E-LNG, E-diesel, and E-methanol, are crucial for decarbonising the sector.

According to the International Energy Agency (IEA), green hydrogen has a 90% lower greenhouse gas footprint than traditional fuels. Achieving net-zero by 2050 requires 59.5 million tonnes of hydrogen annually for direct use and clean fuel production. The IEA also estimates an additional 600TWh of renewable energy to meet hydrogen demand, requiring 230GW of installed wind and solar capacity.

Over 2,200 projects for carbon-neutral fuels are in planning, with container vessel modifications needed for clean fuel transition. The maritime industry faces rising energy demands, net-zero targets by 2050, and volatile fuel costs. Success depends on scalable, accessible alternative fuels, supportive policies, green fuel innovation, carbon capture advancements, and cost efficiencies. A strong carbon pricing mechanism can shift LNG, ammonia, and methanol towards renewable sources.

Fuel flexibility is vital, highlighting the need for diverse fuel bunkering infrastructure. Innovation in clean fuels and propulsion technologies, like hydrogen along with biofuels, will drive this transition. Collaboration among shipping companies, fuel producers, port authorities, and governments is essential to accelerate decarbonisation, ensuring a sustainable future for the industry.

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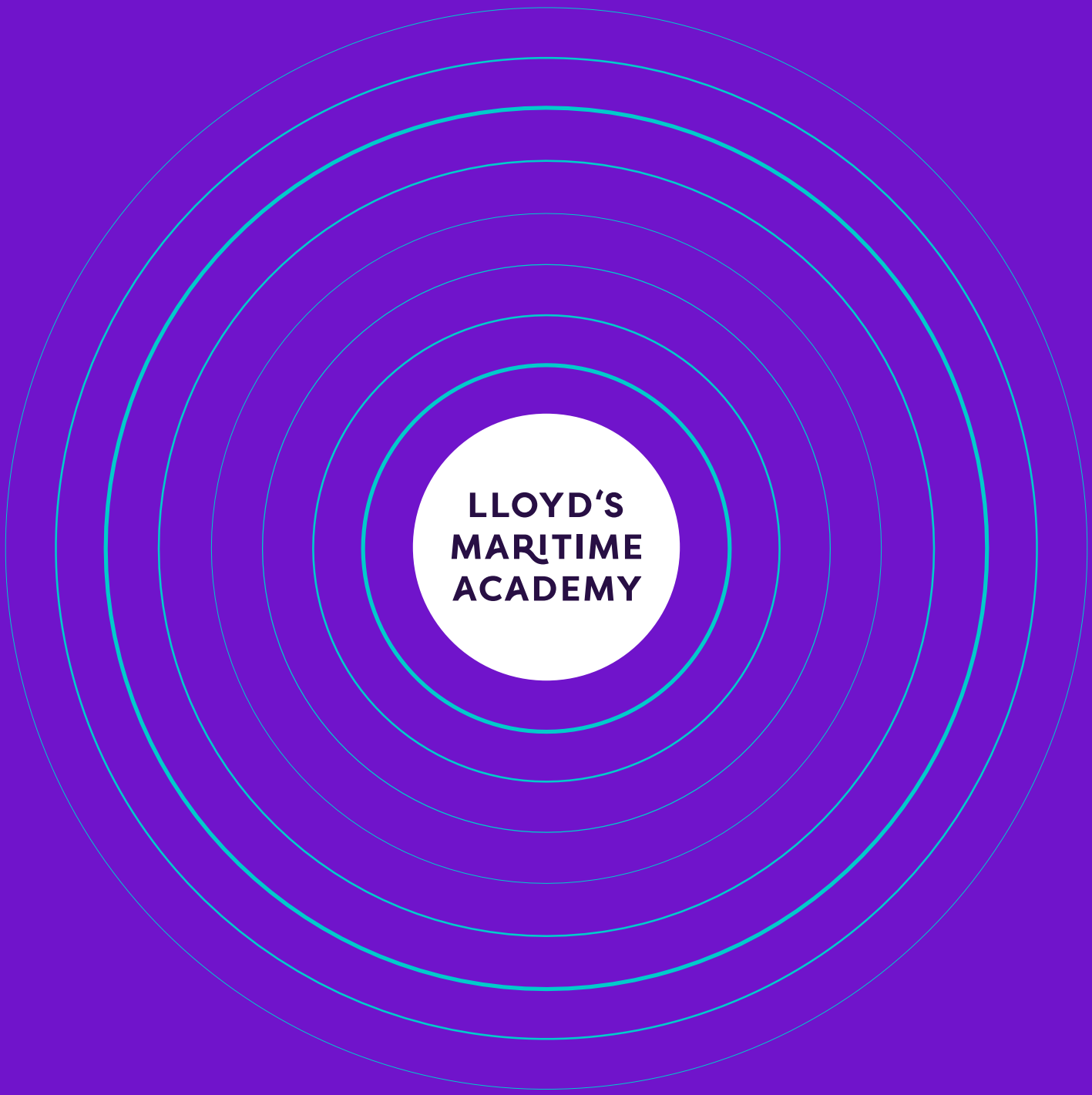

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