

PORT GEAR

- hard- & software for better operations -



The Port of Opportunities

The Port of HaminaKotka is a multipurpose seaport serving trade and industry. This major Finnish port is an important hub in Europe and in the Baltic Sea region.

Welcome to the Port of HaminaKotka!



DEAR READERS,

The maritime and logistics community is no longer just talking about the future; it's actively engineering it. As we move through 2026, the industry has reached a tipping point where digital promises finally might have the chance of translating into profitable, real-world deliveries. In this issue, we dive deep into the twin currents pushing our sector ahead: decarbonization and intelligence.

The path to net-zero is becoming more tangible, but also more scrutinized. From the high-stakes potential of nuclear propulsion and battery retrofits to the practical realities of on-board carbon capture, we explore the tech that is moving the needle. However, we also pause to ask the tough question whether the green credentials of our future fuels truly up to the task?

AI is no longer a buzzword; it is a bridge-side ally and an intralogistics reinventer. We take you on a ride to witness the evolution from reactive to responsive operations and introduce a new standard for trustworthy industrial AI. That said, we remain focused on the human element. Whether it is an interview on the human part in the tech mix or our two-part deep dive into designing danger out of cargo handling, safety remains our North Star.

Beyond these pages, we invite you to join us for a hands-on deep dive into infrastructure deployment. The Port Gear Team is hosting an exclusive **OPS Seminar & Study Visit** at the **Port of Hamburg** on **26 June 2026**. Designed specifically for decision-makers and technology leads, this event prioritizes technical depth over marketing narratives, offering a platform for rigorous discourse and the precise data needed to energize your port projects forward. We look forward to seeing you there and continuing the conversation in person. Until then, enjoy the read!



THE HARBOUR IN HAMBURG BY HEINRICH HILLER, PHOTO: ARTVEE

PORT GEAR

Publisher

BALTIC PRESS SP. Z O.O.
Address: Aleja Zwycięstwa 96/98
81-451 Gdynia, Poland
office@baltictransportjournal.com

portgear.org

www.baltictransportjournal.com
www.europeantransportmaps.com
www.linkedin.com/company/baltic-transport-journal

President of the Board
BOGDAN OŁDAKOWSKI

Managing Director
PRZEMYSŁAW OPIŁOCKI

Editor-in-Chief
PRZEMYSŁAW MYSZKA
przemek@baltictransportjournal.com

Issue Editor
ANDRZEJ URBAŚ

Proofreading Editor
EWA KOCHAŃSKA

Contributing Writers
JOY BASU, MICHELLE COTTET, PHILIPPOS IOULIANOU,
ALEXA IVY, ROB MORTIMER, EMIN NAKILCIOĞLU,
DOR RAVIV, OLIVER SCHMITZ, FITZWILLIAM SCOTT,
RICHARD STEELE, MELANIE TERNE

Art Director/DTP
DANUTA SAWICKA

Head of Marketing & Sales
PRZEMYSŁAW OPIŁOCKI
po@baltictransportjournal.com

If you wish to share your feedback or have information for us, do not hesitate to contact us at: editorial@baltictransportjournal.com

Contact us:
PRZEMYSŁAW OPIŁOCKI
tel.: +48 603 520 020

Cover
Canva

 PORT GEAR
— build & advance the better operations —



Subscriptions

Go to www.baltictransportjournal.com and click: **SUBSCRIPTION** or contact us at subscription@baltictransportjournal.com

170+ operators
620+ ports
1,130+ services
1,150+ terminals



EUROPEAN
TRANSPORT
MAPS

EUROPE:

all over the ro-ro & ferry,
container, and rail maps

www.europeantransportmaps.com



- 9 Hanseatic Global Terminals Acquires Full Ownership of FIT Expansion Project Deepens HMM and TTI Algeciras Cooperation Damen Hosts Kick-off for Turkish Coast Guard SAR Vessel Order PSW Power & Automation to Deliver Megawatt Charging System in Geiranger
Kalmar to Deliver Hybrid Straddle Carriers to PSA Antwerp
- 11 Liebherr Reports Stable Growth and Record Revenue in 2025 AMLab Secures Major European Contracts for LiDAR Crane Systems ONE Acquires 30% Stake in Hutchison Laemchabang Terminal Port Houston Reports Cargo Growth in February Port of London Trade Reaches Highest Level Since 1973
- 12 APM Terminals Becomes Minority Shareholder and Operating Partner in HHIT...
... and launches Phase II in Lázaro Cárdenas Launches, While Announcing Major Phase III Investment Valenciaport Launches Climate Change Adaptation Strategy Singapore Signs Multiple MOUs Fostering Innovation
- 13 Wallenius Wilhelmsen Strengthens Position in 2025 Annual Report Kongsberg Maritime to Supply Waterjets for Indian Navy's NGMV Programme
Liebherr RL 2600 Crane Selected for Offshore Project in Azerbaijan
- 14 Hapag-Lloyd Reports 2025 Annual Results and Proposes Dividend Cavotec Wins EUR 3m Shore Power Order for Southern Italian Ports CMA CGM Foundation Delivers 800 Tonnes of Humanitarian Aid to Lebanon
Van Oord Reports Record Profits and Strong Operational Growth CMA CGM Initiates Phase 2 Expansion of Gemalink Container Terminal
- 15 Georgia Ports Authority to Open New Gainesville Inland Port in May Maersk Opens Fully Automated Distribution Centre in Singapore ICTSI Launches US\$800m South Luzon Container Terminal Port of Rotterdam Secures EU Financing for Shore Power Expansion
- 16 NorthPort Advances Pier 14 Infrastructure Upgrades Yilport Adds 19 New Konecranes Lift Trucks to its Fleet MSC Group Secures 45-Year Concession for Snake Island Terminal Antwerp-Bruges and ZES Eyeing Zero-Emission Inland Shipping
- 17 Singapore Updates Maritime Operations with OCEANS-X Platform and AI Partnership
MUA Urges AI Regulation to Protect Australian Ports and Jobs KR Launches AI-Integrated 'SeaTrust Software Hub'
- 18 Vancouver and GCT Partner to Advance Roberts Bank Terminal 2 Port of Seattle Launches 2026 Cruise Season Project44 Introduces AI Freight Procurement Agent
- 19 Long Beach, Los Angeles and Singapore Renew MoU Extending Green and Digital Shipping Corridor OPCSA Expands Hybrid RTG Fleet at Port of Las Palmas
- 20 Suez Canal Authority and ICS Sign Long-term Cooperation MoU Teignmouth Completes Heavy-Lift Project for National Grid TransTec to Adopt Electric Empty Container Handlers San Pedro Bay Ports Release Cargo Equipment Feasibility Assessment
- 21 WPU (Vitol) to Build Plastic Recycling Plant in Rotterdam Port of Long Beach Secures \$70m Federal Infrastructure Grant Port of Thessaloniki Reports Record Revenue and Profitability for 2025 Kalmar and Port of Tauranga Expand Eco-Efficient Fleet
- 23 Togo Container Terminal Expands Fleet with Nine Lift Trucks Kuenz and ABB to Deliver Nine Stacking Cranes for TraPac Los Angeles





BEST ACTOR



BEST FILM



BEST PRODUCER

WHAT A RIDE.

BEST PRODUCTION IN YEARS

Cine Truck Magazine

ELME DOES IT

YEAR OUT AND YEAR IN

Terminal Harbour Movie

THE Spreader

BASED ON FICTION

The until-now untold story of 'The Spreader'

A hard working thriller

AN ELME SPREADER PRODUCTION

ELME
Swedish Spreader Systems

24 THE (ZERO-EMISSION) PRIZE AT THE END OF THE (LONG) RACE

- *Tech & regulatory developments towards nuclear ship propulsion*
ALEXA IVY

26 FROM SPECULATION TO ENGINEERING

- *A requirements-led foundation for container ship design*
FITZWILLIAM SCOTT

28 CURE WORSE THAN ILLNESS?

- *A call for rigorously scrutinising the green credentials of future fuels*
ROB MORTIMER

30 THE HUMAN PART IN THE TECH MIX

- *Interview with Espen Ranvik, CEO, Grieg Connect*
PRZEMYSŁAW MYŚKA

34 FROM REACTIVE TO RESPONSIVE

- *KILOG's AI journey at HHLA terminals*
OLIVER SCHMITZ AND EMIN NAKILCIOĞLU

36 YOUR NEW ALLY ON THE BRIDGE

- *AI's potential for safer & smarter navigation in the busy Baltic waters*
DOR RAVIV

38 MIST, POWER, ACTION! COOLING MODERN LOGISTICS

- *Interview with Fredrik Rönngvist and Gustav Stigsohn, Fogmaker (Material Handling/Development)*
ANDRZEJ URBAŚ

40 CHAPTER SEALED

- *The year when digital transformation goes from optional promises to profitable deliveries*
JOY BASU

42 TRUSTWORTHY INDUSTRIAL AI IN INTRALOGISTICS

- *Presenting the M-AIR network*
MELANIE TERNE

44 SAFETY REFINED MANY A WAY

- *Designing danger out of cargo handling – part one*
RICHARD STEELE

46 BRIGHTER – SAFER – FUTURE

- *Designing danger out of cargo handling – part two*
RICHARD STEELE

48 BUILT TO EVOLVE

- *Inside the world's largest marine battery retrofit*
MICHELLE COTTET

52 CLOSING THE LOOP(S)

- *An end-to-end trial reveals that on-board carbon capture works – and how it can work better*
EWA KOCHAŃSKA

58 DECARBONISATION BY REVOLUTION SYSTEMS ENGINEERING

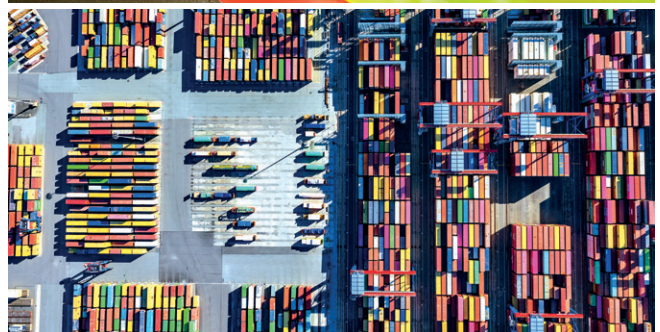
- *Why 2026 will redefine shipping's path to net-zero*
PHILIPPOS IOULIANOU

60 THE RAW REALITY

- *Where are the material resources needed to feed Europe's energy transition?*
EWA KOCHAŃSKA

66 ONSHORE POWER SUPPLY: JOIN THE STUDY VISIT AND SEMINAR AT THE PORT OF HAMBURG

- ANDRZEJ URBAŚ



FOGMAKER

INTERNATIONAL AB

Protect Lives and Equipment

Minimize the risk of downtime and damages with Fogmaker's fire suppression system!

ECO

1 PFAS-Free
for the
Future!



The Fogmaker fire suppression system is tailor-made for each type of material handling equipment. High-pressure water-based mist chokes fires quickly and cools the area to prevent reignition. Automatic, independent of electricity, with 100% PFAS-Free liquid, and always ready!

www.fogmaker.com

HANSEATIC GLOBAL TERMINALS ACQUIRES FULL OWNERSHIP OF FIT

Hanseatic Global Terminals has completed a capital structure adjustment with Grupo Empresas Navieras and its affiliate Agunsa USA, Inc. to become the sole owner of Florida International Terminal, LLC (FIT). The transaction, finalized in April 2026, results in the exit of AGUNSA from its minority position as part of a strategic portfolio streamlining. Located in Port Everglades, South Florida, FIT serves as a critical hub for container and general cargo handling in one of the world's largest consumer markets.

The facility offers direct connectivity to major rail and high-way networks, ensuring efficient intermodal transportation and access to the regional hinterland. Established in 2023 as an independent entity within the Hapag-Lloyd Group, Hanseatic Global Terminals currently manages 21 port terminals across 11 countries. This acquisition aligns with the company's 2030 strategy to expand its global footprint to approximately 30 terminals, reinforcing its position as a leading international terminal operator.

EXPANSION PROJECT DEEPENS HMM AND TTI ALGECIRAS COOPERATION

HMM and TTI Algeciras have solidified their strategic cooperation following the official approval of the Phase B expansion project at the Port of Algeciras. This development marks a significant milestone in the long-term relationship between the South Korean carrier and the terminal operator, aimed at enhancing transshipment capabilities in Southern Europe. The partnership supports HMM's broader strategy to secure a competitive edge on European trade routes while managing its expanding fleet through a dedicated Mediterranean hub. The collaborative project involves a €150m investment to extend the terminal by 160,000 square meters at the Isla Verde Exterior. This expansion is set to increase TTI Algeciras's annual handling capacity from 1.6 million to 2.1m TEUs by 2028, with a future target of 2.8 million TEUs. As part of this renewed commitment, the terminal's operating concession has been extended until 2065, providing a stable foundation for HMM and its partners to grow their logistics operations over the coming decades.

DAMEN HOSTS KICK-OFF FOR TURKISH COAST GUARD SAR VESSEL ORDER

Damen Shipyards Antalya recently hosted a kick-off meeting with delegations from the International Organization for Migration (IOM), the Turkish Coast Guard (TURCG), and the European Union to mark a new contract for thirteen Search and Rescue (SAR) 1906 vessels. This initiative is part of an EU-funded project designed to enhance the operational capacity of the Turkish Coast Guard. The order follows the successful deployment of fifteen similar vessels delivered in 2016 and 2019, which have already contributed to saving over 27,000 lives. The thirteen new vessels will be constructed locally at Damen Shipyards Antalya, with deliveries scheduled throughout 2027 and 2028. This production cycle leverages a local maritime supply chain and a specialized regional workforce capable of delivering approximately 28 vessels annually. The project reinforces the long-standing partnership between Damen, the IOM, and Turkish authorities to support critical life-saving operations at sea. The SAR 1906 is a 19.5-meter aluminum craft featuring a Damen Sea Axe bow for high fuel efficiency and a self-righting capability for extreme weather conditions. Capable of reaching speeds up to 30 knots, each vessel can carry a crew of six and up to 120 survivors. Current data shows the existing fleet maintains over 90% operational availability, providing a reliable platform for the Turkish Coast Guard's ongoing search-and-rescue missions.

PSW POWER & AUTOMATION TO DELIVER MEGAWATT CHARGING SYSTEM IN GEIRANGER

PSW Power & Automation has signed an agreement with Plug to deliver a battery-integrated Megawatt Charging System (MCS) for zero-emission vessels. The system features an 8.3MWh Battery Energy Storage System (BESS) combined with a smart energy management system to enable rapid charging for fast ferries while ensuring grid stabilization. The solution will be located in Geiranger, a UNESCO World Heritage site, to support the transition to greener maritime operations in a protected natural environment. By integrating shore power with battery storage, the system reduces strain on the local grid and optimizes energy supply, storage, and consumption through a coordinated approach.

KALMAR TO DELIVER HYBRID STRADDLE CARRIERS TO PSA ANTWERP

Kalmar has signed an agreement to supply 14 hybrid straddle carriers to PSA Antwerp in Belgium. The order, which was recorded in Kalmar's Q1 2026 intake, is part of PSA Antwerp's broader strategy to modernize its terminal equipment and enhance the eco-efficiency of its cargo-handling operations at the Port of Antwerp-Bruges. The hybrid straddle carriers utilize a battery system combined with a diesel engine to recover and reuse energy. This technology significantly reduces fuel consumption and CO₂ emissions compared to traditional diesel-powered machines. The units are scheduled for delivery in the fourth quarter of 2026.



PHOTO: PSW POWER & AUTOMATION



PHOTO: KALMAR

TOC

EUROPE

Events | Live & Digital Content | Networking

19 - 21 May 2026
Hamburg Messe, Germany



THE AGM FOR PORT & CARGO SUPPLY CHAIN PROFESSIONALS



Register Now!

Join the conversation online #TOCEurope



www.tocevents-europe.com

LIEBHERR REPORTS STABLE GROWTH AND RECORD REVENUE IN 2025

The Liebherr Group concluded the 2025 business year with a total revenue of €14,772m, representing a 1.0% increase of €150m compared to the previous year. This growth was supported by the Group's broad diversification and decentralized structure, which helped offset declines in specific sectors. While the construction machine and mining sectors saw a revenue drop of 5.5% to €9,345m, other segments including maritime cranes, aerospace, and refrigerators achieved a significant combined growth of 14.7%, totaling €5,427m. Investment remained high at €1,059m, with €708m specifically allocated to research and development. Key milestones included the unveiling of autonomous wheel loaders and battery-electric crawler excavators at Bauma 2025, alongside advancements in digital solutions and alternative drive technologies. Geographically, growth was driven by the European Union, particularly Germany, as well as regions in Central and South America, Africa, and the Middle East. The Group's workforce also expanded by 1,235 employees, reaching a total of 55,963 worldwide. The Group achieved a net income of €272m for the year.



ONE ACQUIRES 30% STAKE IN HUTCHISON LAEMCHABANG TERMINAL

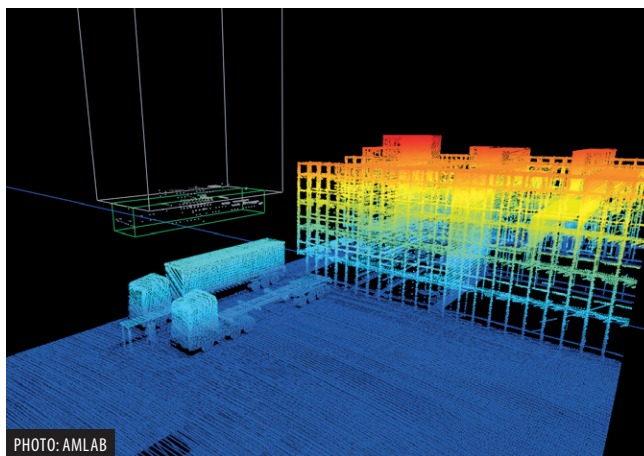
Ocean Network Express (ONE) has signed a share purchase agreement for a 30% stake in Hutchison Laemchabang Terminal Limited (HLT) in Thailand. This strategic investment in the Eastern Economic Corridor secures long-term access to competitive capacity in a primary Southeast Asian gateway. The acquisition is currently subject to customary closing conditions and regulatory approvals. HLT is the leading deep-water operator at Laem Chabang Port, managing the highly automated Terminal D as well as Terminals C1, C2, and A3. By deepening its partnership with Hutchison Ports, ONE intends to leverage advanced port technology to improve service reliability. The move aligns with the company's global strategy to secure infrastructure in essential trade hubs.

PORT OF LONDON TRADE REACHES HIGHEST LEVEL SINCE 1973

Trade through the Port of London reached a 50-year high in 2025, with nearly 57 million tonnes of cargo passing through the facility. According to the Port of London Authority's (PLA) Annual Trade Report, this represents a 9% year-on-year increase and the highest volume recorded since 1973. The results solidify the port's position as the UK's largest, driven by significant growth in both traditional and emerging cargo sectors. The growth was led by a 23% increase

AMLAB SECURES MAJOR EUROPEAN CONTRACTS FOR LIDAR CRANE SYSTEMS

AMLab has been awarded two significant contracts to supply advanced LiDAR sensor systems for 34 Automated Rail Mounted Gantry (ARMG) cranes across Europe. These agreements mark a substantial expansion of the company's footprint in the European maritime and logistics sector, reinforcing the adoption of automated technology in port operations. The contracts involve the delivery of AMLab's proprietary sensor solutions designed to enhance the precision and safety of automated container handling. By integrating these LiDAR systems, the 34 ARMG cranes will achieve improved object detection and positioning capabilities, which are critical for maintaining high efficiency in high-throughput terminal environments. The implementation focuses on streamlining port workflows through robust automation, reducing manual intervention in crane operations.



PORT HOUSTON REPORTS CARGO GROWTH IN FEBRUARY

Port Houston handled 4,380,996 short tons across its public terminals in February, marking a 4% increase compared to the same month last year. This performance brings the year-to-date total to nearly 9 million short tons, representing a 5% overall rise. While container activity remained steady with 326,799 TEUs, loaded exports and imports grew by 5% and 3% respectively during the first two months of the year. The Port's multi-purpose facilities saw significant gains, with dry bulk volumes increasing by 28% and liquid bulk rising by 31%. To support this ongoing expansion, the Port Commission recently approved the construction of Wharf 1 at the Bayport Container Terminal, which will add 1,300 linear feet of space by 2028. This follows the recent opening of Wharf 7, both of which are designed to significantly increase berth capacity.

in container cargo, alongside rises in commodities such as grains, sugars, and vegetable oil. While imports continue to account for 80% of total tonnage, the report highlights a notable 30% surge in exports. Additionally, ethanol trade has grown by 60% over the last four years, reflecting the port's role in the transition toward sustainable aviation fuel, while sea-dredged aggregates for construction saw a decline of approximately one-third in the same period.

APM TERMINALS BECOMES MINORITY SHAREHOLDER AND OPERATING PARTNER IN HHIT...

APM Terminals has officially joined Hateco Group as a 49% minority shareholder and operating partner in the Hateco Haiphong International Container Terminal (HHIT). The strategic move follows three years of development and the successful ramp-up of the facility, which is now the largest and most advanced deep-water port in Northern Vietnam. Strategically located in the Lach Huyen area of Haiphong City, the terminal capitalizes on favorable natural conditions to facilitate direct trade between Northern Vietnam and major European and American markets. The terminal features two new deep-water berths capable of efficiently servicing mega-vessels with capacities of up to 18,000 TEU. Throughout the project's realization, APM Terminals has shared global best practices in safety, port automation, artificial intelligence, process optimization, and decarbonization. These technological advancements have already resulted in the highest berth productivities in the Port of Haiphong and set new records for automated gate operations, establishing HHIT as a benchmark for efficiency and sustainability in the region.



PHOTO: APM TERMINALS

... AND LAUNCHES PHASE II IN LÁZARO CÁRDENAS LAUNCHES, WHILE ANNOUNCING MAJOR PHASE III INVESTMENT

APM Terminals Lázaro Cárdenas has officially inaugurated the Phase II expansion of its container terminal in Mexico and announced the immediate commencement of Phase III construction. Supported by a new investment exceeding USD 350 million, this growth strategy aims to strengthen the port's logistics capacity and its role as a strategic regional trade hub. The expansion aligns with global decarbonization goals by incorporating automated, electrified equipment and renewable energy sources. The newly commissioned Phase II, developed with over USD 140 million, increases the terminal's operational area to 65 hectares and its capacity to 2 million TEUs. This stage introduces state-of-the-art technology, including six electric automated rail-mounted gantry cranes and a high-efficiency shuttle carrier fleet. These advancements enhance container movement precision, cargo traceability, and overall operational safety while establishing the facility as one of the most advanced logistics platforms in Latin America. The upcoming Phase III will add 450 meters of berth, extending the total quay length to 1,200 meters to accommodate the world's largest container vessels.

VALENCIAPORT LAUNCHES CLIMATE CHANGE ADAPTATION STRATEGY

The Port Authority of Valencia (APV) has initiated a comprehensive plan to adapt the ports of Valencia, Sagunto, and Gandia to climate change impacts. Part of the broader Net Zero Emissions Plan, this strategy aims to transform these locations into eco-proactive ports by assessing and mitigating risks from rising sea levels, extreme heatwaves, and heavy rainfall. This initiative aligns with the national strategic framework requiring all state-owned ports to implement such adaptations by 2030. The project, awarded to Ineco for approximately €181,000, will span 14 months and focus on identifying critical vulnerabilities across quays, breakwaters, and terminal operations. Key tasks include conducting cost-benefit

analyses for priority infrastructure improvements and establishing continuous monitoring systems. These measures are designed to ensure the long-term resilience of port services against volatile weather patterns while maintaining economic viability. This adaptation strategy serves as a milestone toward the APV's goal of achieving carbon neutrality by 2035. Future developments under this roadmap include the completion of two new electrical substations by 2028, the implementation of shore power supply points for vessels, and the rollout of a digital twin-based smart energy management system in 2027. By 2035, the ports aim to reach full energy self-sufficiency to support all commercial and maritime activities.

SINGAPORE SIGNS MULTIPLE MOUS FOSTERING INNOVATION

The Maritime and Port Authority of Singapore (MPA) has reaffirmed its commitment to strengthening Singapore's position as a global maritime hub by launching new initiatives focused on digitalization, talent development, and operational excellence. During the Maritime Week, several Memorandums of Understanding (MoUs) were signed with international partners to foster innovation and streamline port operations. These strategic collaborations aim to enhance the efficiency of global supply chains while ensuring that Singapore remains at the forefront of the maritime industry's ongoing digital transformation. Central to these efforts is the enhancement of the digital infrastructure within the Port of Singapore, including the implementation of advanced technologies to improve vessel

traffic management and port clearance processes. The MPA is also investing heavily in human capital through specialized training programs designed to upskill the maritime workforce, preparing them for future challenges in decarbonization and automation. By integrating these technological advancements with a highly skilled workforce, the authority seeks to maintain a resilient and competitive maritime ecosystem that can adapt to the evolving demands of international trade. Specific measures introduced include the expansion of the Maritime 5G network to support remote pilotage and the use of autonomous vessels in Singapore's waters. Furthermore, the MPA has established new frameworks for cybersecurity to protect critical maritime infrastructure from emerging digital threats.

WALLENIUS WILHELMSSEN STRENGTHENS POSITION IN 2025 ANNUAL REPORT

Wallenius Wilhelmsen delivered a solid financial and operational performance in 2025, reporting a net profit of USD 1,104 million from total revenues of USD 5,240 million. Despite a complex operating environment and shifting trade patterns, the company strengthened its contract portfolio and maintained a core focus on safety and responsible operations, recording no serious accidents throughout the year. The company's

financial foundation was further bolstered by an adjusted EBITDA of USD 1,811 million and a reduction in net debt to approximately USD 1.7 billion. Commercially, Wallenius Wilhelmsen secured USD 4.8 billion in multi-year contract renewals, bringing its total contract backlog to over USD 10 billion by year-end. Shareholders received USD 892 million in dividends, representing an increase from the previous year.



PHOTO: WALLENIUS WILHELMSSEN

KONGSBERG MARITIME TO SUPPLY WATERJETTS FOR INDIAN NAVY'S NGMV PROGRAMME

Kongsberg Maritime has secured a contract to provide 18 large Kamewa waterjets for the Indian Navy's Next Generation Missile Vessel (NGMV) programme. These high-speed vessels, currently under construction at Cochin Shipyard Limited (CSL), are designed to incorporate advanced surface-to-surface missiles and anti-missile defence systems. The propulsion package is intended to provide the fleet with the specific speed and manoeuvrability required for modern naval operations. This agreement represents Kongsberg Maritime's largest single waterjet order to date, marking a significant return to large-scale waterjet manufacturing. The collaboration builds on a long-standing partnership between

Kongsberg, the Indian Navy, and CSL. The delivery of the waterjet systems will be synchronised with the shipyard's construction schedule to support India's maritime defence strategy and its focus on developing home-grown naval capabilities. The Kamewa waterjets are selected for their performance in demanding naval applications, offering the agility and reliability essential for missile vessels. This project reinforces Kongsberg Maritime's presence in the Indian market and its commitment to delivering world-class technology for critical defence programmes. The NGMV fleet will also feature air surveillance and fire control radars to enhance its operational effectiveness in maritime security.

LIEBHERR RL 2600 CRANE SELECTED FOR OFFSHORE PROJECT IN AZERBAIJAN

A major international energy operator has selected the Liebherr RL 2600 offshore crane for a key hydrocarbon development in the Caspian Sea. Scheduled for delivery in 2027, the crane will be installed on a new electrically powered unmanned compression platform located approximately 70 kilometers southwest of Baku. This expansion project aims to enhance the operational capabilities of one of the region's most significant energy hubs. The RL 2600 is designed for both fixed and floating installations, featuring a compact profile with minimal tail swing to optimize limited platform

space. It offers a 45-meter outreach and a lifting capacity of 25 tonnes, providing the versatility required for various offshore handling and maintenance tasks. Its robust engineering ensures consistent performance and high uptime even in challenging sea and weather conditions. To support autonomous operations, the crane is equipped with the LiMain digital maintenance system, allowing key technical tasks to be managed from shore. This technology includes automatic lubrication and hydraulic self-tests, reducing the need for physical technician visits to normally unattended facilities.

HAPAG-LLOYD REPORTS 2025 ANNUAL RESULTS AND PROPOSES DIVIDEND

Hapag-Lloyd has concluded the 2025 fiscal year with a Group profit of USD 1.0 billion (EUR 0.9 billion) and a Group EBITDA of USD 3.6 billion. While these solid results reached the upper end of the earnings forecast, they remained below the previous year's levels due to lower freight rates and increased operational costs. Based on this performance, the Executive and Supervisory Boards will propose a dividend of EUR 3.00 per share at the Annual General Meeting. The Liner Shipping segment saw transport volumes rise

by 8% to 13.5 million TEU, supported by the implementation of the Gemini network, though average freight rates declined by 8% to 1,376 USD/TEU. Revenues in this segment reached USD 20.6 billion, while the Terminal & Infrastructure segment saw revenues increase to USD 514 million. Operational challenges, including Red Sea security tensions and start-up expenses for the Gemini network, impacted overall earnings despite significant investments in fleet efficiency and decarbonization.

CAVOTEC WINS EUR 3M SHORE POWER ORDER FOR SOUTHERN ITALIAN PORTS

Cavotec has secured a EUR 3 million contract to supply advanced shore power systems to several ports in Southern Italy. This project focuses on providing shoreside electricity to various vessel types, significantly reducing environmental impact by allowing ships to turn off their engines while at berth. The order includes the delivery of PowerFeed, PowerReach, and PowerMove systems, designed to offer flexible and modular electrical connections. These technologies will enable port authorities to meet increasing regulatory requirements and support the broader transition toward zero-emission maritime operations in the Mediterranean.



PHOTO: CAVOTEC

VAN OORD REPORTS RECORD PROFITS AND STRONG OPERATIONAL GROWTH

Van Oord has more than doubled its net profit to EUR 110m in 2025, up from EUR 43m the previous year, despite geopolitical and economic volatility. The company achieved a revenue of EUR 2.6bn, supported by an EBITDA growth of 139% to EUR 403m. Operational performance remained robust across 213 projects in 36 countries, while the order book remained stable at EUR 4.4bn. The Offshore Energy business led the growth with revenues of EUR 1.471bn, while the Dredging & Infra segment contributed EUR 1.119m. Beyond financial gains, the company increased its renewable energy impact to 3,283 MW and protected 89 kilometers of coastline. Key strategic milestones included the christening of the Boreas, the company's largest offshore wind installation vessel, and the acquisition of the climate-adaptation brand 'Xbloc'. Looking toward 2026, Van Oord is streamlining operations through digitalization and the implementation of AI via its 'Founding the Future' programme. While the company monitors increasing uncertainty and disruptions in the Middle East, it remains focused on long-term value creation driven by global demand for marine transport and climate mitigation.

CMA CGM FOUNDATION DELIVERS 800 TONNES OF HUMANITARIAN AID TO LEBANON

The CMA CGM Foundation, in partnership with Egypt's Tahya Misr Fund, has organized the transport of 800 tons of emergency aid from Egypt to Lebanon. This maritime operation provides essential relief to displaced and vulnerable populations following a previous 60-ton airborne shipment from France. The initiative leverages the Group's logistics expertise to address the growing humanitarian crisis in the region. The shipment consists of 53 containers filled with medical supplies, pharmaceuticals, hygiene kits, and food items. The logistics chain involved transporting the cargo by rail to the Alexandria terminal before loading it onto the "CMA CGM Sahara" for delivery to the Port of Beirut. Upon arrival, the goods will be distributed to Lebanese authorities and various non-governmental organizations. This action is part of the "Containers of Hope" program, which utilizes the Group's global transport network to respond to international crises. By integrating maritime and land logistics, the Foundation ensures the rapid delivery of basic necessities to areas facing massive displacement.

CMA CGM INITIATES PHASE 2 EXPANSION OF GEMALINK CONTAINER TERMINAL

The CMA CGM Group, in partnership with Gemadept, has launched Phase 2 of the Gemalink container terminal expansion in Cai Mep, southern Vietnam. This project aims to double the terminal's annual capacity from 1.7 million to 3 million TEUs by 2027. The expansion works include extending the existing quay by 450 meters and increasing the container yard area from 32 to 44 hectares. To support this increased infrastructure, the terminal will add five Ship-to-Shore (STS) cranes, bringing the total to 13 units, along with additional yard equipment. These technical upgrades are designed to accommodate growing volumes and enhance the operational efficiency of the terminal, which has been operating at full capacity since its opening in 2021. CMA CGM, which holds a 25% stake in the terminal, has maintained a presence in Vietnam since 1989 and currently operates 29 weekly services across seven national ports.



PHOTO: CMA CGM

GEORGIA PORTS AUTHORITY TO OPEN NEW GAINESVILLE INLAND PORT IN MAY

The Georgia Ports Authority (GPA) announced that its new \$134 million inland port in Gainesville, Georgia, is scheduled to officially open on May 4, 2026. This 104-acre facility is designed to enhance Northeast Georgia's business competitiveness by providing a direct logistical link to the Port of Savannah's global ocean carrier network, which handles approximately 40 ship calls per week. The project is part of a broader \$5 billion infrastructure investment plan aimed at expanding rail, yard, and berth capacity over the next decade. The inland terminal will offer direct Norfolk Southern rail service five days a week, providing regional manufacturers—particularly in the poultry, heavy equipment, and forest products sectors—a more efficient alternative to traditional trucking. By replacing a 600-mile roundtrip truck route, the facility is expected to eliminate an estimated 26,000 truck trips in its first year of operation alone. This shift is projected to significantly reduce traffic congestion in the Atlanta region while improving air quality through lower carbon emissions. At full build-out, the Gainesville Inland Port will feature an annual capacity of 200,000 containers. To support the new terminal, GPA and local authorities have already completed \$17.7 million in infrastructure upgrades, including the realignment of White Sulphur Road and the resurfacing of Cagle Road to maintain traffic flow and emergency access.



PHOTO: GEORGIA PORTS AUTHORITY

PORT OF ROTTERDAM SECURES EU FINANCING FOR SHORE POWER EXPANSION

The European Investment Bank (EIB) has provided a €90 million loan to the Port of Rotterdam Authority for the installation of shore power at three deep-sea container terminals. This funding supports Rotterdam Shore Power, a joint venture between the Port of Rotterdam Authority and Eneco, and is supplemented by a €70 million grant from the European Commission's Connecting Europe Facility. The project is part of the port's strategy to reach climate-neutral operations by 2050 while maintaining its maritime position in North-West Europe. The infrastructure project covers eight kilometers of quay and includes 35 connection points for seagoing container vessels. In addition to the power supply units, the work involves grid connections, cabling, and associated construction and excavation. These facilities allow large ships to turn off their engines and generators while docked, which reduces CO₂ emissions, noise, and particulate matter compared to using onboard fossil fuel systems. The new installations are scheduled for delivery and operation in phases starting from the second half of 2028.

MAERSK OPENS FULLY AUTOMATED DISTRIBUTION CENTRE IN SINGAPORE

A.P. Moller – Maersk has officially launched World Gateway II, a 1.1 million square foot, fully automated distribution centre in Singapore. The facility is designed to strengthen the company's regional leadership in contract logistics and meet the rising demand for e-commerce fulfillment across Asia Pacific. Located near Tuas Port and Changi Airport, the centre serves as a global hub for various sectors, including lifestyle, retail, technology, and FMCG. The project represents an investment of over S\$200 million and features advanced technologies such as an Automated Storage and Retrieval System (ASRS) and autonomous case-handling robots. These innovations are intended to reduce manual handling, shorten lead times, and enhance order accuracy. The facility has already reached approximately 70% occupancy and is expected to create around 500 jobs focused on digital and automated operations once fully operational.

ICTSI LAUNCHES US\$800M SOUTH LUZON CONTAINER TERMINAL

International Container Terminal Services Inc. (ICTSI) has officially launched the South Luzon Container Terminal (SLCT) in Batangas, marking the start of construction for the Philippines' second-largest container facility. This US\$800 million project, situated within the Bauan International Port, is designed to expand trade facilitation for Southern Luzon and the entire country while supporting regional industrial, manufacturing, and energy-related projects. The terminal aligns with the national "Build Better More" infrastructure program and will complement existing trade capabilities in Manila. The facility is being developed in a naturally protected cove on Batangas Bay to ensure operational stability, with a target completion date set for 2028. At full development, SLCT will feature an 800-meter quay, a 38-hectare yard, and an 18-meter berth depth, allowing it to handle ultra-large container vessels with an annual capacity exceeding two million TEUs. Phase 1 of the construction, focusing on marine works and a 425-meter quay for super post-Panamax operations, is scheduled to run through 2027. Designed as a smart technology terminal, the site will be equipped with eight remote-controlled ship-to-shore cranes, 20 rail-mounted gantries, and 32 diesel-hybrid carriers. Accessibility to the terminal is provided via the Bauan–San Pascual–Batangas–STAR route and major South Luzon tollways, with further connectivity under consideration for the Cavite-to-Bauan corridor.

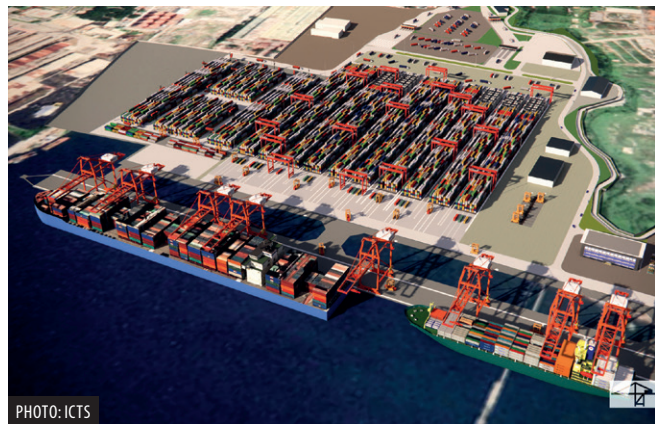


PHOTO: ICTSI

NORTHPORT ADVANCES PIER 14 INFRASTRUCTURE UPGRADES

NorthPort, the Philippines' premier domestic cargo terminal, is making significant progress on the structural strengthening of Pier 14 as part of its ongoing three-year terminal upgrade program. The initiative aims to enhance the terminal's structural integrity and seismic resilience to support long-term domestic trade growth while ensuring safe and reliable operations. Structural works on the second and

third 42.5-meter segments of the pier have been completed ahead of schedule, reinforcing the Terminal 1 wharf. As of February, construction has moved to the fourth and final 52.5-meter segment. Current activities include resurfacing the deck area, repairing above-deck damage to prevent deterioration, and upgrading the fender system from 700 mm to 1,000 mm cell fenders for safer vessel berthing.



PHOTO: ICTSI

YILPORT ADDS 19 NEW KONECRANES LIFT TRUCKS TO ITS FLEET

International terminal operator Yilport Holding, Inc. has modernized its equipment fleet by deploying 19 new Konecranes lift trucks across three continents. The delivery, which includes five reach stackers, five empty container handlers, and nine forklifts, is now operational at terminals in Ghana, El Salvador, and Portugal. This strategic investment replaces older machinery to ensure continued safety and maximum uptime within Yilport's expanding global network. The new equipment is designed to meet diverse handling requirements and strict customer deadlines in demanding environments. To optimize performance, the fleet is integrated with TRUCONNECT Remote Monitoring, which provides real-time usage data through a secure customer portal. This digital integration allows Yilport to track individual units or the entire fleet, enabling data-driven decisions to enhance operational resilience and service reliability.

MSC GROUP SECURES 45-YEAR CONCESSION FOR SNAKE ISLAND TERMINAL

MSC Group has signed a 45-year concession agreement with Nigerdock to develop a state-of-the-art container terminal within Snake Island Port in Lagos, Nigeria. This project is a key component of the Group's broader investment in the country's infrastructure and logistics sector, which totals over USD 1 billion. To facilitate the development, MSC has also finalized an Engineering, Procurement, and Construction (EPC) contract with ITB Nigeria Ltd. and DEME Group. The new terminal is designed to enhance regional shipping efficiency with a 910-meter quay equipped for both Ship-to-Shore and Mobile Harbor Cranes, serving deep-sea vessels and barges. Initial dredging will reach a depth of -16.5 meters, matching the existing navigation channel, with a scalable design allowing for future deepening to -18 meters. The facility will also feature a 30-hectare yard utilizing hybrid rubber-tyred gantry cranes to support sustainable operations.

ANTWERP-BRUGES AND ZES EYEING ZERO-EMISSION INLAND SHIPPING

Port of Antwerp-Bruges and Zero Emission Services (ZES) are exploring the development of mobile battery container charging stations dedicated to inland navigation. This initiative aims to establish robust charging infrastructure at strategic waterway locations, enabling vessel operators to transition to battery-electric power. The project emphasizes the vital role of ports in providing reliable, sustainable energy access to the shipping industry. The study focuses on two specific locations: one operated

by PSA Belgium and another by ATO in collaboration with Boortmalt and Van Moer Logistics. In partnership with VLEEMO NV, the research explores how to maximize the use of locally generated renewable energy within the network. These efforts are designed to strengthen the logistical link between Belgium and the Netherlands, fostering a future-proof, zero-emission fleet. Research is scheduled for the first half of 2026, with the goal of having the charging infrastructure operational by 2027.

SINGAPORE UPDATES MARITIME OPERATIONS WITH OCEANS-X PLATFORM AND AI PARTNERSHIP

The Maritime and Port Authority of Singapore (MPA) has introduced two new initiatives to update operations and technology use in the maritime sector. The first is the launch of OCEANS-X, a platform designed to improve digital connectivity and data sharing across the industry. The second is a partnership with the Singapore Shipping Association (SSA) aimed at helping maritime companies integrate artificial intelligence (AI) into their daily workflows. OCEANS-X serves as a data and Application Programming Interface (API) exchange platform. It allows shipping companies, agents, and government agencies to connect their internal software directly to the MPA's systems. One immediate application of this platform is digital port clearance, which lets users transmit necessary clearance documents directly without relying on intermediary web portals. Furthermore, it supports the electronic exchange of ship certificates between global partner ports, reducing the need for manual checks and physical paperwork. Currently, the OCEANS-X platform provides access to over 100 datasets and APIs. These datasets offer practical, real-time information such as vessel arrival and departure schedules, standardized port codes, and the precise positions of vessels within Singapore's waters. By making this data accessible, the MPA allows industry developers, researchers, and startups to build and deploy their own digital services, including specialized analytics and new AI tools. To further support the implementation of these new technologies, the MPA and the SSA signed a Memorandum of Understanding (MOU) focused specifically on AI adoption. This agreement is designed to help maritime businesses apply AI to core operational functions,



including ship management, chartering, and bunkering. Under this partnership, companies can access a database of existing AI use cases to see how the technology works in practice, and they can use AI Singapore's AI Readiness Index to evaluate their current systems and plan their next steps. To ensure the workforce is prepared for these changes, the partnership includes practical training and education. The MPA and SSA are working with educational institutes to create programs that teach employees the skills necessary to work alongside new AI tools. An initial training run has already begun with 21 participating companies, with a full program rollout scheduled for later in 2026. In addition, the organizations will host a Maritime AI Forum in the second half of 2026 to discuss real-world applications and practical use cases with the broader industry.

MUA URGES AI REGULATION TO PROTECT AUSTRALIAN PORTS AND JOBS

The Maritime Union of Australia (MUA) has called on the Federal Government to urgently regulate artificial intelligence within critical supply chain sectors, including stevedoring and port services. This demand follows a report highlighting large-scale AI automation plans by Dubai Ports (DP World) at major terminals in Brisbane, Sydney, and Melbourne. The union warns that uncontrolled automation by foreign multinationals poses a significant sovereign risk to Australia's national security and economic stability during a period of global supply chain uncertainty. The proposed transition to driverless vehicles and remote-operated cranes

threatens approximately 1,000 positions, representing over 60% of the current workforce. The MUA and the Centre for International Corporate Tax Accountability and Research (CICTAR) argue that these measures prioritize labor cost reduction and corporate profit over efficiency or public benefit. Furthermore, the union points to DP World's history of avoiding corporate income tax in Australia as evidence that such automation serves foreign interests rather than the national economy. To mitigate these risks, the MUA is advocating for a regulatory framework that ensures transparency, safety, and mandatory worker consultation.

KR LAUNCHES AI-INTEGRATED 'SEATRUST SOFTWARE HUB'

The Korean Register (KR) has officially launched its upgraded 'SeaTrust Software Hub', a sophisticated technical platform designed to streamline user accessibility and bolster customer support through AI integration. Acting as a unified digital knowledge center, the hub reorganizes KR's technical software suite into a single interface where users can manage entire workflows—from downloading structural assessment tools like SeaTrust-HullScan to accessing web-based applications for route-specific calculations. This strategic upgrade aims to systematically accumulate operational expertise and technical

knowledge in one centralized location. The core of this advancement is a new AI-driven feedback processing system developed from extensive engineering documentation, user manuals, and historical correspondence. This system automatically analyzes and directs user inquiries to the appropriate teams while generating context-aware responses to ensure high-quality technical assistance. As the platform processes more data over time, the AI is expected to continuously improve the speed and accuracy of the support provided to shipyards, design companies, and container shipping operators.

VANCOUVER AND GCT PARTNER TO ADVANCE ROBERTS BANK TERMINAL 2

The Vancouver Fraser Port Authority (VFPA) and GCT Global Container Terminals (GCT) have signed a Memorandum of Understanding (MOU) to explore a partnership for the development and operation of the Roberts Bank Terminal 2 (RBT2) project. As part of this agreement, GCT will withdraw its separate Deltaport Berth 4 expansion proposal to focus on the joint advancement of RBT2. Under the terms of the one-year MOU,

the VFPA will work exclusively with GCT to assess the operational expertise and synergies the Canadian-owned operator can contribute as a potential terminal builder and operator. While negotiations proceed toward a Joint Development Agreement, the port authority will maintain its lead on the RBT2 landmass development, including responsibility for permitting and ongoing engagement with Indigenous communities.



PHOTO: VANCOUVER FRASER PORT AUTHORITY

PORT OF SEATTLE LAUNCHES 2026 CRUISE SEASON

The Port of Seattle has officially commenced the 2026 Alaska cruise season, marking a historic milestone for the region. This year's schedule features 330 vessel calls and is expected to host a record 2.1m revenue passengers, the highest in the port's history. The season, which began on April 17, reinforces Seattle's position as North America's primary gateway to Alaska while generating an estimated \$1.2b in local economic impact and supporting over 5,000 jobs. This year sees the broadest lineup of ships to date, with 16 homeport vessels including the debut of two new cruise lines: MSC Cruises and Virgin

Voyages. To accommodate this growth, the Port has invested in new passenger gangways and continues to prioritize maritime decarbonization. Eleven homeport vessels will connect to clean shore power this season, with infrastructure expansion underway to allow every homeport ship to plug in by 2027. The 2026 cruise season will run through October 11, drawing travelers from around the world to Seattle's newly redeveloped waterfront. Beyond the cruise terminals, the influx of visitors is expected to benefit local businesses, farms, and various neighborhoods throughout the Puget Sound area.

PROJECT44 INTRODUCES AI FREIGHT PROCUREMENT AGENT

Project44 has announced the launch of its AI Freight Procurement Agent, a sophisticated tool designed to automate carrier selection, rate benchmarking, and negotiations across various transportation modes. Embedded directly into transportation workflows, this agent leverages a logistics data graph connecting over 259,000 carriers and 1.5 billion annual shipments to provide context-fueled intelligence. By moving from sequential, manual workflows to parallel, automated processes, the solution aims to transform how shippers manage their freight spend and carrier relationships. The AI agent

provides end-to-end execution capabilities, including the ability to identify lanes with savings opportunities, launch digital mini-bids autonomously, and evaluate carriers based on cost, transit time, and reliability. Early deployments of the technology have demonstrated significant operational improvements, including a 4.1% reduction in freight spend, up to a 75% decrease in sourcing cycle times, and a 70% reduction in manual coordination efforts. The system operates within defined governance guardrails, allowing teams to maintain control while the agent handles repetitive tasks.

LONG BEACH, LOS ANGELES AND SINGAPORE RENEW MOU EXTENDING GREEN AND DIGITAL SHIPPING CORRIDOR

The Maritime and Port Authority of Singapore, the Port of Los Angeles, and the Port of Long Beach have renewed their memorandum of understanding to extend the Green and Digital Shipping Corridor for an additional three years. This partnership, supported by C40 Cities, focuses on decarbonizing and digitalizing the trans-Pacific route, which remains one of the world's busiest container trade lanes. The renewal aims to transition the initiative from planning to active implementation while strengthening global supply chain resilience. The collaboration has already achieved several milestones, including the completion of a baseline study and the establishment of workstreams for alternative fuels and energy

efficiency. All three ports have expanded their bunkering capabilities, with Singapore completing methanol trials and the California ports preparing for a 2026 methanol pilot. Additionally, the partners have successfully conducted port-to-port data exchange testing and initiated pilot collaborations with industry leaders like Mitsui O.S.K. Lines. Under the extended agreement, the ports will focus on deploying zero-emission fuels and advanced digital solutions to support the goal of operating zero-lifecycle carbon container ships by 2030. Future efforts will include developing essential infrastructure for green fuel supply, enhancing cybersecurity, and promoting common standards for data connectivity.

OPCSA EXPANDS HYBRID RTG FLEET AT PORT OF LAS PALMAS

Operaciones Portuarias Canarias S.A. (OPCSA) has ordered four additional diesel-hybrid Konecranes Rubber-Tired Gantry (RTG) cranes to enhance its operations at the Port of Las Palmas de Gran Canaria. This agreement follows an initial investment in eight similar units made in 2025, bringing the total number of Konecranes RTGs at the terminal to 18. The order was booked in the first quarter of 2026, with delivery scheduled for the final quarter of the year. The modernization project aims to support increasing container volumes while improving energy efficiency and reducing emissions. The hybrid technology integrated into these cranes captures and stores energy during hoisting and lowering, which is then reused to power the equipment. This system significantly lowers fuel consumption and operating costs compared to traditional diesel-powered RTGs. The cranes are also equipped with advanced safety features, including an Anti-Truck Lift Prevention System and

gas-type fire prevention. This expansion aligns with Konecranes' Ecolifting initiative, a strategic roadmap focused on decarbonizing port operations and achieving zero tailpipe emissions. In addition to the equipment acquisition, OPCSA previously signed a five-year service agreement with Konecranes Port Services in late 2025 to ensure long-term operational support. The move reinforces the terminal's role as a key container hub for trade across the Canary Islands and the wider Atlantic region.



PHOTO: KONECRANES

HAMBURG YOUR PORT

global
transPORT
solutions

portofhamburg.com
info@portofhamburg.com
in @portofhamburg



@Stackphotos



SUEZ CANAL AUTHORITY AND ICS SIGN LONG-TERM COOPERATION MOU

Admiral Osama Rabiee, Chairman of the Suez Canal Authority (SCA), met with Thomas Kazakos, Secretary General of the International Chamber of Shipping (ICS) to sign a Memorandum of Understanding (MoU) aimed at sustaining long-term strategic cooperation. The agreement focuses on enhancing communication, exchanging maritime expertise, and marketing the canal's logistical services to global clients. This partnership marks a renewal of previous collaboration frameworks intended to support the global shipping industry through the vital waterway. The terms of the MoU include monitoring waterway development projects and reviewing the SCA's marketing and pricing policies to ensure they align with industry needs. Furthermore, the cooperation extends to enhancing maritime security and adhering to international environmental standards for carbon emission reduction. Admiral Rabiee emphasized that the SCA's ongoing modernization strategy is a critical investment that will yield significant benefits once regional conditions stabilize and navigation returns to regular rates.



PHOTO: SUEZ CANAL AUTHORITY

TEIGNMOUTH COMPLETES HEAVY-LIFT PROJECT FOR NATIONAL GRID

ABP's Port of Teignmouth has successfully finalized a complex, multi-stage logistics operation involving the arrival, storage, and onward movement of a 150-tonne transformer for National Grid infrastructure in Exeter. The project concluded on April 10, 2026, when the unit departed the port for its final destination. This operation followed an international shipment from Rotterdam and required extensive coordination between port authorities and heavy-lift specialists. The initial phase began in December 2025, when the transformer arrived aboard the vessel MV Honesty. Heavy-lift specialist Allelys managed the discharge using a 1,000-tonne crane to move the cargo directly from the vessel's hold to a secure storage area within the port. During the storage period, ABP and Allelys coordinated traffic management and logistics to ensure the massive unit could be safely housed while planning the final road transport phase. The operation culminated in a 20-mile road journey from Teignmouth to Exeter, which took approximately six hours to complete. The transport required a full police escort and temporary road closures due to the scale of the load.



PHOTO: PORT OF TEIGNMOUTH

TRANSTEC TO ADOPT ELECTRIC EMPTY CONTAINER HANDLERS

TransTec World has ordered two Konecranes E-VER electric empty container handlers for its terminal in Panama, becoming the first operator in the Americas to adopt this technology. The investment is part of the company's strategy to modernize its fleet with zero-emission equipment, aiming to reduce the environmental footprint of its logistics operations. The delivery is scheduled for the second quarter of 2025. The E-VER machines are equipped with high-efficiency lithium-ion batteries that support fast charging during shifts, ensuring high productivity without the need for diesel fuel. By replacing internal combustion engines with electric drivetrains, TransTec World expects to significantly lower energy

costs and reduce maintenance requirements. The units also feature advanced digitalization tools for real-time monitoring of performance and battery status. This purchase aligns with TransTec World's commitment to sustainable port operations and carbon neutrality. By integrating these electric handlers into their daily workflow, the terminal operator aims to decrease local noise pollution and eliminate exhaust emissions.



PHOTO: KONECRANES

SAN PEDRO BAY PORTS RELEASE CARGO EQUIPMENT FEASIBILITY ASSESSMENT

The ports of Long Beach and Los Angeles have published a final feasibility assessment evaluating battery-electric and hydrogen fuel cell cargo-handling technologies. This report is part of the Clean Air Action Plan (CAAP) and aims to track progress toward zero-emissions goals by analyzing the current state and viability of clean energy solutions in port operations. Building on the 2025 draft and previous studies from 2018 and 2021, the 2024 assessment examines five key areas: technical viability, commercial

availability, operational feasibility, economic workability, and infrastructure readiness. The findings indicate that while zero-emission technologies continue to advance, further efforts are required to address specific challenges related to costs, infrastructure development, and large-scale operational deployment. To support these goals, the ports have invested over \$431 million since 2007 through the Technology Advancement Program to accelerate the commercialization of cleaner equipment.

WPU (VITOL) TO BUILD PLASTIC RECYCLING PLANT IN ROTTERDAM

WPU, Vitol’s plastics recycling division, has announced plans to construct a new chemical recycling facility for end-of-life plastics in the Port of Rotterdam. Located adjacent to Vitol’s VPR refinery, the plant will have an annual capacity to process 80,000 tonnes of post-consumer plastic waste. Once operational, it is expected to become one of the largest chemical recycling plants in Europe. The facility will utilize WPU’s proprietary batch pyrolysis technology to convert plastic waste into pyrolysis oil, which serves as a circular feedstock for chemicals and new plastics. This process

provides a sustainable substitute for fossil-based naphtha. The technology is already proven at WPU’s existing commercial-scale plant in Denmark, and the new Rotterdam site will incorporate advanced furnace technology designed to minimize emissions and energy consumption. To support the project’s logistics, the facility will leverage existing industrial infrastructure and a strategic partnership with Vopak. Vopak plans to repurpose approximately 20,000 cubic meters of storage capacity at its Europoort naphtha hub specifically for the handling and storage of the produced pyrolysis oil.

PORT OF LONG BEACH SECURES \$70M FEDERAL INFRASTRUCTURE GRANT

The Port of Long Beach is set to receive nearly \$70m in federal funding from the U.S. Army Corps of Engineers to revitalize critical infrastructure and enhance freight transportation safety. This record allocation is part of a larger \$148m work plan shared with the Port of Los Angeles, aimed at strengthening the nation’s busiest seaport complex and ensuring resilient supply chains. The investment will support essential projects, including maintenance dredging, the replacement of the steel bulkhead along the Back Channel,

and upgrades to fenders and bollards. Additionally, the funds will cover seismic retrofits for the Pier C wharf, improvements to the Pier F dike, and repairs to berthing systems. These upgrades address long-overdue maintenance while supporting the port’s goal of doubling cargo throughput to 20m container units annually by 2050. Beyond physical improvements, the federal dollars are expected to bolster the local economy by supporting high-paying jobs and maintaining the port’s status as a premier global trade hub.

PORT OF THESSALONIKI REPORTS RECORD REVENUE AND PROFITABILITY FOR 2025

Port of Thessaloniki (ThPA S.A.) achieved a new historic high in financial performance for the fiscal year 2025, driven by dynamic business operations and significant growth in the Container Terminal. Group revenues reached €107.4m, a 6.7% increase from €100.7m in 2024. This growth was primarily supported by an 11.3% rise in Container Terminal revenue, while container throughput reached 617k TEUs, marking a 9.1% year-on-year increase. The Group’s profitability showed substantial improvement across all key metrics. Net profits after taxes rose by 9.7% to €30.8m, up from €28m in the previous year, while EBITDA reached €48.2m, representing a 13.1% increase. The EBITDA margin improved to 44.9%, a performance notably higher than the average of previous years. Despite a 12.5% decline in conventional cargo volumes, revenue from Real Estate and Cruise & Ferry sectors grew by 5% and 21.9% respectively. ThPA S.A. maintains a strong liquidity position with operating cash flows exceeding €34.8m. The organization continues to implement its investment strategy, highlighted by the expansion of Pier 6, which is expected to more than double the container terminal’s capacity. Total investments from March 2018 through the end of 2025 have exceeded €89.6m, reinforcing the port’s competitiveness and its ability to serve Ultra Large Container Vessels.

KALMAR AND PORT OF TAURANGA EXPAND ECO-EFFICIENT FLEET

Kalmar has secured an order from the Port of Tauranga in New Zealand for six hybrid straddle carriers and one electric straddle carrier. This agreement strengthens a 25-year partnership and supports the port’s strategic goal of becoming carbon-zero by 2050. The Port of Tauranga, New Zealand’s largest container terminal, currently processes 1.2m TEU annually and has invested heavily to accommodate the world’s largest container vessels. The new equipment will be integrated into the port’s existing fleet, which already includes several Kalmar straddle carriers and seven hybrid models. The transition to eco-efficient technology is a key component of the port’s environmental strategy, which targets a 5% annual reduction in emissions relative to cargo volumes. These hybrid and electric units are specifically designed to minimize fuel consumption and emissions while maintaining operational efficiency in high-capacity terminal environments. The delivery of the new straddle carriers marks a significant step in the port’s journey toward a zero-emission future and a more socially responsible operation. According to port officials, expanding the use of such technology is vital for meeting their long-term sustainability commitments.

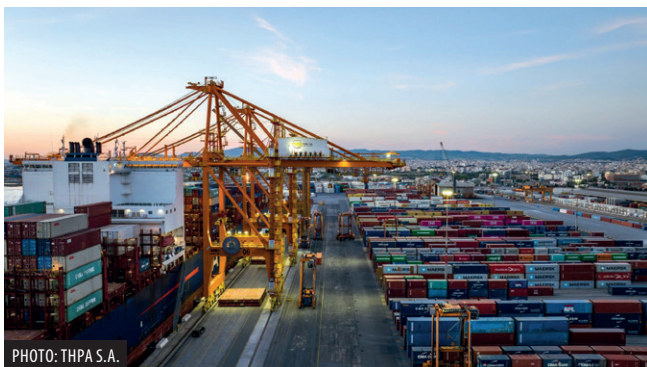


PHOTO: THPA S.A.

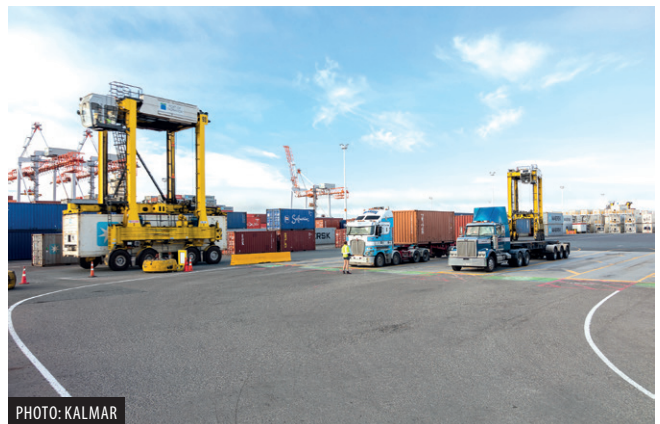


PHOTO: KALMAR



Baltic Transport bimonthly-daily companion
Journal



TOGO CONTAINER TERMINAL EXPANDS FLEET WITH NINE LIFT TRUCKS

Lomé Container Terminal (LCT) has ordered nine Konecranes lift trucks to support its expansion and rising operational demands. The delivery, scheduled for the second quarter of 2026, includes two SMV 4632 TC5 reach stackers and seven SMV 7/8 ECC90 empty container handlers. This investment strengthens the long-term partnership between the terminal and Konecranes, as LCT continues to develop as a key regional logistics hub in West Africa. The new equipment will replace older units within LCT's existing fleet, which already features 32 Konecranes rubber-tired gantry

cranes (RTGs). The reach stackers will manage container operations across the yard, while the empty container handlers will facilitate efficient stacking and repositioning. These machines are designed with high safety and ergonomic standards and are equipped with TRUCONNECT® Remote Monitoring to provide real-time performance insights and support preventative maintenance. The order is being handled in collaboration with Paterson Simons, Konecranes' regional distributor, which provides sales and after-sales support across West and Central Africa.



PHOTO: LOMÉ CONTAINER TERMINAL S.A.

KUENZ AND ABB TO DELIVER NINE STACKING CRANES FOR TRAPAC LOS ANGELES

Künz GmbH and ABB have secured an order to deliver nine rail-mounted stacking cranes for the terminal expansion of TraPac LLC in Los Angeles, California. This project aims to increase yard capacity and support the long-term development of container handling operations on the U.S. West Coast. The investment ensures that the terminal infrastructure can meet increasing demand while operating as a cohesive and efficient system. Under the agreement, Kuenz will provide the complete steel structures and mechanical components, while ABB will handle the design, installation, and commissioning of the electrification and control systems. In addition to the new units, ABB will upgrade systems on 29 existing stacking cranes and three rail-mounted gantry cranes to align performance across the fleet. This integration of OEM-agnostic technology is designed to extend equipment lifecycles. The cranes will be manufactured at Kuenz's European production facilities, with final assembly taking place in Poland to allow for delivery of fully erected and tested units. The equipment is scheduled for delivery between 2027 and 2028.



PHOTO: KÜNZ

THE (ZERO-EMISSION) PRIZE AT THE END OF THE (LONG) RACE

by Alexa Ivy

Nuclear-powered vessels have a long history in naval and icebreaker applications, though atom-freighters did not leave the demonstration-project period of 1962-72 (with one still working since the late 1980s exception). That said, the emergence of the 4th generation small modular reactors (SMR) is opening the way for using this emission-free technology also in commercial shipping. But any race towards a nuclear-powered commercial maritime future will require a marathon-like rather than a sprint commitment.

In September 2025, ABB signed a memorandum of understanding with Blykalla, a Swedish nuclear energy company, to support and accelerate the deployment of small modular lead-cooled reactors to the maritime industry. The agreement builds on the terms of a 2024 deal between the two, which targets developing SMR technology to support Sweden's clean energy requirements.

Blykalla's Swedish Advanced Lead Reactor (SEALER) is a highly compact, passively safe reactor with inherent safety features ensuring stability even without external control. SEALER is also one of the three reactors identified in the Nuclear Propulsion for Merchant Ships I (NuProShip I) project, which aims to adapt a gen-IV SMR to the requirements of maritime vessels – in particular, larger ships. “With our compact reactor design, we see a unique opportunity to lead the way in maritime nuclear propulsion – a solution uniquely positioned to meet the sector's demand for clean energy,” commented Jacob Stedman, CEO at Blykalla. “Realising this vision will require an ecosystem of committed partners, and this collaboration is a critical building block.”

ABB's expertise in system integration as well as in power distribution, control, and automation technologies will be key to ensuring the successful deployment of

the SMR as a shipboard solution. Once put on a vessel, an SMR would require little or no refuelling at all. “We look forward to advancing the viability of SMRs in maritime applications. Next-generation SMRs will enable innovative ship designs that can help to reduce emissions compared to vessels powered by carbon-based fuels,” said Samuli Hänninen, Segment Manager, Icebreaking ships, ABB Marine & Ports.

Nuclear intervention

The expansion of the agreement's terms is certainly timely. This October, the International Maritime Organization (IMO) is set to adopt the Net-Zero Framework to make it legally binding to reduce ship greenhouse gas emissions to net-zero by 2050 (with entry into force due in 2027).

Many in the maritime industry are expressing doubts over the availability of alternatives to heavy fuel oil and liquefied natural gas so far proposed. Stakeholders hold different views on the extent to which biofuels, methanol, ammonia, batteries, and fuel cells can get the ‘net zero’ job done, considering the size of the affected ship fleet, with some suggesting that – even in the best-case scenario – “all of the above” will be needed.

In early 2024, the European Commission announced the launch of the European Industrial Alliance on SMRs, which aims

to facilitate and speed up the development, demonstration, and deployment of SMRs in Europe by the early 2030s. The case for nuclear ship propulsion was also distilled by the EU's closest neighbour when Torbjørn Lie, OSM Thome's Business Development Manager, earlier this year introduced Norway's Green Shipping Program's Advanced Nuclear in Maritime Report. He commented, “In the pilot, the aspect of insurance has been particularly interesting to learn more about, including the challenges, possible solutions, and seeing that the Norwegian marine insurance industry is an active and inquisitive party that wants to contribute to the success of the maritime industry's green ambitions.” Skuld's Decarbonisation and Transition Risk Lead, Matias Bøe Olsen, added accordingly, “Nuclear is an interesting zero-emission option that can meet IMO ambitions for 2050, support energy demand, and be a viable technological possibility. As insurance excludes nuclear fuels and lacks international conventions to change this, we welcome insight and a new debate on the topic. The pilot project allows us to get a basic insight into the risks associated with nuclear fuel. We have to mature as an industry to allow the industry to discuss nuclear as one of the many options for reducing emissions.” With appropriate investments and regulatory

support, nuclear propulsion would contribute strongly to maritime decarbonisation, “especially since 85% of the one billion tonnes of carbon emissions we are supposed to eliminate by 2050 comes from deep sea ships of above 5.0-megawatts,” Lie added.

Patience will be instrumental to realise the full potential of nuclear ship propulsion, according to Markus Virtasalo, Solution Manager, Electric Solutions, ABB Marine & Ports. “From ABB’s perspective, we have been empowered to make an early start on nuclear ship propulsion, which puts us in a strong position to accommodate any surprises that we’ll meet along the way. But the prize is a reliable source of ship power that generates zero emissions – even at high vessel speed – works independently of any external decarbonisation device or fuel supply chain issue, and needs little or no refuelling at all. That is certainly a marathon worth running!”

Getting those regulations in shipshape

Stamina for the long game will also be needed to align with the timeline of regulators as they reframe maritime legislation to accommodate nuclear-powered ship propulsion.

Formally, the IMO adopted the Convention on the Liability of Operators of Nuclear Ships in 1962 (the year when States Marine Lines started operating NS Savannah), but the instrument was never ratified. Even though the Code of Safety for Nuclear Merchant Ships was adopted by the IMO Resolution A.491.XII in 1981 into the Safety of Life at Sea Convention, there is currently no marine liability convention applicable to commercial vessels using nuclear power for propulsion.

In June this year, IMO’s Maritime Safety Committee (MSC110) agreed to begin updating legacy regulations governing nuclear-powered ships, tasking the Sub-Committee on Ship Design and Construction to start work on a framework to bring nuclear propulsion into the mix to achieve net-zero emissions by (around) 2050. Critically, the updated Code of Safety for Nuclear Merchant Ships will look beyond pressurised water reactor (PWR) systems with direct steam cycle propulsion to incorporate the 4th generation nuclear technology innovations.

Soon after, in July 2025, the IMO gave NGO status to the Nuclear Energy Maritime Organization (NEMO), in what must be seen as a rapid acceptance

of a grouping established only last year. NEMO – whose members include, among others, shipowners, shipyards, classification societies, insurers, legal companies, and port authorities – focuses on developing the fine detail of regulatory frameworks for SMRs and floating nuclear power systems to bring to the IMO recommendations for port calls.

Other regulators are proving comparably receptive: the International Atomic Energy Agency is developing ATLAS (Atomic Technologies Licensed for Applications at Sea), a set of regulatory structures for nuclear propulsion and floating nuclear power facilities. Class (Lloyd’s Register, ABS, RINA, and DNV) are also making strong efforts to support the nuclear option. Last year, for example, Maersk joined a nuclear-powered container ship feasibility study, working with Lloyd’s Register and Core Power. In September 2025, Samsung Heavy Industries and the Korea Atomic Energy Research Institute, in co-op with ABS and the Flag of Liberia, jointly developed a concept for an SMR-powered LNG carrier design. Elsewhere, an SMR-powered 15,000-TEU container ship design from South Korea’s HD Korea Shipbuilding & Offshore Engineering has already secured approval in principle from ABS (with a HAZMAT study also underway with DNV).

Festina lente

Today, the concept design work carried out by ABB Marine & Ports includes engineering the systems needed to convert thermal energy to electricity and propulsion. “From the naval architect’s perspective, work to interface a nuclear reactor with a versatile ‘steam-electric’ power plant and to integrate it with electric motor-driven shaft lines or Azipod propulsion involves familiar thought processes, and practical knowledge of the flexibility of steam-electric power as a suitable solution across diverse vessel

types,” said Hänninen. He furthers, “Currently, it is possible to work on generic system solutions, leaving reactor-specific interface work until later.”

Pre-dating the recent Blykalla announcement, ABB’s work on nuclear power has already included concepts like a shuttle tanker and a container vessel. While the timeline for market readiness of the maritime SMR remains elusive, it is closely monitored, and plans are updated accordingly. Blykalla foresees its first nuclear reactor reaching criticality in the early 2030s.

Nuclear propulsion went truly mainstream at this year’s London International Shipping Week, as the headline topic at four seminars and a frequent discussion point for financiers, owners, consultants, insurers, reinsurers, and others at general fuel events. Virtasalo is taking a pragmatic position towards the recent increase in interest in maritime nuclear. “Now is a good moment to assess main goals and principles as we approach overall system design, while applicable rules for commercial nuclear ship installations are not yet available. Reviewing the old rules written for 3rd generation PWR technology and evaluating which parts of those will remain and which parts will be updated to cover 4th generation SMR technology will take due time to process,” he said.

First on-board nuclear solutions could be pilot projects with pioneering shipowners or unique vessel types (like power plant barges). First marine-SMR adoptions could also be seen in special trades or in dedicated green corridors that are subject to bilateral agreements, Virtasalo thinks. He sums up by cautioning, “Patience will be critical. Nuclear-powered ship concept design work will involve collaboration with more stakeholders and more thorough documentation than conventional vessels and may thus take a longer time. Design schedules are also linked to SMR developers’ roadmaps for developing reactors of different sizes and types.” ■



A global technology leader in electrification and automation, enabling a more sustainable and resource-efficient future. By connecting its engineering and digitalisation expertise, the company helps industries – including the maritime (ports & shipping) sector – run at high performance, while becoming more efficient, productive, and sustainable so they outperform. Sail to global.abb.com to discover more.

BLYKALLA

A Swedish developer of advanced small modular reactors (SMR), commercialising lead-cooled fast reactors for industrial use. Based on 20+ years of research, their SEALER technology is a compact 55MWe unit designed to offer a safe, efficient, and scalable power solution. The company aims to deliver Europe’s first advanced SMR, providing reliable and sustainable baseload energy to power AI and clean industries. Head to blykalla.com to learn more.

FROM SPECULATION TO ENGINEERING

by Fitzwilliam Scott

A study by Lloyd's Register (LR) and LucidCatalyst for Seaspan shows that defining what shipowners need makes nuclear propulsion not only feasible but economically compelling. The headline numbers demand attention: approximately \$68 million in potential annual savings in fuel and carbon costs per vessel, a 32% increase in annual cargo capacity, and increased speeds (in the case of this study – 25 knots). A nuclear-powered 15,000-TEU container ship would not merely match conventional vessels on economics; it would fundamentally outperform them.

But these figures only become meaningful within a rigorous engineering framework. The study's most significant contribution is establishing a comprehensive set of functional requirements that defines what a nuclear power system must physically achieve when integrated into a modern container carrier. This requirements-led approach transforms nuclear propulsion from an open-ended research question into a defined engineering challenge – and that shift changes everything.

Previous efforts to evaluate nuclear propulsion for merchant ships have suffered from an excessively broad design space. With no clear use cases or performance targets, assessments default to comparing reactor technologies on generic metrics such as levelised cost of energy, without first defining the actual performance thresholds required. Missing the requirements to filter against, every option must be evaluated, and the regulatory implications multiply accordingly. “The result of having requirements specified is that it begins to sort out what the technical design work would need to actually do,” explains Eric Ingersoll, Managing Partner at LucidCatalyst. “One of the problems we've had is that there isn't this kind of broader framework and understanding. Without making decisions about what the requirements are, the problem becomes much, much harder than it needs to be.”

Constraining a cascade of complexity – without compromising safety

The study addresses this directly by defining a specific use case – a 15,000-TEU

Asia-to-Europe container ship operating at sustained high speed – and developing requirements across 17 categories, from technical design through decommissioning. The essential ‘must-have’ specifications, representing roughly 20% of total requirements but driving 80% of project risk, coalesce around three principles: operational competitiveness, technical maturity & modularity, and regulatory viability.

The nuclear system must deliver approximately 74 megawatts electric to sustain a cruise speed of 25 knots, enabling 6.3 Asia-Europe round-trips per year compared with five for slow-steaming conventional ships. The reactor module must fit within an approximately 25 m × 10 m × 10 m envelope at no more than 1,000 tonnes, ensuring integration using existing shipyard capacities without fundamentally altering standard container-ship hulls.

Given commercial staffing constraints, the reactor must achieve ‘walk-away safe’ operation, requiring no active crew intervention to maintain safety under all credible conditions. This aligns nuclear operations with commercial maritime norms, where engineering crews are not trained nuclear specialists.

But perhaps the most consequential single requirement is that each reactor operates as a sealed cartridge for five to seven years, with refuelling aligned to the vessel's standard dry-dock schedule. This eliminates the need for at-sea refuelling infrastructure, nuclear-trained port personnel, on-board spent fuel storage, and specialised bunkering operations. The regulatory scope narrows dramatically, and

port state acceptance becomes significantly more viable. This single constraint eliminates a cascade of complexity.

The framework also treats safety not as a downstream verification step but as a core design requirement originating from stakeholder concerns about nuclear hazards. Safety-critical interfaces – including hazard monitoring, emergency shutdown, failure signalling, and damage control – are defined early in system design, ensuring that decisions protect the crew, the public, and the environment from the outset. By deriving safety requirements from rigorous risk scenarios, the framework links hazards directly to protective design features, supporting feasibility studies, risk assessments, and structured regulatory engagement.

This approach ensures that the nuclear system is engineered to be both intrinsically safe and operationally compatible with commercial shipping realities. As LR continues advancing regulatory readiness and technical assurance, this safety-driven foundation will serve as a durable framework guiding all subsequent engineering and risk evaluation.

More than just a new engine drop-in

Operating at 25 knots, a nuclear-powered container ship achieves a 39% speed increase over conventional slow-steaming vessels, driving up annual cargo capacity by 32-38%. Eliminating bunker fuel entirely delivers roughly \$50 million in annual savings, while avoiding carbon penalties under projected regulatory regimes contributes an additional \$18m. Crucially, conventional vessels must slow-steam to comply with



PHOTO: CANVA

the International Maritime Organization's Carbon Intensity Indicator thresholds, while nuclear vessels face no such penalty at higher speeds, a divergence that will only widen as carbon pricing intensifies.

The study also compares nuclear against the alternative fuels the industry is actively pursuing. E-methanol and e-ammonia face fundamental availability constraints. The current global production of the former stands at approximately 0.5 million tonnes annually, while a fleet of 250 vessels would require 34 million tonnes. Ammonia bunkering infrastructure does not exist at scale. The synthetic fuels promising zero-emission shipping require massive green hydrogen production, itself competing for limited renewable electricity across multiple industrial sectors.

Meg Dowling, Senior Engineer for Nuclear Technology and Alternative Fuels at LR, notes that the economic modelling reveals opportunities that static fuel-cost comparisons miss: "It's not just a drop-in new engine. You could potentially change your entire operating profile of a ship and your business case." An operator might redesign routes to exploit higher cruising speeds, bypass fuelling ports, or serve routes where alternative fuel infrastructure will remain sparse for the foreseeable future.

Modularity, manufacturing, and co-design

By defining a standardised physical envelope and operational specification prior to vendor selection, the framework creates a competitive environment where multiple reactor developers design against the same requirements. Propulsion modules can be

factory-built, transported, and installed using predictable, repeatable procedures. The study envisions a cross-industry consortium with purchase commitments for 1,000+ reactor units over 10-15 years, spanning maritime, mining, chemical processing, and data centre applications. At this volume, reactor costs of \$750-1,000/kWe become achievable – well below the \$3,000-5,000/kWe typical of bespoke nuclear projects.

The study deliberately avoids specifying reactor technologies, defining instead the requirements any successful design must meet. Because reactor technology is not yet locked in, maritime requirements can still shape designs, and vice versa. As Dowling notes, the process is "a two-way street of technology development," where vessel requirements inform nuclear system configuration and reactor capabilities open new operational models. Ingersoll adds, "The longer we wait to bring these two parts of the process together, the longer it's going to take to get solutions in the water. You don't want someone to go through years of detailed testing and then have us say, 'Well, how does that work when the platform's moving around?'"

This work establishes the foundation for subsequent concept design, shipyard engagement, and a detailed supply chain strategy. Market modelling indicates potential uptake of 40-90GW of nuclear propulsion by 2050, with manufactured units potentially reaching commercial readiness within four years of an intensive programme launch.

More than an alternative

Through rigorous, functional engineering, LR and LucidCatalyst have created the first comprehensive technical foundation for nuclear-powered container ships, tied explicitly to real-world operations. By defining clear physical dimensions, power requirements, safety criteria, and life-cycle considerations, this work converts nuclear propulsion from a speculative proposition into an actionable engineering pathway.

As the maritime sector confronts rising carbon costs, fuel volatility, and intensifying regulation, nuclear-powered shipping – designed and evaluated through strict requirements – offers not merely an alternative but, at its core, a superior pathway for safe, reliable, zero-emission global trade. ■



Lloyd's Register (LR) is a global professional services group specialising in marine engineering, technology, and digital solutions. We were created more than 260 years ago as the world's first marine classification society to improve and set standards for the safety of ships. Today, we are a leading provider of classification and compliance services to the marine and offshore industries, helping our clients design, construct, and operate their assets to accepted levels of safety and environmental compliance. Head to lr.org/en to learn more.



LucidCatalyst is an international consultancy offering thought leadership, strategy development, and techno-economic expertise, specialising in interventions that deliver the critical strategic changes necessary to bring about deep and rapid cuts to carbon emissions worldwide while expanding affordable energy access. Go to lucidcatalyst.com to discover more.

CURE WORSE THAN ILLNESS?

by Rob Mortimer, CEO, Fuelre4m

The global conversation around decarbonisation has reached a fever pitch, with the International Maritime Organization (IMO) even failing to reach a decision on the Net-zero Framework during the autumn meeting of the Marine Environment Protection Committee – the vote delaying the decision for a year. Policymakers, NGOs, and industry leaders line up to hail new technologies as the silver bullet that will deliver a clean future. Hydrogen, ammonia, synthetic fuels, electrification, you-name-it – the list is long and growing. Projections estimate that 2050 Baltic international shipping CO₂ emissions (for IMO-registered ships) will be ~48% lower than 2008 levels. Each new announcement is made with a sense of inevitability, as if the mere fact that an alternative exists means fossil fuels should be discarded immediately. But the uncomfortable truth is this: we cannot yet answer the most important question. Better than what?

Until that question is answered with evidence, data, and accountability, there is a real risk that in rushing to embrace the new, we may create something worse than the old. If the cure proves more damaging than the illness, nothing has been achieved. The world deserves honesty – not slogans – and this is where the maritime sector must take a firmer, more disciplined stance.

The mirage

In every cycle of innovation, there is a temptation to believe in miracles; in the Next Big Thing that will send the competition to the ash heap of history. The shipping industry has seen this before with liquefied natural gas (LNG). Heralded as the clean (transition) fuel of its era, it was rolled out at speed across fleets without a full grasp of the life-cycle of methane slip that undermines much of its environmental benefit.

The lesson is painful but vital. Simply switching fuels or technologies without holistic measurement can replace one set of problems with another. Today, hydrogen, ammonia, and synthetic fuels are being elevated in the same way... and before we fully understand the safety implications, the production emissions, and the infrastructure realities.

The maritime sector cannot afford to repeat the LNG experience. We need innovation, sure enough, but we need it grounded in rigorous measurement, not marketing.

The unfashionable but unavoidable reality

It has become politically incorrect to say this, but fossil fuels remain the backbone of global transport. More than 90% of world trade moves by sea, and almost all of it depends on oil-based fuels. No amount

of ambition alters the scale of that reality.

This is not a defence of the status quo. Fossil fuels will – must – decline. But in the interim, until viable large-scale alternatives are ready, the world will continue to consume more barrels a day. Millions more. The question is whether those barrels are burned wastefully or optimised to deliver every possible unit of efficiency.

That is the space where companies like Fuelre4m are working: not to defend fossil fuels indefinitely but to ensure that each drop is used with maximum efficiency, minimum waste, and a measurable reduction in emissions. Optimisation is not glamorous, but it is measurable, immediate, and available today.

Optimising existing fuels is not an excuse for delay. It is the pragmatic bridge between aspiration and reality. Every percentage point of efficiency gained in existing operations reduces emissions right



PHOTO: FUELRE4M

now, without waiting for infrastructure, regulation, or technology to catch up. In practical terms, that means extending the useful life of existing assets while making them cleaner. Zero retrofit – or limited technology addition. Reducing waste and inefficiency that needlessly add to emissions. Delivering verifiable data that can be audited – not simply promised.

Our company's work in maritime is built on this philosophy. By focusing on real-world optimisation of fossil fuels in use today, the industry can buy the time and space to develop tomorrow's fuels properly – without forcing immature solutions into the market.

Accountability for all

If fossil fuels are to be scrutinised and regulated to the last decimal point of emissions, then new fuels must be subject to the same discipline. Yet too often, new solutions are exempt from critical questioning simply because they are new.

The message must be consistent: any fuel or technology must prove that it is better – both demonstrably and measurably better, across its whole life cycle. That includes: production emissions and energy intensity; supply chain safety and scalability; end-use efficiency and pollutant profile; and real-world performance in maritime conditions.

Without such accountability, we risk sleepwalking into new dependencies that are no more sustainable than the ones we are leaving behind. A fuel that looks 'green' in theory but creates larger upstream emissions in practice does not solve the problem.

Progress through discipline

The scale of maritime decarbonisation is almost unimaginable. To replace oil-based fuels at scale would require trillions in investment, new global infrastructure, and radical redesigns of ship technologies. It will happen over decades, not years.

That long horizon creates risk. If industry abandons fossil fuels prematurely, without fully functional alternatives, the result will be disruption to trade, higher costs, and potentially higher emissions elsewhere in the value chain. If industry clings to fossil fuels indefinitely, we lock in unacceptable levels of warming.

The only rational path is a dual approach: squeeze every possible drop of efficiency from current fuels while developing and testing new alternatives under the most rigorous conditions. This is not caution. It is discipline. It is what genuine progress looks like.

As such, "better than what?" should be the first question-test applied to any decarbonisation pathway. It should be asked relentlessly of every new technology and each optimisation claim. Without that benchmark, the conversation is reduced to aspiration and marketing spin. Take hydrogen. Is it better than fossil fuels produced under optimised,

measured conditions? Only if its production is decarbonised, its distribution made safe, and its life-cycle emissions proven lower in practice. Ammonia, methanol, biofuels, and electrification must pass the same test.

The industry must demand hard evidence, not theoretical models. And until that evidence is robust, fossil fuels optimised to their maximum potential remain not just necessary but responsible.

Fuelre4m has been working with partners across the industry to apply this thinking in practice. Optimisation technologies, when deployed across fleets, demonstrate that immediate emission reductions are achievable without waiting for new fuels to mature. This is not an abstract argument. It is measurable, verifiable, and already delivering results. Partnerships are essential because no single company or solution will solve the decarbonisation challenge alone. By working across the supply chain, shipowners, fuel suppliers, technology providers, regulators – the industry at large – can ensure that progress is made on multiple fronts, with accountability embedded at every stage.

Realism without defeatism

The shipping industry is at a crossroads, with the debate polarised between climate urgency and industrial reality. Either we must decarbonise overnight, or we are accused of dragging our feet. The truth lies in the middle. Urgency without realism leads to failure. Realism without urgency leads to complacency. The maritime industry cannot afford either.

Decarbonisation is not a beauty contest of new ideas. It is a battlefield where reason can sharpen itself to the benefit of transport & logistics and all those who rely on it (you and me and pretty much everybody else on the third rock from the Sun). It should ask 'why?' instead of wowing the high shine of the polished surface.

If we hold ourselves accountable at every step, the shipping industry can transition with integrity – and ensure that the next era of fuels is truly worthy of replacing the last. ■



Fuelre4m empowers businesses to operate more sustainably by revolutionising the use of fossil fuels. The company's product range, Re4mx, is a powerful, completely organic, fossil fuel reforming nanobiotechnology that enhances the combustion process in engines. By breaking down impurities and complex hydrocarbons in liquid fossil fuels, the tech ensures a more efficient and cleaner burn, resulting in increased power output, lower fuel consumption, and a significant reduction in harmful emissions. Visit fuelre4m.com to learn more.

THE HUMAN PART IN THE TECH MIX

by Przemysław Myszka

The IT industry is like an ocean – vast and deep. The maritime part of it, though a niche, has very much matured over the years. Among the big venture-led and small start-up fish, there are also established software companies that have been steadily developing their offerings for decades. We are talking with Grieg Connect’s chief executive, Espen Ranvik, about his own transition within the tech domain, what differentiates the Oslo-based company from other vendors, its solutions and how they deploy them, as well as its expansion in the Baltic Sea region.

■ **Having worked for such multinationals as Deloitte and Capgemini, employing thousands of people and doing consultancy gigs all over the world, why did you decide to become a member of the Grieg Connect team, a slightly more slenderly built organisation?**

I joined the company in the spring of 2024 – and these months have been truly informative in getting to know the particulars of the maritime industry, which I really grew to like. I have been filling consultancy & managerial roles for the past quarter of a century, including the last 12 years in the tech world. In my previous occupation, I visited the Baltics and Finland quite often to deploy digital solutions. These not only improved performance or heightened security but maybe, above all else, targeted customer satisfaction. Sure, you can dump IT on clients and leave them to wrap their heads around it – for better or worse. Yet, that’s certainly not my way of doing things – and surely not how projects are executed here at Grieg

Connect. Another key lesson from that Baltic period of my career was the finding that although Estonia, Latvia, Lithuania, and Finland are distinct cultures, what unites them is the shared openness to employ digital solutions to improve work – be it safety or efficiency. Believe me, it makes business life a lot easier in the IT world when you’re met with an open mind instead of pitchforks and torches.

I sincerely hope this ‘critical mass’ of software-for-heavy-duty-hardware & business experience, the staff’s likewise mine, will come in handy now that Grieg Connect has decided on a considerable market expansion in the Baltic Sea region. As we near the end of 2025, we have the opportunity, both personally and as a company, to catch our breath ahead of what will in all probability be an exciting period of building the enterprise on the Baltic Sea pillar. We are ready and eager to grow with the help of our new customers in Estonia, Finland and Sweden – and whoever jumps on the maritime digitalisation bandwagon along the way. Though we want to develop, which will

by all means result in onboarding more people, Grieg Connect will stay a company that’s nimble, one that offers the personal touch in the IT sector. Besides, we’ve got excellent solutions that we’d proudly like to present to a wider, tech-performance-hungry audience. Personally, it really feels invigorating to leverage one’s accumulated experience in IT, consultancy & executive management, leadership, telecom, and finance to set sail into new waters!

We are also very fortunate to have the backing of the Grieg Group. While Connect’s team is 30+ person strong, the Group counts some 2,000, well-established in various industries (seafood, shipping, ship-broking, maritime innovation, logistics, and investments) and with a solid maritime heritage reputation built throughout 140 years. From its inception, the Group has been a family-owned organisation. From an IT perspective, this has a clear advantage. Unlike venture-led vendors, we’re not subordinated to chasing after quarterly dividends. And in contrast to start-ups, we’re not on a hunt after that



PHOTOS: GRIEG CONNECT

unicorn client that will lift the business off before it implodes. Grieg Connect was born more than a quarter of a century ago. It became part of the Grieg Group about a decade ago, with long-term thinking as the guiding star. Fast forward to end-2025, and we serve over 90 ports & terminals, plus 320 ferries & high-speed vessels. We prioritise stability, continuity, and responsible development over quick returns. That holds for both our partners, who benefit from predictable roadmaps, as well as our team, which gains from the

trust put in them and gradual competence building. Whereas it's true that IT, software, and digital solutions are about data and coding, it's not that we have AI working for another AI. We have people working for people, doing business with each other, implementing and maintaining what's been invented thanks to the power of the human brain. If there's one secret ingredient to Grieg Connect's to-date success, it is exactly not losing sight of the human part in the tech mix. If we are a family-owned firm, it is that kin-centric

relationship we try to foster in parallel to developing a top-notch offer.

■ *What's in Grieg Connect's current portfolio?*

In a nutshell, our Port Management Information System (PMIS) is a modular, software-as-a-service platform that 'sits' in the cloud. It has your back in the areas of port calls, berth and resource planning, tariffs and invoicing, contracts, statistics, reporting, port community services, security and access control, and business intelligence. PMIS is one configurable, modern, and secure (NIS2-compliant) system covering the full port mandate. Scalable from small to large ports, our solution is out there to assist companies in their journey from pen & paper to 24/7/365 digital operations.

But of course, it takes two to tango. Fortunately, we can see a growing momentum in the maritime community to level up their businesses digitally. Ports understand that delaying the digital transformation increases operational risk and cost. Manual processes simply do not scale with business or regulations. If somebody is sceptical about the whole transition, or perhaps just overwhelmed, Grieg Connect is ready to show value early on. A typical implementation takes the client and us through process design, configuration, data migration, training, and phased go-live. Afterwards, we provide support, maintenance, upgrades, and access to





new modules. Worth mentioning is that we research in advance to illustrate what practical benefits our solution can bring to this-and-that concrete port. This individual approach proves especially useful when dealing with a customer who might at first be stunned by the different options and the amount of data.

■ ***Grieg Connect highlights its work in creating smart and sustainable ports. What stands behind your understanding of these two terms?***

Smart, as we understand it, means improving the daily life of those engaged in port (and shipping) activities. A process can be done manually or digitally. Automating the former is impossible. Going digital simply unlocks improvements unattainable through manual processing. But modern solutions such as our PMIS must go beyond spreadsheets, this pen & paper 2.0 of handling things. This is done by automatically integrating various data sources into an actionable insight – whether a berth is free to welcome a ship or dispatch an invoice for completed services. For

somebody running the port business, an overview of what is happening and where and over a set period (not only in the snapshot moment) is also crucial. As such, smart stands for visibility of the port value chain.

Data is called the new currency. With a port management system, it's vital to have enough data, not too little but also not too much, and of the right quality. Data should be a nutritious feedstock for business intelligence – not business guesswork. So, if smart means digital, data-driven, and interoperable operations, then it naturally ties to the sustainability part of the equation. Sustainable means efficient use of resources, reduced emissions through better planning, and reliable reporting to meet regulatory requirements. In short, while dockers sometimes have to work in a foggy environment, there is absolutely no need for a port company to shorten their line of sight or have to deal with blind spots. Data is knowledge, and knowledge is a springboard to action. And if a port functions better, then the positive effects trickle down the on- & offshore logistics chain and the trade, economies, and people it serves.

■ ***Not every port company is well-versed in all things IT. How do you introduce such clients into the world of maritime software?***

Because Grieg Connect's PMIS is modular, a client can start with the basics, say the port call feature. It is vitally important for both the customer and us that our solution – the concept, likewise the use of it – is 'domesticated' so that it can deliver tangible benefits. There are real differences between having a digital solution, using it, and using it proficiently. Grieg Connect is here to ensure clients get to the 'how-could-I-been-working-without-it-earlier' stage. Then, we don't have a customer anymore – we've got a committed partner with whom we can develop further. And, of course, we're flexible to accommodate any level of tech-savviness a client has – from absolute null to those who have got a handle on their 0s and 1s.

As we grew over the years, the major challenge was handling diverse port practices. Here, the lesson was to build configurability and work closely with the users. We are still here, so it must mean we proved to be as good of a solutions provider as we were

a student! What we learnt was that reliability and consistency matter more than features and that standard processes must still allow for local adaptation. Support, uptime, and data quality are critical at scale. Patience and solidity, in other words. We also invested a lot in making our solution (cyber)secure through strict access control, role management, logging, and secure hosting. That NIS2 compliance didn't materialise from nowhere. These days, security must sit at the very core. Apart from that, the R&D team is now busy with polishing interoperability, automation, analytics, and regulatory reporting. As such, the strategic focus is on robustness and usability rather than experimental technology.

■ ***Why did you choose the Baltic Sea region as your next growth chapter?***

We have built a strong network in the Nordics over the years. Grieg Connect has four offices on our home turf in Norway, plus two in Finland and Sweden. Localised expertise is second to none! That is also the plan for the ongoing Baltic Sea expansion – first a firmer foothold in Finland through the acquisition of

Wellamo Data. Founded in 1996 and run by Atte Rotko, this 'integration-is-us' boutique establishment was, among many other developments, the very first Finnish PDS developer that provided a portnet integration. Today, the company's data-enriching solutions are integrated into different vendor systems. Having Atte and his expertise on our side makes us more than confident that Grieg Connect can pull it off on the Finnish market. Organic growth is one thing; takeovers are another. With Wellamo Data, we can have the best of both worlds. We are ready to test ourselves by bringing more competition to Finland's maritime IT scene. Overall, growth will come mainly from small and mid-sized ports modernising their legacy systems. Recent wins, like the one in Estonia with Saarte Liinid, reflect just that – local presence, credibility, and stepwise delivery. The Estonian deal encapsulates the suitability of our offer. Saarte Liinid manages 18 harbours, cargo and passenger alike, dotted throughout the country's mainland, islands, and lakes. In short, different needs are being satisfied through one platform.

Grieg Connect's PMIS is used by over 90 ports in northern Europe. These are as

diverse as the industry itself. The Port of Bergen uses the system to collect cargo data from Sea-Cargo ro-ro traffic automatically. It flows directly into invoicing, thus improving data quality & tax accuracy, and forms the basis for statutory reporting. In Oxelösund, a large industrial port in Sweden, PMIS supports port calls, warehouse rentals, and invoicing. The system has reduced manual work and simplified daily operations. The Port of Harstad uses PMIS to manage ISPS requirements. The Port Security feature supports planning of security activities, access management, permits, and inspections. Deviations, zoning, and movements are handled directly in the system, with documentation available for audits and follow-up.

These are just a few examples showcasing that our system, the complete package or the particular solutions, is tried and trusted in different settings, including in the Baltic Sea region. We will gladly add other success stories in the coming months and years. And this isn't just your standard corporate jargon – nowhere close to it! Success-by-Grieg Connect is measured in efficiency, data quality, revenue capture, and compliance. ■



FROM REACTIVE TO RESPONSIVE

by Oliver Schmitz, *Research Associate*,
and Emin Nakilcioğlu, *Research Associate, Fraunhofer Center for Maritime Logistics and Services (CML)*

As container logistics grows increasingly complex, the ability to anticipate and respond to disruptions becomes a defining factor in terminal performance. The KILOG project (Künstliche Intelligenz für Logistikoptimierung in deutschen Häfen/Artificial intelligence for logistics optimization in German ports) explores how artificial intelligence (AI) can strengthen operational precision and resilience at the Altenwerder (CTA) and Burchardkai (CTB) container terminals of HHLA. Funded under the IHATEC II program (Innovative Hafentechnologien/Innovative port technologies), the project addresses intermodal use cases such as rail slot optimization, predictive maintenance, and container availability forecasts. This article focuses on two of those initiatives: a container flow forecast that predicts yard blockages before they occur and on a pipeline, based on a large language model (LLM) that consolidates ship arrival information from heterogeneous sources. Together, they reduce manual effort, enhance planning reliability, and provide the foundation for scalable, data-driven decision-making across terminal operations.

Global supply chains have entered a phase marked by growing complexity, data fragmentation, and operational uncertainty. Ports and terminals, as pivotal nodes in this system, face increasing pressure to synchronize planning decisions with ever-changing cargo flows. Within this context, HHLA's CTA and CTB in the Port of Hamburg are taking decisive steps toward more responsive and data-driven operations through KILOG, which unites expertise from HHLA, Fraunhofer CML, and Hamburg Port Consulting (with Modility and Metrans contributing their intermodal experience).

The project's goal is to make terminal operations more predictive, adaptive, and sustainable by pairing algorithmic forecasting with LLM agents that structure and interpret real-world data on the spot. The focus is not on replacing established systems but on augmenting them, embedding AI-driven intelligence directly into daily decision-making. Achieving this requires a foundation of clean & reliable data, well-integrated interfaces, and clear governance to ensure trust and continuity in critical operations.

Through two concrete use cases – a container flow forecasting system and an LLM-powered ship arrival data pipeline – KILOG shows how targeted, human-centered AI applications can translate research into operational value, improving both efficiency and decision reliability across maritime logistics.

Resource-unlocking structure built on ground truth

Ship arrival data comes in many formats: spreadsheets with varying layouts, PDFs, emails, websites, and APIs. It changes frequently and must be kept up to date. In most terminals, assembling and maintaining a single, reliable picture of arrivals is still manual work, which is time-consuming, repetitive, and prone to inconsistencies.

KILOG deploys specialized LLM agents to ingest and understand these diverse sources, extract relevant fields, and structure them into a trustworthy dataset. A dedicated pipeline supports the agents with parsers for different media, connectors to source systems, and rules for reconciling discrepancies into a defensible ground truth. To improve performance in maritime contexts, the agents are fine-tuned on domain-specific data and guided with carefully crafted prompts and contexts. We benchmark different LLMs to balance accuracy, robustness, latency, and cost.

Crucially, operational trust is built through a human-in-the-loop validation system. Experienced maritime professionals review edge cases, provide continuous feedback, and capture nuanced domain knowledge, ensuring that data anomalies are detected before they affect mission-critical downstream decisions. This collaborative loop has proven essential to adoption, giving confidence in the AI's outputs and transparency in its logic to the operational teams.

The consolidated data set is delivered to a dashboard for OP teams and written to the data lakehouse, where it supports AI use cases as well as various stakeholders relying on precise ship arrival information. As updates propagate in near real time, schedulers move from manual wrangling to oversight and exception handling. The payoff extends beyond speed and reduced effort: skilled staff reclaim time for strategic thinking while automated agents handle routine data extraction; data quality and traceability improve significantly; and the same agent-based framework can be applied to other workflows (processing invoices, packing lists, or work orders), ensuring consistent, auditable information flows across shipping operations.

Completing the picture – with intelligent granularity & dynamic action

Terminal yards pulse with constant motion – containers flowing in from ships, trucks, and trains, then departing through another mean of transport. Yet, for all this orchestrated movement, yard planning has traditionally relied on seasoned intuition rather than granular intelligence. Existing research often focuses on long-term predictions, such as monthly, weekly, or daily forecasts, which help with broad planning but lack the precision needed to prevent localized pressure, blockages, or cascading congestion.

KILOG's forecasting engine provides near-real-time insights for yard operations: hourly predictions spanning 48-hour horizons, drilling down to individual yard

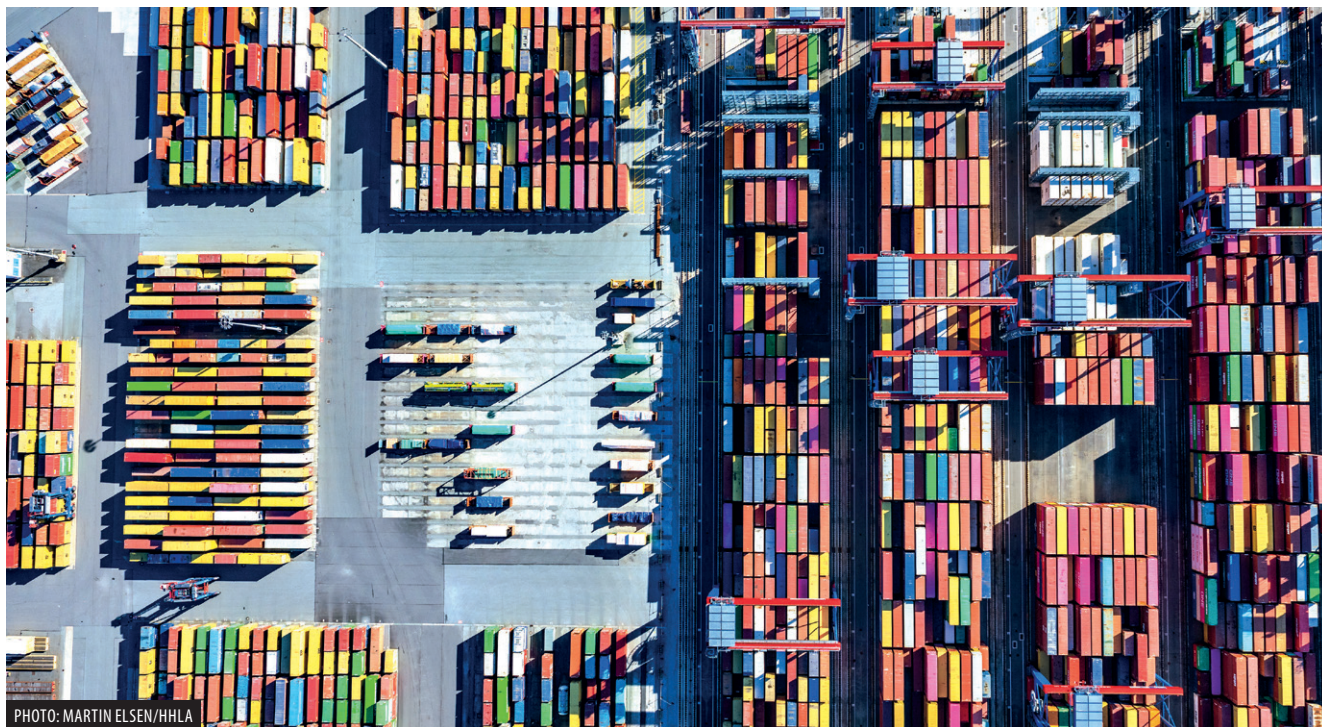


PHOTO: MARTIN EISEN/HHLA

blocks. The system processes multiple data streams simultaneously: terminal-operating-system signals capturing block utilization and equipment status; vessel schedules enriched with live ETAs and cargo manifests; and truck appointment systems revealing ground transport patterns. Weather data, holiday calendars, and disruption reports complete the intelligence picture, creating forecasts that adapt continuously as conditions evolve.

Advanced algorithms, tested and benchmarked across different modeling approaches, process this data stream into actionable intelligence. The models learn from operational patterns while incorporating live feedback loops, ensuring predictions track reality rather than theoretical schedules. Integration with optimization tools enables automated responses: equipment redeployment ahead of demand spikes, container routing adjustments to prevent blockades, and resource scheduling that anticipates rather than reacts.

With our forecasting framework in place, planners shift from reactive problem-solving to proactive orchestrators, repositioning resources ahead of demand surges, rerouting containers around predicted bottlenecks, and smoothing operational flows through strategic intervention. This transforms disruptive variability from an operational threat into a managed part of the plan.

Solid & clear design – ready to scale!

KILOG proves that the step from reactive to responsive operations is achievable when AI is grounded in solid data foundations, human-centered design, and clear governance. Granular yard forecasts turn uncertainty into manageable variation, while LLM agents convert fragmented, unstructured data into dependable, high-quality information.

The project's next phase will deepen integration with optimization systems, expand into adjacent use cases (such as container availability forecasting and predictive maintenance) and scale across

terminals and transport modes. As these systems mature, scalability and sustainability emerge as shared outcomes: consistent forecasting frameworks and data pipelines streamline operations, reduce idle time and emissions, and strengthen the resilience of entire logistics networks.

Ultimately, KILOG offers a blueprint for AI adoption in the maritime sector; one built on trust, transparency, and measurable operational impact. In a sector where slight delays can ripple through complex chains, timely, trustworthy information is not just helpful – it is decisive. ■



chains and has already

Oliver Schmitz completed his bachelor's degree in supply chain management at the University of Duisburg-Essen and then got a master's in business administration with a focus on operations research and production management. Since June 2021, he has been working as a research associate at Fraunhofer CML, where he is primarily involved in optimizing various processes in terminals (e.g., through AI-based forecasting of container dwell times or the development of various algorithms for optimizing container handling). Furthermore, Schmitz has a deep understanding of intermodal supply chains and has already successfully collaborated with a variety of stakeholders in this field.



providing software development and technical support for maritime-specialized projects.

Emin Nakilcioğlu completed his B.Sc. in mechanical engineering at Istanbul Technical University and his M.Sc. in mechatronics at the Hamburg University of Technology. During his graduate studies, he specialized in intelligent systems, robotics, and deep learning. Since August 2020, Nakilcioğlu has been a research associate at Fraunhofer CML, contributing to AI- and data-driven digital innovations in maritime logistics. His work focuses on developing solutions for automatic speech recognition, natural language processing applications, time-series forecasting, and workload prediction, alongside providing software development and technical support for maritime-specialized projects.

YOUR NEW ALLY ON THE BRIDGE

by Dor Raviv, CTO and Co-founder, Orca AI

The Baltic Sea has long been a proving ground for maritime innovation – from pioneering ice-class vessel design to early adoption of e-navigation concepts such as digital traffic management. Small but intensely sailed, the Baltic links nine coastal nations through a dense network of short-sea routes. Its shallow waters, narrow fairways, and strict environmental rules have made it a living laboratory for efficient, low-impact shipping.

From ferry corridors between Helsinki and Tallinn to the approaches to Gdańsk and Klaipėda – and beyond the Danish Straits to Gothenburg and the North Sea routes – vessels of every size share limited space under shifting weather and visibility conditions (not to mention not unsuccessful attempts by malevolent parties to jam navigational signals...). In such an environment, situational awareness is not a luxury; it is a defining factor for safety, efficiency, and environmental performance.

As shipping in the Baltic becomes more automated and data-driven, artificial intelligence (AI) is emerging as a new ally on the bridge. Rather than replacing human judgment, AI-powered computer vision augments it – turning vast amounts of visual, radar, and navigational data into real-time insights that help crews operate more safely and confidently in complex waters.

A sea of constraints

The combination of high vessel density, complex geography, and strict environmental regulation within a confined basin represents a concentration of operational variables matched by few other regions. Thousands of ship movements each day mix with ferry traffic, offshore wind construction, fishing vessels, and leisure craft (and, again, a 'shadow fleet' that detrimentally blurs the picture...). Fairways are narrow and often shallow, with long winter nights and sudden fog.

Such conditions demand constant vigilance. Even experienced bridge teams can find the workload overwhelming when multiple small targets appear on the radar and the light fades early. According to statistics from the European Maritime Safety Agency, human error contributes to over 75% of navigational incidents in the waters of Europe. Fatigue, sensory overload, and misinterpretation of data are

common precursors. For shipowners and ports under pressure to maintain punctual schedules and reduce risk, these constraints are increasingly hard to manage through traditional means alone.

That and the generational shift in how a crew member approaches navigation. While older officers rely more on 'feeling' how the ship behaves, an expert 'sense-memory' built by sailing thousands and thousands of miles with intentional focus, the younger generation bases its assessment more on technology – what the screen says rather than what's outside the porthole. This is not to judge whether the former is better than the latter; instead, it's a call to provide future crews with the best possible tech that makes them as proficient in navigation as those salty dogs who sailed according to their gut.

From incidents to intelligence

AI-enabled situational awareness addresses the problem at its root: perception. Our operational platform uses highly sensitive day- and night-vision cameras with an unmatched field of view to create a continuous visual record of the vessel's surroundings, detecting and classifying objects – from merchant ships to small fishing boats – in real time and in all weathers.

This information is fused with radar and AIS inputs to generate an enhanced display and predictive alerts. The system can flag potential collision risks earlier than the human eye could, tracking their evolution using COLREG-based logic. In the Baltic's dense approaches, this is not about taking control away from officers but clarifying the picture. AI becomes a second pair of eyes that never tires and can see in the dark. The result is earlier avoidance manoeuvres, smoother speed adjustments, and fewer near-misses – translating into measurable safety and fuel-efficiency gains.

Each detection or alert becomes part of a continuously expanding record of how a vessel behaves in specific conditions. Fleet managers can review this data onshore to see where challenges occur, how watch teams react, and which areas correlate with higher alert rates. This shifts safety management from reactive to preventive.

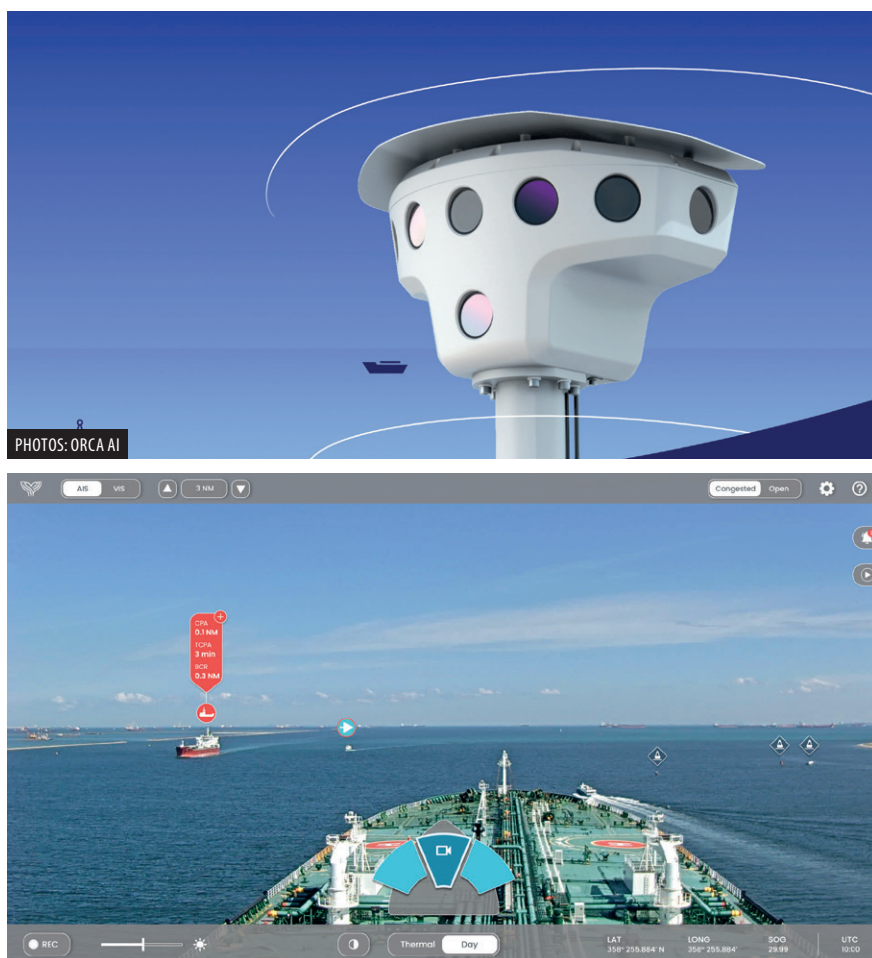
When aggregated across fleets, AI navigation data reveals where navigational challenges occur most frequently and under what conditions. Shared with port or coastal authorities, these insights could reliably inform improved traffic management and safety measures. This kind of data aggregation aligns closely with the digitalisation agendas of Baltic ports, providing a foundation for data-driven discussions on pilotage procedures, harbour entry protocols, and risk assessment.

Few regions test human perception like the Baltic in winter. Northern darkness extends bridge watches over long hours, while snow and spray can potentially degrade radar returns. AI vision systems mitigate these challenges by detecting moving or static targets even when visibility is poor. The psychological effect is significant. Knowing that the system will alert them to unseen risks allows officers on watch to focus on higher-order decisions rather than constant scanning. This reduces cognitive load and fatigue, especially on night passages.

Linking ship and shore (in many a way)

AI-supported navigation also acts as a bridge between onboard and onshore perspectives. With secure cloud connectivity, fleet managers can monitor live or recorded data – for example, to assess whether a vessel can safely enter port during reduced visibility or to validate a near-miss report.

This supports the region's smart port strategies, which integrate vessel-traffic



management, environmental monitoring, and predictive maintenance. Over time, shared situational awareness between ships, shore, ports, and even insurers can improve collective decision-making and reduce disputes.

Speaking of which, safety at sea is both operational and financial. Traditionally, insurance premiums were set on static factors such as vessel age and claims history. AI-derived performance data changes that equation. Through partnerships with leading insurers, like NorthStandard, Orca AI is helping to build dynamic risk models that reflect how ships are actually operated. Real-world navigational behaviour – speed in congested areas, frequency of close-quarters encounters, adherence to COLREGs – can now inform insurance assessments. For shipowners, this means safer performance can translate into improved terms and faster claims resolution. For insurers, it enhances transparency and reduces disputes – a development likely to reshape the economics of maritime risk across the Baltic.

Improved situational awareness is also a decarbonisation tool. Fewer near-misses and better-planned avoidance manoeuvres mean smoother power profiles and lower fuel consumption. By helping navigators maintain optimal distances and speeds, AI indirectly cuts emissions and can help minimise wash impacts in sensitive coastal zones.

Several regional ports are developing green-corridor initiatives, with the world's very first green shipping corridor already online between Finland and Sweden in the Kvarken – that rely on digital data to monitor emissions and operational efficiency. As these projects mature, AI-derived performance data could provide an additional layer of transparency, linking navigational safety with sustainability outcomes.



ORCA AI Founded in 2018 by a team of Navy veterans, Orca AI, a maritime tech startup, empowers shipping companies to enhance their operational safety, efficiency, and sustainability through a single AI and computer-vision-based operations platform. In June 2025, over 1,200 vessels were already part of the platform. Sail to orca-ai.io to discover more.

A step towards autonomy (with humans in command)

The term “autonomy” may trigger unease in a region that values seamanship. In practice, it will emerge incrementally, through layers of intelligent assistance rather than crew replacement.

AI-assisted navigation enables ships to operate with greater precision and awareness while keeping humans firmly in control. For the Baltic, where digital infrastructure and regulatory maturity are high, the region could become a leading test bed for safe, human-centred autonomy.

And indeed, feedback from early adopters shows that watchkeepers quickly develop trust in the system once they see its consistency and accuracy. Instead of replacing judgment, it validates and supports it. Officers can review annotated video timelines during handovers or training, turning experience into verifiable learning.

This blending of technology and seamanship may prove the real legacy of AI on the bridge: redefining professionalism not as infallibility but as continuous learning supported by data and shared understanding.

Safer, smoother, smarter!

From the bone-freezing northern Nordic to the narrow Danish Straits, the Baltic maritime community has always combined practicality with innovation. Its dense traffic and demanding weather have driven advances in ice & e-navigation and digital port integration. AI-enhanced situational awareness is the next staple in that tradition.

As regulatory attention to safety and environmental performance intensifies, shipowners and port operators recognise that the next efficiency gains will come not from bigger ships or faster turnarounds but from better information; information that helps humans make the right decision at the right time.

The promise of AI on the bridge is simple: to make every voyage in the Baltic a little safer, smoother, and smarter. The technology is ready; the opportunity now lies in making it part and parcel of everyday navigation. ■

MIST, POWER, ACTION! COOLING MODERN LOGISTICS

by Andrzej Urbaś

In the world of modern logistics and port handling, where machinery operates under immense pressure and downtime is measured in significant financial loss, the margin for error is nearly non-existent. As the industry shifts toward low-emission engines and electrification, new and complex fire safety challenges are emerging.

Recently, we had the chance to have a chat with Fredrik Rönnqvist and Gustav Stigsohn of the Fogmaker fame, discussing the strategic and technical pillars of their technology. How can a company effectively protect multi-million-dollar equipment and, most importantly, human lives in such demanding environments? Let's find out!

■ **Port Gear:** *To provide a baseline for our readers, could you briefly introduce Fogmaker International and define the core mission that drives your development of fire suppression technology for the material handling sector?*

Fredrik Rönnqvist: Fogmaker International, founded over 30 years ago, supplies high-pressure water mist fire suppression for vehicles and other enclosed spaces (such as gensets). We have approximately 350,000 systems installed in 70 countries

in applications ranging from race cars to mobile harbour cranes. Our core mission, not just for material handling, but for all the segments we work in, is that "everyone gets home alive after work".

■ **PG:** *How does Fogmaker's water-based mist system address the specific fire risks created by higher engine temperatures and fuel pressures in modern, low-emission machinery?*

FR: We do this by supplying a state-of-the-art, field-proven, fully mechanical, automatic fire suppression system that has high pressure and long activation time.

Gustav Stigsohn: High pressure breaks down the suppression liquid into tiny droplets. Smaller droplets will give more contact area per volume and subsequently cool hot components better. A mechanical system removes the risk of electrical failures causing the FSS not to function. The loss-of-pressure system

is always active and a major failure on a component usually means that the system deploys. 350,000 systems in the market tells the story that our customers are happy with our product. We, as all, of course have our flaws but we are constantly working to improve our product and our offer.

■ **PG:** *Material handling equipment often contains large volumes of diesel and hydraulic oil that act as intense fuel sources. Could you elaborate on the "Triple Action" technology and why achieving a cooling effect is more critical for preventing re-ignition than simply choking the oxygen supply?*

FR: For a fire to start you need three things: Fuel, heat and oxygen. Remove one and the pre-requisites aren't there. The Fogmaker system attacks all three at the same time. A long activation time allows for extensive cooling thus



PHOTO: ADOBESTOCK:THOMASLERCHPHOTO

effectively reducing the heat. Then, as the water mist is sprayed out into the engine bay, the mist expands into water vapor (1L of water mist turns into 1700L of water vapor) thus displacing the oxygen.

GS: Furthermore, a small percentage of fluorine-free foam is added to the suppression liquid to act as a chemical “fire blanket” on fuels. The foam prevents fumes from mixing with air and ignite.

■ **PG:** *With the industry shifting toward electrification and fuel cells, how has Fogmaker adapted its detection and suppression strategies to protect these new energy sources from external fire initiators?*

GS: A fire is a fire despite the source. While this is a simplification, it is also fundamentally true. The Fogmaker system works on several different types of fires including A, B and C-class fires. The major difference is not in the product, it is in the application; new fire risks need new methods when installing the fire suppression system - for example placement of nozzles and detection.

■ **PG:** *The Fogmaker system is fully automatic and independent of electricity. In remote environments like railyards or port terminals, why is this mechanical independence a vital safety factor during a thermal event?*

GS: A mechanical system removes the risk of electrical failures causing the FSS not to function. A dead starter battery will for example not have any impact on the FSS.

■ **PG:** *For global logistics companies operating across different jurisdictions, how does Fogmaker ensure that a system installed in one region meets the rigorous service and insurance requirements of another?*

FR: Fogmaker is the most tested and certified vehicle fire suppression system in the world, and we test and certify on a continuous base to ensure that we meet local, regional and global standards and requirements. Apart from testing at the authorities and certification bodies we also have our own in-house fire test cell where we conduct testing daily. This is done, not only to meet requirements but also to improve the system as much as possible and find the optimal configuration for different applications and standards. Just lately we have added two more standards/certifications: UAE and FM Standard.

■ **PG:** *While the system requires annual, five-year, and ten-year services, Fogmaker emphasizes a low Total Cost of Ownership (TCO). How do these structured service intervals translate into long-term financial stability for port and logistics operators?*

FR: In a ten-year period, there are only two extended service intervals, namely

the five- and the ten-year service intervals. The other eight annual services are a validation of the system and making sure that the system is functioning. These eight annual services are done in a very short time thus ensuring minimal downtime and minimum disruptions in an industry where up-time is key.

■ **PG:** *Looking ahead at the evolving landscape of material handling and port safety, what upcoming developments or future plans at Fogmaker are you most excited about in terms of advancing fire safety technology?*

FR: Right now, we are doing a couple of things. For one thing we are expanding our market presence and global reach through an increased partner network but have also opened three regional offices in the last years. Without revealing too much or going into too much detail, I can say that this journey is in its infancy and in the years to come you will see a lot of development here.

GS: On the technology side we are finishing the transition to PFAS-free liquid, we have also launched a new section valve that can direct suppression liquid to different compartments depending on where there is a fire, a cost-effective solution for example electric vehicles where the fire risks are spread over the machine.

■ **PG:** *Thank you both for your time!* ■

CHAPTER SEALED

by Joy Basu, CEO, Smart Ship Hub

The maritime industry should brace itself for a defining moment in 2026. This will be the year digital transformation stops being discussed as an aspiration and starts being proven as a commercial necessity. The argument is no longer about whether the industry should digitise, but how fast companies can capture the value already on the table.

Technology adoption across fleets and the broader maritime value chain will speed up sharply in 2026, not because of hype but because the economics now work. Owners, operators, and charterers are demanding a measurable return on investment (ROI), real-time intelligence, and enterprise-grade AI. Digital tools are finally delivering on all three.

By the end of the year, roughly 30% of owners, operators, and charterers will have launched pilot programmes. Crucially, many of these will not remain trials for long. They will scale into production deployments as data-driven intelligence proves its value in daily operations. What's different this time is that mid-sized and smaller maritime companies are joining the movement. Falling technology costs and compelling value outcomes have removed the historical barriers to entry. Digital advantage is no longer reserved for the largest fleets.

Customers no longer pay for technology itself; they pay for the future value it unlocks. That means the end state must be articulated as clearly as the path to reach it. Vague promises will fail. Platforms that can show how data translates into better decisions, lower costs, and faster execution will win.

A technical financial conversation

This year will also see a steep change in the use of high-frequency sensor data, combined with AI and machine learning. Most organisations will begin with one high-impact use case – and that will be enough. More than half of these deployments will generate clear outcome statements: accurate insights, multi-variable analysis, and predictive intelligence that directly supports sustainability, business continuity, profitability, and value creation.

Standardisation will quietly become one of the most powerful enablers of progress. Wider adoption of ISO 19847:2024 (ships and marine technology – shipboard data servers

for sharing field data at sea) and 19848:2024 (ships and marine technology – standard data for shipboard machinery and equipment) will accelerate data exchange between ship and shore. Common schemes and application programming interfaces (APIs) will reduce custom integration work, allowing data providers and last-mile users to connect faster and cheaper. This is how digital scale is achieved – not through bespoke projects, but through shared foundations.

The strongest digital momentum in 2026 will come from measurable ROI frameworks. These will need to be clearly defined, mutually agreed upon, and tied to hard key performance indicators. Narratives without metrics will be dismissed. Owners, operators, charterers, insurers, ports, and manufacturers all need an unobstructed benefit-line of sight: time savings, increased agility, fewer intermediaries, and direct bottom-line impact. Digitalisation is now a financial conversation, not a technical one.

Value regardless of regulations

The International Maritime Organization's delayed Net-Zero Framework has created policy uncertainty. However, this is not a setback; it's a window of opportunity. Rather than delaying, it advances digitalisation. Companies now have time to strengthen data foundations, modernise workflows, and adopt fuel-agnostic digital platforms that simplify compliance while protecting margins. In uncertain regulatory environments, digital transformation is the smartest strategic choice available.

The green transition is non-negotiable, but it will only pay back through smarter systems. Fuel transition carries short-term costs, and emerging technologies will determine how quickly those expenses are recovered. A technology-first approach in this period of uncertainty will disrupt legacy processes and reward organisations that move early.

Platforms that can automate compliance, monitor performance, and remain fuel-agnostic will be preferred because they deliver value regardless of regulatory outcomes.

What makes this transformation particularly compelling is its capital efficiency. Digital platforms deliver agility, data syndication (delivering accurate service/product information), and cost savings without requiring immediate fuel transitions or vessel overhauls. This low-CAPEX, high-impact model is reshaping the market and broadening adoption.

What will ultimately separate leaders from laggards in 2026 is execution speed. The technology is ready; the economics are proven; and the operational pain points are well understood. The only remaining variable is organisational willingness to act. Companies that continue to delay under the guise of 'watching the market' will find themselves structurally disadvantaged, not just technologically behind.

Core infrastructure

Digital maturity will increasingly influence commercial competitiveness. Charterers will favour operators that can provide transparent performance data, emissions visibility, and reliable estimated-time-of-arrival (ETA) intelligence. Insurers and financiers will price risk more precisely, rewarding fleets with demonstrable operational control and penalising those that rely on manual reporting and fragmented systems. Ports and terminals will integrate faster with digitally enabled vessels, reducing delays and inefficiencies. In this environment, digital capability becomes a commercial credential.

There will also be a shift in how digital initiatives are governed internally. Successful organisations will move ownership away from siloed IT teams and place accountability with operations, commercial, and safety leadership. Digital transformation will be



PHOTO: SMART SHIP HUB

treated as core infrastructure, not an innovation side project. This cultural shift will matter as much as the technology itself.

Another defining change will be the convergence of operational, commercial, and compliance data. Historically, these domains have been managed separately, creating blind spots and inefficiencies. In 2026, integrated platforms will enable a single source of truth, allowing organisations to optimise voyages, manage emissions, forecast costs, and support regulatory reporting from the same data foundation. This convergence will unlock decision-making speed that legacy systems simply cannot match.

Finally, expectations will rise permanently. Once organisations get their hands on real-time visibility, predictive alerts, and automated workflows, there is no return to manual processes. Crews, shore teams, and partners will demand the same level of intelligence across all operations. Digitalisation will cease to be a differentiator and instead become the baseline for participation in the market.

Those who act/hesitate

This year will, therefore, not be remembered as a time of experimentation but as the point at which maritime decisively crossed from digital exploration to digital nativeness. Those who act now will shape the standards, partnerships, and operating models of the next decade. Those who hesitate will be forced to catch up at far greater cost and with far fewer strategic options.

Innovation will quicken further through low-cost edge gateways, plug-and-play sensors, and high-frequency data streaming from engines, shafts, bridges, flow meters,

and cameras. These technologies will drive retrofits across older vessels while enabling situational awareness, predictive insights, and real-time decision support. As costs continue to fall, data-driven intelligence will be democratised across the industry.

Integrated systems will mature rapidly. Unified platforms combining machinery data, video feeds, human inputs, and vibration monitoring will enable remote fleet performance management, safety oversight, condition monitoring, and real-time alerts. These are no longer experimental capabilities; they are becoming operational standards.

AI and robotic process automation will also move from isolated tools to embedded enterprise systems. Digital twins will enable collaboration across owners, ports, charterers, brokers, and agents. Use cases such as emissions forecasting, performance benchmarking, procurement prediction, and scenario modelling will become routine. AI, supported by rule engines, will be trusted for real-time risk profiling, vessel health assessment, and remote inspections, delivering tangible value to owners, insurers, and port authorities alike.

For AI to deliver results, it must be context-specific and trained on real maritime data. Historical sensor data, transactional records, documents, manuals, and reports will form the foundation of accurate models. Predictive

intelligence, once expensive and exclusive, is rapidly becoming affordable and mainstream. ETA planning, fuel optimisation, emissions forecasting, machinery life prediction, port coordination, and commercial decision-making are already being transformed.

The wider impact will be profound. AI will embed itself across on-board operations, shore-based workflows, safety management, and regulatory compliance. Automation, interoperability, Internet-of-Things gateways, and API-driven data exchange are already reshaping how ships, ports, insurers, and classification societies interact.

No longer the privilege of a few

The industry has entered a decisive phase. Owners and operators no longer tolerate vague promises. They demand proof – and digitalisation is now delivering it. Time savings, agility, reduced intermediaries, and data-driven execution are strengthening both top and bottom lines.

The winners of 2026 will not be those with the most technology, but those who can clearly articulate value and show exactly how digital tools lead to smarter operations. These innovations will democratise data and ensure that advanced insights are no longer the privilege of a few, but the foundation of a more resilient, profitable, and future-ready maritime industry. ■



Digital transformation challenges every company. Why face it alone when we can move faster together? The Open Logistics Foundation is a non-profit organisation that offers companies a neutral platform for the collaborative development of open-source software. More than 50 companies and network partners from over a dozen countries are already engaged in the Foundation's unique and purposeful approach of jointly tackling and advancing digitalisation projects. Visit openlogisticsfoundation.org to learn more.

TRUSTWORTHY INDUSTRIAL AI IN INTRALOGISTICS

by Melanie Terne, *Cluster Mobility & Logistics Regensburg*

The Cluster Mobility & Logistics Regensburg, operated by TechBase Regensburg, provides the organisational and strategic framework for a broad range of innovation activities spanning mobility, logistics, industrial automation, software, and artificial intelligence (AI). Within this ecosystem, the Multimodal AI for Adaptive Intralogistics and Robotics (M-AIR) network represents a focused R&D initiative that's tasked with sparking research impulses through the Cluster's technological depth and methodological rigour.

Established under the German ZIM programme (Zentrales Innovationsprogramm Mittelstand / Central Innovation Programme for SMEs), M-AIR follows its core principles: pre-competitive collaboration, clear R&D character, and the deliberate acceptance of technological risk. The network does not aim to deliver short-term market solutions; instead, it addresses unresolved questions around the use of multimodal AI in industrial production, intralogistics, and robotic systems, where probabilistic AI approaches must be reconciled with deterministic, safety-relevant processes.

The M-AIR network brings together a broad ecosystem of companies and academic institutions active in AI, robotics, and industrial systems. The overall network comprises various SMEs and several universities that are involved in workshops, thematic exchanges, and early-stage ideation processes. Within this broader ecosystem, individual R&D activities are carried out by smaller, dedicated core consortia, formed according to the ZIM framework. This structure allows M-AIR to combine openness and diversity at the network level with focus, feasibility, and research depth at the project level.

Effective R&D

A central research challenge addressed by M-AIR lies in the tension between non-deterministic AI behaviour and the requirements of industrial systems. Questions of explainability, verifiability, and controllability are critical wherever AI outputs directly influence machines, processes, or safety-relevant decisions. Exploring how AI systems can be embedded into such environments in a reliable and transparent manner clearly falls within the scope of experimental development as defined by the ZIM guideline.

A defining characteristic of M-AIR is its long and structured build-up phase. Since December 2024, the network has been shaped through a series of moderated workshops, bilateral technical discussions, and joint consolidation phases. These formats were explicitly designed as working sessions rather than presentation platforms. The focus lay on aligning terminology, clarifying system boundaries, identifying genuine research risks, and distinguishing research questions from implementation tasks.

This extended preparation has proven its value by enabling the partners to move beyond generic AI narratives towards developing shared problem definitions

that are both scientifically grounded and industrially relevant. By the time the network structure was consolidated, roles, interfaces, and research objectives were not only defined but mutually understood – an essential prerequisite for effective R&D collaboration under the ZIM framework.

Research impulses

The intensive exchange within M-AIR has already led to the identification of several potential project directions. These ideas reflect the current state of discussion within the network and illustrate the breadth of topics that could be further explored or deepened in future R&D activities.

First, speech-based mission definition for mobile robots, aiming to simplify the formulation of complex tasks and translate them automatically into precise machine commands. Second, intelligent path planning for autonomous systems, combining sensor data, digital plans, and user input to enable more flexible and safer navigation. Third, adaptive bin-picking systems using multimodal AI, extending automation in warehouse and production environments through integrating computer vision, robotics, and language models. Fourth, AI-supported grasp point detection in robotics, improving

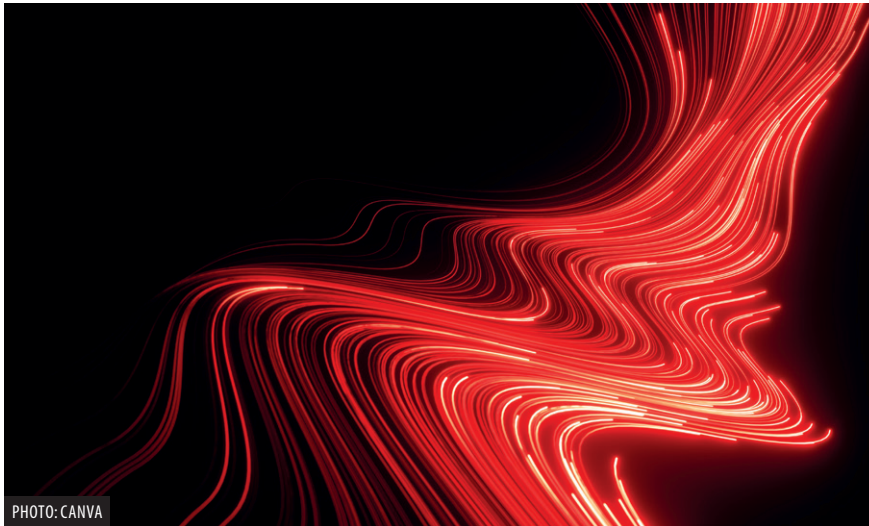


PHOTO: CANVA

risk evaluation when machines or plants are modified. Finally, AI-supported product compliance management, addressing the automated interpretation of international standards and labelling requirements in global value chains.

Though not yet active projects, these research impulses have emerged from the structured dialogue within the network. They illustrate the exploratory character of M-AIR and underline its role as a platform for early-stage, high-risk technological development.

To initiate, structure, and sustain

Within the broader activities of the Cluster Mobility & Logistics, M-AIR represents a small but highly visible pillar of excellence. It demonstrates the capability to initiate, structure, and sustain demanding research processes across disciplinary and organisational boundaries. ■

manipulation performance even for unknown or variable objects.

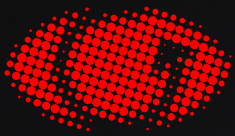
Next, generative planning of industrial layouts, exploring how AI models could automatically generate and evaluate factory or intralogistics layouts to speed up planning processes. Sixth, digital remodelling of existing plants, focusing on the automated transformation of 2D plans or scans into 3D models for modernisation,

simulation, or optimisation. Seventh, automated safety assessment of technical systems, investigating how AI could support



In the age of electromobility and IT logistics – including AI – TechBase Regensburg’s Cluster Mobility & Logistics, holder of the European Cluster Excellence Initiative Gold Label, works together with its partners and members to find innovative, intelligent, and sustainable solutions to upcoming societal and technological challenges. Visit mobilitylogistics.de/en to discover more.

In the age of electromobility and IT logistics – including AI – TechBase Regensburg’s Cluster Mobility & Logistics, holder of the European Cluster Excellence Initiative Gold Label, works together with its partners and members to find innovative, intelligent, and sustainable solutions to upcoming societal and technological challenges. Visit mobilitylogistics.de/en to discover more.




VISY

Stop Paying for Damage You Didn't Cause

[Learn more →](#)

Automatic Damage Detection System 2.0

Instant condition check the moment containers enter your terminal. No delays, no disputes, no surprises.

Expand 
Your vision



SAFETY REFINED MANY A WAY

by Richard Steele, CEO, ICHCA International

Safety in cargo handling has never been a fixed point. It evolves, sometimes gradually, sometimes in more decisive steps, shaped by operational experience, technological progress, and, often, by hard lessons learned. What is striking in the latest TT Club Innovation in Safety Awards is not just the range of solutions being put forward but the clear shift in mindset behind them. Across ports, terminals, and the wider cargo supply chain, there is a growing movement away from simply managing risk towards actively removing it, through better design, smarter use of technology, and a more realistic understanding of how people behave in complex environments.

These are not abstract ideas. They are being delivered by organisations working at the operational frontline, and increasingly they are addressing long-standing risks in ways that feel both practical and scalable.

Towards actionable competence & confidence

For many years, safety strategies have relied heavily on procedures, compliance frameworks, and training programmes designed to instruct people on what to do. While these remain essential, there is a growing recognition that they do not always reflect the realities of day-to-day operations.

This is where organisations such as Psychology Applied, working alongside the Energy Institute, as well as the Active Training Team (ATT), are helping to shift the dial. Their approaches, while distinct, are complementary. Psychology Applied's work is grounded in behavioural science, focusing on how people perceive and respond to risk in real-world settings. ATT, meanwhile, brings this to life through immersive, scenario-based learning that places participants in realistic, high-pressure situations. Rather than passively absorbing information, individuals experience how incidents unfold, how distractions creep in, how communication can falter, and how small decisions can escalate into serious consequences.

The value of this approach lies in its realism. It acknowledges that people do not operate in ideal classroom/laboratory conditions, and it equips them to make better decisions in the environments they actually face. Similarly, initiatives from the United Kingdom Maritime Pilots' Association emphasise situational awareness and human performance in dynamic,

often unpredictable settings, reinforcing the idea that safety requires informed and active human judgement as well as systems of rules.

What connects these efforts is a move beyond compliance towards actionable competence and confidence. It is about enabling individuals not just to follow procedures, but to recognise risk, speak up, and intervene when it matters.

Designing out exposure

At the same time, some of the most impactful innovations are those that eliminate or reduce risk by removing the need to do hazardous activities.

In port environments, the interface between personnel and heavy equipment has long been a source of risk. Traditionally, this has been managed through separation measures, training, and vigilance. Increasingly, however, organisations are looking to innovative technology to support existing approaches.

The Peel Ports Group, for example, has introduced a new authorisation and permit-to-work system designed to manage high-risk activities across its harbours. Moving away from a historically paper-based and inconsistent approach, this digital system provides greater standardisation, visibility, and control across the business, representing a more holistic, organisation-wide step change in how risk is managed.

By contrast, Lyttelton Port Company has focused on reducing exposure during specific high-risk operational tasks. While targeted in origin, the success of this initiative is now opening up opportunities to apply similar approaches across other activities within the New Zealand seaport, demonstrating how focused interventions can scale.

Technology providers are also reshaping this space. TrafficAngel, for instance, is

addressing a different but equally important risk: driver security. Its AI-enabled systems monitor the surroundings of stationary vehicles, helping detect suspicious activity when drivers may be resting in their cabs. In doing so, it extends the concept of safety beyond traditional operational risks to include personal security within the logistics chain.

Elsewhere, companies such as Bollard Proof are tackling the risks associated with mooring operations, an area where the consequences of failure can be severe. Their engineered solutions are designed to prevent catastrophic bollard failures, reducing the risk to personnel working nearby. Similarly, SIBRE is focusing on the safe handling of heavy loads, developing lifting and securing systems that reduce the likelihood of equipment failure and the need for manual intervention.

What is notable across these examples is that they operationalise the hierarchy of controls at the engineering stage – solutions that address risk at source rather than relying solely on human behaviour to manage it.

Turning data into (anticipating) action

Another defining trend is the increasing use of data to improve safety outcomes, not just retrospectively, but in real time. Organisations such as SICK are leading this development, deploying advanced sensor technologies that monitor operational environments and detect hazards as they emerge. These systems can identify the presence of people or obstacles within predefined safety zones, triggering alerts or automatic responses that help prevent incidents before they occur.

Similarly, LASE Industrielle Lasertechnik is using laser-based measurement and positioning technologies to improve precision and situational awareness in cargo-handling



PHOTO: CANVA

operations. By providing accurate, real-time information, these systems support safer decision-making in environments where visibility and spatial awareness might be restricted.

The application of data is not confined to equipment and infrastructure. Organisations such as the National Cargo Bureau are addressing safety challenges at a systemic level, particularly in relation to the handling of dangerous goods. By improving data quality, standardising reporting, and enhancing transparency across the supply chain, they are helping to reduce the risk of misdeclared or improperly handled freight, an issue that has been at the root of numerous incidents globally.

Together, these innovations point to a more proactive approach to safety, one that anticipates and mitigates risk before it results in harm.

The value of (big & small) practical ingenuity

What is particularly encouraging is that many of the solutions being developed are grounded in operational reality. They are designed to solve real-world challenges in practical ways.

Fire-Containers, for instance, is addressing the growing challenge of containerised fire risk with engineered solutions that can contain and manage fires within cargo units. As the industry grapples with the increasing prevalence of lithium-ion batteries and other potentially high-risk cargoes, such interventions are becoming ever more critical.

Meanwhile, companies like Passify are focusing on the flow of vehicles and people through terminal environments. By digitising and streamlining access processes, they are reducing congestion at entry points, an

often-overlooked factor that can contribute to unsafe conditions through queuing, frustration, and rushed behaviour.

Even smaller-scale innovations, including those put forward by individual entrants, demonstrate how incremental improvements can have a meaningful impact. Whether it is a new approach to securing cargo, a refinement in equipment design, or a low-cost intervention that addresses a persistent hazard, these ideas highlight the value of practical ingenuity.

Contributing to a common goal

Innovation does not happen in isolation, and its impact depends on how effectively it is shared and adopted. The most brilliant innovation may fail if you cannot bring people along with you.

One of the encouraging aspects of the current landscape is the level of collaboration across the sector. Ports, terminal operators, technology providers, and industry bodies are increasingly working together to develop solutions that can be applied more broadly.

This is reflected in the diversity of organisations represented in the TT Club Innovation in Safety Awards, from global operators to specialist technology firms and training providers. Each brings a different perspective, but all are contributing to a common goal: safer operations.

Standardisation is also an important part of this process. Consistent approaches to safety, whether in training, equipment, or procedures, help reduce variability and confusion,

particularly in environments where workers move between different sites and roles.

Taken together, these developments signal a continuing shift in how safety is understood and delivered. Moving away from approaches that are limited to managing risk through procedures, towards a richer picture that seeks to eliminate risk through design, technology, and behavioural insight. This is not about replacing existing safety frameworks, but about strengthening them, making them more effective, more resilient, and better aligned with operational realities.

The challenge now is to ensure that these innovations do not remain isolated examples of good practice. Their real value lies both in their adoption and in inspiring others to continue the innovation journey.

Safety within reach

At ICHCA, our role is to help facilitate learning and the exchange of ideas: identifying effective solutions, sharing them widely, and supporting their implementation across the global cargo-handling community. And what is becoming increasingly clear is that many of the tools needed to improve safety are already within reach. The task ahead is to apply them consistently and collaboratively, focusing clearly on the outcomes that matter most: protecting people, improving operations, and raising standards across the industry as a whole. Safety is not defined by what is possible, but by what is accepted as normal. ■

ICHCA INTERNATIONAL

The International Cargo Handling Coordination Association (ICHCA), founded in 1952, is an independent, not-for-profit organisation dedicated to improving the safety, security, sustainability, productivity, and efficiency of cargo handling and goods movement by all modes and through all phases of national and international supply chains. Visit ichca.com to learn more.

BRIGHTER – SAFER – FUTURE

by Richard Steele, CEO, ICHCA International

*Safety innovation is not confined to one aspect of the operation. It is continuously emerging across training, equipment design, digital systems, cargo integrity, and the critical interface between people and machinery. In *Safety refined many a way*. Designing danger out of cargo handling – part one, we explored how organisations are reshaping safety through behavioural insight, engineering controls, and better use of data. What becomes even clearer when looking across the full breadth of this year's TT Club Innovation in Safety Awards is just how widely that thinking is now being applied.*

The diversity of this year's entries reflects an industry that is not only innovating but doing so in ways that are increasingly connected and practical. As we've seen in part one of how to design danger out of cargo handling, several entrants are rethinking how safety knowledge is built in the first place, not as a one-off exercise, but as something embedded in operational culture.

Safety is not just taught

CM Labs Simulations is pushing the boundaries of immersive training through high-fidelity simulation environments. These allow operators to experience complex cargo handling scenarios, crane operations, equipment failures, and environmental challenges in a setting where mistakes can be made safely and learned from. This is not theoretical training; it is experiential learning that builds instinct as well as knowledge.

At an organisational level, Dublin Port Company is demonstrating how to unite multiple independent terminals within their port through open dialogue, structured safety training, standardised rules, and joint problem-solving. This peer-led engagement has been seeded into everyday port operations, reinforcing expectations consistently across the workforce. Similarly, the ESLI School of Logistics and Global Supply Chain Classroom are tackling the issue earlier in the pipeline, ensuring that cyber-risk understanding is embedded into the education of future logistics professionals, rather than retrofitted once they enter the workforce.

G2 Ocean adds another dimension, focusing on how safety engagement can be sustained. Rather than relying on periodic

interventions, their approach reinforces real-world applicable safety behaviours through continuous communication and operational integration, helping to prevent complacency and keep risk awareness alive in day-to-day activities.

Taken together with the initiatives highlighted in part one, these entries point to a more mature understanding of learning: safety is not just taught; it's experienced, reinforced, and lived.

Re-engineering the people-equipment interface

If there is one area where innovation is both critical and increasingly visible, it is at the interface between people and equipment. Terminal operators such as APM Terminals Callao are focusing on improving how people and machinery coexist in busy operational environments. Their approaches centre on reducing uncertainty – whether through clearer separation, better communication protocols, or operational redesign that limits unnecessary interaction between personnel and moving equipment.

Alongside this, Aqaba Container Terminal is addressing safety from a different but equally important angle: the standardisation of personal protective equipment. By implementing a single, globally aligned system, Aqaba is bringing greater consistency and clarity to front-line safety practices, an undertaking that is operationally complex but critical in reinforcing expectations and reducing variability across the workforce. At Long Beach Container Terminal, this thinking is visibly present in the integration of technology and operational design to create more predictable, controlled

environments. The aim is not simply to react to risk, but to structure operations so that it is less likely to arise in the first place.

Equipment and cargo-focused innovations are also playing a critical role. Autolash is addressing one of the most physically hazardous aspects of container operations, lashing, by developing automated systems that reduce or remove the need for manual intervention in potentially dangerous zones. This represents a direct application of the 'designing out risk' principle explored in *Safety refined many a way*.

Similarly, Cordstrap is focusing on cargo securement, ensuring that loads remain stable throughout the transport chain and that securing is more ergonomic and has a lower physical impact on those doing the work day in and out. Failures in this area can have serious consequences, and improved securing systems reduce the likelihood of incidents during handling.

KALP brings an engineering solution to 'pinning' operations where the traditional approach is to have people manually handle twistlocks, while port authorities such as Shoreham Port and Warrenpoint Harbour demonstrate how local operational changes, often grounded in detailed knowledge of site-specific risks, can deliver meaningful safety improvements to port work.

What unites these efforts is a move towards predictability and control. By reducing ambiguity in how people and equipment interact, they curtail the opportunity for error.

Building a system, not just solutions

Beyond the interface itself, several TT Club Innovation in Safety Awards entrants are tackling the broader challenge of how cargo operations are structured. The



PHOTO: CANVA

Euroports Group, working with Notra, is exploring novel approaches to cargo handling to reduce manual intervention, altogether lowering the risk of cuts, eye injuries, and musculoskeletal injuries. Their work reflects a broader trend towards rethinking processes rather than simply refining them. Modalinta is similarly focused on improving the safety of access through an accommodation ladder design, which is simpler and safer to deploy.

Fire risk continues to be an area of focus, and Turtle Fire Systems is addressing this through specialised fire suppression technologies designed for the unique challenges of cargo environments. Their work complements the solutions highlighted in part one, reinforcing the growing emphasis on preventing and managing high-consequence incidents such as container fires. Also addressing the potential for fire, Lokistix provides bespoke modular cargo packaging designed to contain and control fires, as well as providing digital alert and documentation benefits.

Data-driven safety continues to evolve as well, with several entrants showing how insight can be translated into action. Frederik Elting's SeaTag Float design addresses a very specific but important issue: the tracking and recovery of containers lost at sea. By improving the visibility of lost cargo, it not only supports recovery efforts but also reduces navigational hazards and environmental risks.

Similarly, Rombit Europe is applying wearable and connected technologies to improve worker safety. By tracking personnel location and movement and integrating this with operational data, their

systems create a more responsive safety environment, one that can adapt in real time to changing conditions.

These innovations build on the work of organisations highlighted in part one, reinforcing a key point: data is most valuable when it is actionable. The goal is not simply to collect information but to use it to shape safer behaviours and decisions. Also, the inclusion of individual innovators such as Edmund Greenwood is in itself significant by highlighting the fact that not all innovation comes from large organisations. Individual insight, often stemming from direct operational experience, can identify simple but highly effective solutions to persistent safety challenges.

What stands out across all these entries is not just their individual merit but how they contribute to a broader system of embedded safety. Training initiatives are becoming more realistic and continuous. Equipment design is reducing reliance on human intervention for safety. Digital tools are improving visibility and coordination. Operational processes are being rethought to eliminate unnecessary risks.

Crucially, these developments are not happening in isolation. They are increasingly interconnected. A safer system is one where training, technology, process, and culture reinforce each other. This is where the role of collaboration becomes particularly important. Many of these innovations,

whether developed by ports, technology providers, training organisations or individuals, have the potential to be applied far beyond their original context.

From innovation to standard practice

Across both parts of this series, a consistent picture emerges. The industry is neither short of ideas nor lacking in capability. What matters now is how these innovations are adopted and embedded. The challenge is to scale what works; to ensure that effective solutions move beyond individual organisations and become part of standard practice across the sector. At ICHCA, that remains a central focus: showcasing success, learning from what has gone wrong before, facilitating the exchange of ideas, and supporting the industry in turning innovation into expectation.

What is increasingly clear from this year's TT Club Innovation in Safety Awards is that an ever-safer, more resilient cargo handling system is not a distant ambition: it's already taking shape. That progress is down to the ingenuity, commitment, and leadership of people across the industry, including those recognised here.

Congratulations to all those who entered! Your work is not only raising standards today but shaping the tomorrow of the industry. And if these innovations are any indication, that future is not only brighter, but fundamentally safer. ■

ICHCA INTERNATIONAL The International Cargo Handling Coordination Association (ICHCA), founded in 1952, is an independent, not-for-profit organisation dedicated to improving the safety, security, sustainability, productivity, and efficiency of cargo handling and goods movement by all modes and through all phases of national and international supply chains. Visit ichca.com to learn more.

BUILT TO EVOLVE

by Michelle Cottet, *Manager Marketing & Communications, Foreship*

When Aurora Botnia entered service in 2021, she quickly became known as one of the most environmentally advanced ferries in the Baltic Sea. Designed from the outset to minimize emissions, the 24,300 gross tonnage ro-pax was equipped with dual-fuel LNG engines, shore power capability, and a 2.2MWh battery system that enabled zero-emission port stays and efficient hybrid operations. Serving the 52-nautical-mile Kvarken route between Vaasa and Umeå, the world's northernmost regular ferry service, the vessel's performance soon validated its reputation as a model for sustainable short-sea transportation.

With tightening EU and International Maritime Organization regulations, and with electricity costs on shore remaining attractively low up there in the north of the Baltic, the company sought a way to accelerate *Aurora Botnia's* decarbonization pathway. In 2024, Wasaline set an ambitious target to transform the vessel into a next-generation hybrid capable of meeting 2030-and-beyond climate goals by installing the largest battery retrofit system on a ship to date.

Building on a long-standing relationship with Wasaline that began during the vessel's initial design phase, Foreship provided comprehensive technical and strategic support for the retrofit. The project included an extensive feasibility study covering technical impact evaluation, emissions modeling, and cost analysis, later followed by supplier evaluation, classification design, engineering support, and implementation assistance.

Extra capacity without compromise – and with a (chem) twist

Wasaline tasked Foreship with assessing the extension or replacement of *Aurora Botnia's* 2.2MWh battery energy storage system (BESS). The two-part feasibility study also examined the technical implications and business case for converting one or two of the vessel's LNG-fueled engines to operate on e-methanol in a dual-fuel configuration. However,

when regional e-methanol production plans were delayed, the focus shifted toward a solution that could deliver near-term decarbonization results.

Foreship evaluated 12 different options for the BESS extension in terms of return on investment and technical complexity. "We based our analysis on the improved energy efficiency of the vessel and the low price of shore-side electricity, and factored in the shelter and cost incentives the energy type will offer under EU emissions arrangements," details Joonatan Haukilehto, Head of New Technologies at Foreship. Eventually, our company selected a mixed-chemistry architecture that could be safely accommodated in a single compartment, in accordance with stringent battery notation from the vessel's classification society, supported by a comprehensive safety philosophy.

The resulting installation not only added over 10MWh to the vessel's BESS capacity but also saw an innovative integration of two different battery chemistries: Nickel Manganese Cobalt (NMC) and Lithium Ferro Phosphate (LFP). The vessel's original NMC batteries deliver high-power density and are well-suited for peak-load shaving and maneuvering support. The new LFP battery system, meanwhile, offers significantly greater energy capacity with deep-discharge cycles and an overall lower life-cycle cost profile. "With cheap electricity

available from shore power, not only covering 100% of the ship's power needs during port stays but also charging batteries, the retrofit could contribute up to 20% of overall ship energy needs," shares Haukilehto. "Furthermore, the vessel's total energy efficiency is clearly improved by the possibility to run on a single engine under high load for the majority of voyages."

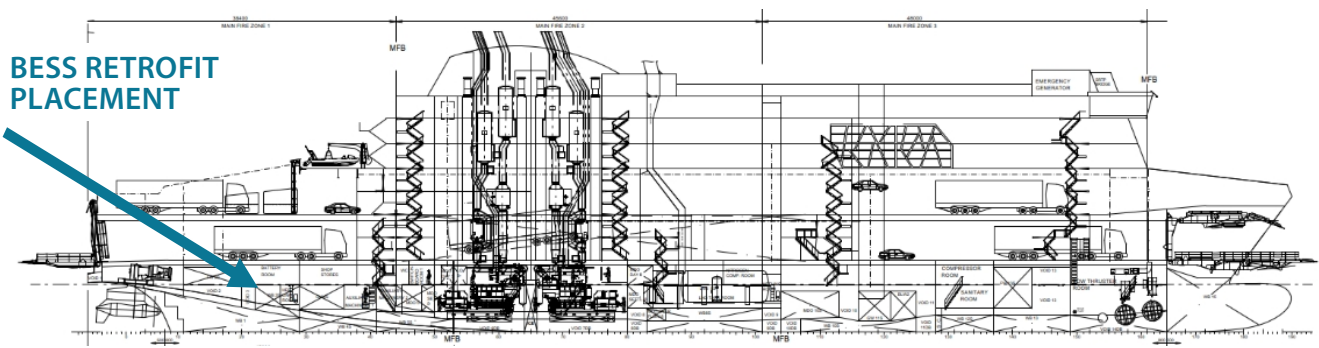
To house the expanded BESS, the project team designed a new battery compartment by extending the existing potable water tank toward a port-side void space. This arrangement was beneficial since it could utilize the power electronics from the existing battery system, reducing the complexity of the modifications and minimizing the impact on the vessel's lightweight.

The majority of the modifications consisted of steelwork, which was carefully designed due to the proximity to the propulsion units. Integrating a battery installation of this scale also required extensive cabling and updates to several auxiliary systems, including firefighting, cooling, ventilation, and lighting. However, these modifications were rather straightforward, as most could be implemented by extending the current on-board systems.

Impact on efficiency

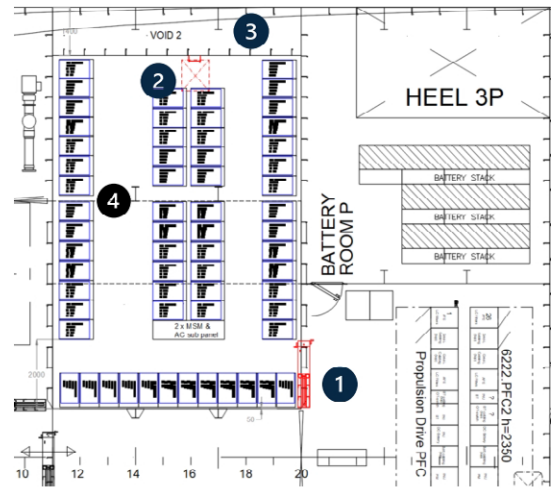
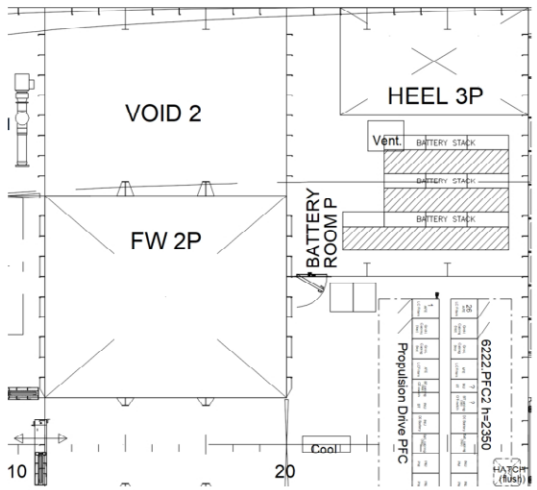
The expanded BESS fundamentally changes how *Aurora Botnia* can be operated. The vessel is powered by four

BESS RETROFIT PLACEMENT



Before conversion

After conversion



1. New WTD
2. Emergency escape
3. Void space 2
4. Bulkhead (partly) removed



Project Targets

- Maximize sailing time with 1 DF-DG on optimum load
- Maximize utilization of shore power



Wärtsilä 8V31DF generating sets (although in normal weather, only two engines have typically been required). With the new energy storage system, most voyages can now be completed with a single engine running at optimal high load, supplemented by the large battery pack to cover the remaining propulsion and hotel loads.

This operational shift brings a series of tangible advantages. By allowing the DF engines to run at a steady, higher load, the vessel operates closer to its optimal efficiency range, reducing both fuel

consumption and methane slip, which typically increase at part-load. At the same time, the enlarged battery system makes far greater use of the renewable electricity available in Vaasa and Umeå: during each port call, the batteries are charged for as long as the stay enables, further decreasing the vessel's reliance on LNG. Foreship's modeling indicates that, with the new hybrid system, as much as one-fifth of *Aurora Botnia's* annual energy demand can be covered by battery power alone, a gain that cuts CO₂ emissions significantly

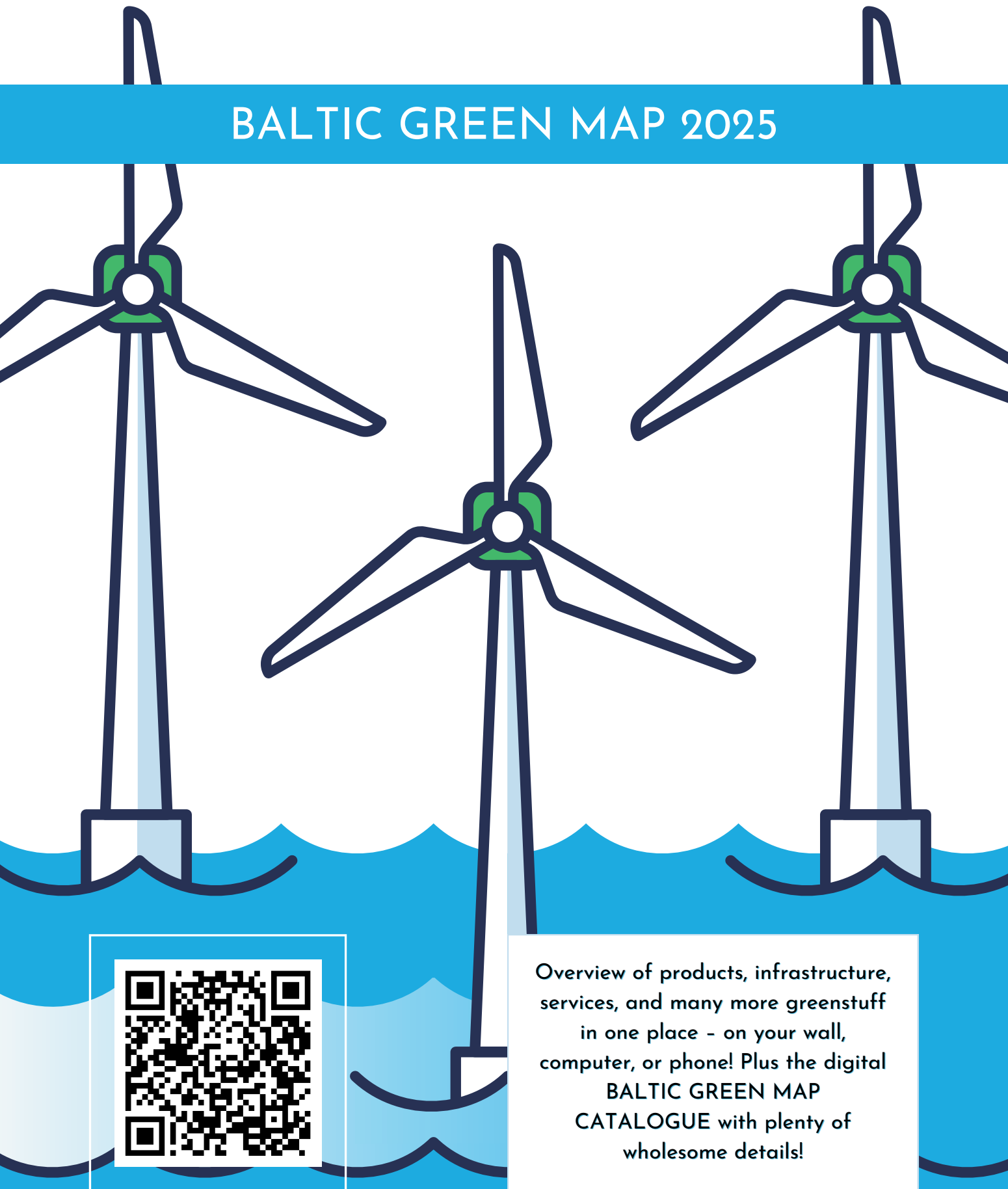
while positioning the vessel to possibly generate surplus emission allowances under the FuelEU Maritime framework.

For a route with challenging winter conditions and a demanding schedule of 20-24 crossings per week, this upgrade reaches the ambitious target of reducing fuel consumption and emissions without compromising operational resilience.

Project delivery and collaboration

The retrofit progressed from the go-ahead decision to commissioning in just 14

BALTIC GREEN MAP 2025



Overview of products, infrastructure, services, and many more greenstuff in one place - on your wall, computer, or phone! Plus the digital **BALTIC GREEN MAP CATALOGUE** with plenty of wholesome details!

CLOSING THE LOOP(S)

by Ewa Kochańska

Project CAPTURED, conducted last year by the Global Centre for Maritime Decarbonisation, produced the world's first end-to-end demonstration of a maritime carbon value chain based on real operational data. By capturing CO₂ on a container vessel, then transferring and transporting it across ship and land for utilising in industrial processes, the study attempted to prove the technical and operational viability of linking ship-based carbon capture with downstream utilisation. The project took into account energy penalties and different CO₂ end pathways to produce various life cycle assessment (LCA) scenarios for on-board carbon capture and storage (OCCS) options.

The study's objective was to find out if OCCS can be connected to industrial use on land, cutting emissions from shipping in the mid-term on the path to a long-term zero-carbon maritime future. OCCS' real climate value becomes clear when emissions are measured across the entire carbon chain – from fuel production through capture, transport, and final use or storage of the CO₂. Therefore, an LCA is essential to show whether reductions achieved on board are genuinely beneficial or simply shifted elsewhere.

The study was conducted in June 2025. First, CO₂ was captured on board Evergreen's container carrier *Ever Top* (368-by-51-metre, gross tonnage of 146,700, 13,808-TEU capacity) on her way from Port Klang to Yangshan Deepwater Port, using a full-scale amine-based carbon capture system. In Shanghai, the captured CO₂ was liquefied and ship-to-ship (StS) offloaded to another vessel, *Dejin 26*. Next, the liquefied CO₂ was transferred from ship to truck (StT) in Zhoushan (Zhejiang Province). It was then transported by road for over 2,200 kilometres to Baotou

(Inner Mongolia). Finally, at Baorong Environmental's facility, the CO₂ was used as an input to recycle steel slag, producing post-carbonated slag (PCS) and low-carbon precipitated calcium carbonate (PCC). The produced PCC was marketed as a high-value additive for use in paper, coatings, plastics, and construction products, while the PCS was reused as sintering feedstock at a nearby steel plant (beyond steel-making, PCS could in theory serve as a supplementary material in concrete to reduce cement use, although the underlying chemistry of cement production places practical limits on how far this substitution can go).

Same CO₂ – different math

The study examined several life cycle scenarios to understand what actually happened during the pilot and what could happen if the system was improved and scaled. Each scenario represents a different way the captured CO₂ could be handled and assessed.

Scenario 1 reflects the real pilot as it was carried out. The CO₂ was captured on *Ever Top* and eventually mineralised

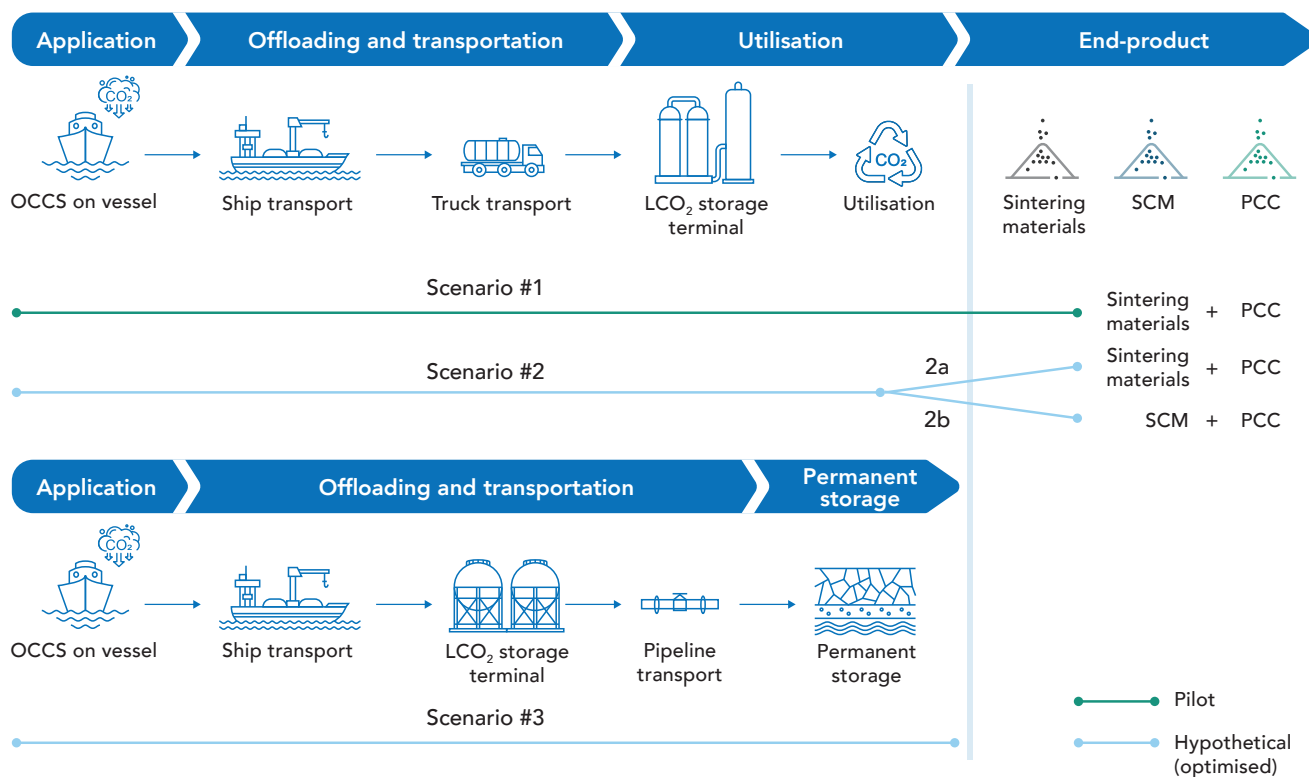
at Baorong's plant, where it was turned into PCS and PCC. The former was sent back to the steel plant that originally produced the slag and reused in the sintering process, reducing the need for fresh iron ore, limestone, and dolomite. In turn, the latter replaced the conventional PCC used in construction materials, chosen specifically because this use ensures the CO₂ remains locked away for the long term. To measure the climate impact, the analysis compared this setup with a reference case where no on-board capture takes place and conventional materials are produced instead. The emissions savings come from avoiding the production of those conventional materials.

Scenario 2 is a 'what-if' case that assumes the whole chain works more efficiently than in the pilot. It removes the operational inefficiencies observed in Scenario 1 and also assumes shorter transport distances for CO₂. This scenario is split into two options. In 2a, the PCS is still used in steel sintering, as in the pilot, but under optimised conditions. In 2b, it is instead used as a supplementary material in concrete, partially replacing

Fig. 1. Demonstration of the world's first end-to-end carbon value chain for onboard captured CO₂



Fig. 2. LCA scenarios considered in the Project CAPTURED study



cement, which could further reduce emissions from cement production.

Scenario 3 looks at a completely different endpoint. Instead of using the captured CO₂ in production, it is transported and permanently stored in an offshore geological reservoir. Because no products are made in this case, there are no emissions savings from replacing conventional materials. The assessment focuses only on the emissions directly associated with capture, transport, and storage.

In addition, two different LCA approaches were applied depending on the scenario. Consequential LCA was used where products made from captured CO₂ replace conventional ones, as it captures wider system effects and avoids emissions. Attributional LCA was used to examine the carbon footprint of individual parts of the chain, such as the ship or the Baorong plant, and to compare CO₂-based products with their conventional equivalents. For products made at Baorong’s facility, emissions were shared between PCC and PCS based on their market value.

Also, the mineralisation process relies on steel slag, which is a by-product of steelmaking and is mostly unused in China, often ending up in stockpiles

that can cause environmental problems. To keep the study focused, steel-making itself was not included in the system boundary. Instead, steel slag was treated as a low-value by-product with an assigned share of the steel plant’s emissions, calculated using an economic allocation method.

Finally, the analysis was based on real-world operational data wherever possible. Measurements from ship trials, CO₂ offloading, transport, and utilisation during the pilot were combined with recognised life cycle databases and published literature to fill any gaps. Standard Intergovernmental Panel on Climate Change climate factors were used to calculate emissions, and the quality of the data was checked and independently verified.

Slips in the chain

Operational data for the OCCS aboard *Ever Top* were collected during a sea trial to check performance under real conditions. It showed that the system captured about 10.7% of the vessel’s CO₂ while operating continuously, using an advanced amine solvent. Steam for solvent regeneration was supplied by an auxiliary boiler burning marine gas oil,

while electricity for capture and liquefaction came from generator sets running on heavy fuel oil. As is typical for amine-based systems, solvent degradation required periodic addition of fresh amine, and the process produced two outputs: liquefied CO₂ stored on board and a corrosive waste sludge that had to be landed ashore for incineration.

Transferring the liquefied CO₂ from ship to shore also caused issues. CO₂ was vented during hose purging and after transfers to avoid contamination and dry ice formation, with further emissions arising from fuel and electricity use by ships, trucks, pumps, and the Baorong plant. Although the StS transfer relied on pressure differences rather than pumps, pumping was required for StT transfer and again at the plant. Some CO₂ also remained trapped as liquid heel or vapour in tanks during cooling and transport. Even though this CO₂ was not released to the atmosphere, it was treated as lost to the value chain because it never reached the end-user.

At Baorong’s facility, the CO₂ was mineralised using steel slag from a nearby steel plant. After vaporisation, the CO₂ reacted with the slag to form PCC and PCS. The assessment considered plant

Fig. 3. Value chain scenarios included in the LCA



energy use, start-up and shut-down phases, reagents, fuel gas for drying, and supporting operations such as slag grinding and wastewater treatment. Based on mass balance, around 65% of the incoming CO₂ was permanently fixed in the products, while the remaining 35% was released during processing. The low-carbon PCC was compared to a conventional limestone-based one, with laboratory testing confirming comparable quality.

The study also followed the CO₂ mass at each transfer step. Of the 25.4 tonnes offloaded from *Ever Top*, losses during StS and StT transfers reduced the amount reaching Baorong to 15.8t, with only 10.3t ultimately fixed into products. About 2.4t were released during transport and handling, while more than 7.0t remained trapped in tanks along the chain. These results highlight how critical tank conditioning, transfer efficiency, and filling practices are for on-board carbon capture to deliver meaningful climate benefits.

Piloting optimisation

The study looked at how the full CO₂ value chain performed in practice during the pilot and how it could improve if optimised. For the pilot case, the results were independently verified by DNV and reflect

what actually happened on board *Ever Top* and downstream.

With the OCCS system capturing 10.7% of the ship's exhaust CO₂, the net greenhouse gas reduction of the entire chain was 7.9% vs normal ship operation. This modest gain was largely due to the capture system having to rely on additional fuel for heat and power (no exhaust heat recovery was installed). As a result, the fuel penalty was around 5.0%, and more than half of the potential emissions savings from captured CO₂ were used up by the energy required to run the system. Almost all of these operational emissions came from extra fuel use, with only a small share linked to solvent production and waste handling. In well-to-wake terms, capturing one tonne of CO₂ avoided about 420 kilograms of emissions.

Offloading and transport turned out to be a major weak point in the pilot. By the time the liquefied CO₂ reached the Baorong plant, emissions from moving it had almost cancelled out the benefits of capturing it. The longest leg – the 2,200+ km truck journey (that's roughly the distance between Gdańsk and Barcelona) – accounted for more than half of all transport-related emissions. Another

big issue was venting during transfers, especially from leftover liquid CO₂ in hoses. In addition, the receiving vessel burned a relatively large amount of fuel to transport a small batch of CO₂, which increased emissions per tonne moved (a purpose-built CO₂ carrier would have a payload of roughly 3,500-4,000 tonnes per voyage). At the utilisation stage, turning CO₂ into PCC and PCS also generated emissions, mainly from reagent supply, electricity use at the plant, and the fraction of CO₂ that was not fixed and escaped during processing.

Even so, the products made from captured CO₂ displaced conventional PCC and sintering materials. According to Project CAPTURED, these avoided emissions more than compensated for the emissions from the mineralisation process itself. PCC delivered the largest benefit because conventional PCC production from limestone is highly carbon-intensive. Overall, when capture, transport, and utilisation were all considered together, each tonne of CO₂ captured resulted in about 840 kg of emissions being avoided, giving the net 7.9% reduction observed for the pilot.

The study then explored what would happen if the value chain elements were properly optimised. A key improvement

Tab. 1. LCA results of the hypothetical value chain^{1,2,3}

Optimised section of the value chain	Optimised parameter	Default value/condition	Optimised value/condition	Unit	Description	GHG emissions (kgCO ₂ eq/tCO ₂)				
						OCCS	Offloading and transport	Utilisation	Total value chain	Variation relative to pilot
Total value chain (pilot)	No parameter is optimised	-	-		Pilot value chain (Scenario 1)	582	375	951	1,908	0%
OCCS	Reboiler heat demand	2.8	0	GJ/tCO ₂	At 10.7% gross capture rate, reboiler heat is supplied by WHRS	187	375	951	1,512	-21%
Offloading and transport	Venting losses	<ul style="list-style-type: none"> Liquid phase in the pipes Two StT transfers 	<ul style="list-style-type: none"> Vapor phase in the pipes One StT transfer 	-	<ul style="list-style-type: none"> Considering whether liquid- or vapor-phase CO₂ is left in the liquid line after offloading Considering one StT offloading instead of two 	582	277	951	1,810	-5%
	Ship transport (CO ₂ offloaded mass)	25.4	525.0	MT	Corresponding loading factor in the Dejin 26 tank: 95%.	582	342	951	1,875	-2%
	Ship transport (distance)	67	500	km	Considering an offloading port close to utilisation plant					
	Land transport (method)	Truck	Pipeline	-	Pipeline is the most common way to transport CO ₂ in a well-established value chain	582	182	951	1,715	-10%
	Land transport (distance)	2,200	200	km	Assuming CO ₂ utilisation plant is located in the same region of the offloading port					
Hypothetical transport value chain	All the above, for offloading and transport		-	Considering all the sensitivity variations above for offloading and transport value chain	582	50	951	1,583	-17%	
Utilisation	Electricity grid carbon factor	0.565	0.191	kgCO ₂ eq/kWh	Low-carbon/ high-efficiency grid electricity in China (Chen et al., 2023)	582	375	756	1,713	-10%
	CO ₂ losses in the process	35%	10%	-	Considering 90% CO ₂ mineralisation efficiency (Lee et al., 2023)	582	375	795	1,752	-8%
	Hypothetical CO ₂ use	All the above, for utilisation		-	Considering both electricity and CO ₂ losses for CO ₂ utilisation	582	375	601	1,558	-18%
Total value chain (hypothetical)	All parameters are optimised	All the above, for the total value chain		-	Hypothetical value chain (Scenario 2)	187	50	601	837	-56%

¹ Orange denotes the changes in GHG emissions with the application of hypothetical values.

² GHG emissions are expressed per MT of CO₂ captured and offloaded from the Ever Top.

³ Credits for captured CO₂ and avoided emissions from displaced products are not included.

would be recovering waste heat from the ship’s exhaust and engine jacket water to supply the capture system. In theory, this heat could fully cover the reboiler demand, sharply cutting the fuel penalty and the associated emissions. Road transport is another area for improvement, as replacing long-distance trucking with a shorter pipeline connection would almost eliminate emissions from CO₂ overland transport. Better hose draining, single-step transfers, and improved tank pre-conditioning would also reduce venting losses to insignificant levels. Moving larger CO₂ volumes that match the capacity of the transport vessel would further improve efficiency and lower emissions per tonne transported.

On the utilisation side, higher mineralisation efficiency and cleaner electricity at the plant would further improve performance. When all these measures are combined, emissions from offloading and transport drop dramatically, and the overall value chain emissions decrease by over 50% compared with the pilot. Under these optimised conditions, net greenhouse gas

savings increase from 7.9% to nearly 18% at the same capture rate.

The analysis finds that using captured CO₂ to make PCC and PCS reduces emissions more than just storing the CO₂ permanently. With a 40% capture rate, permanent storage can cut emissions by about 21% compared to a ship without OCCS. But using CO₂ in production can achieve even greater reductions – up to 70% with an optimised value chain (depending on whether PCS is used in steel sintering or as a cement substitute). This shows that system design, waste heat recovery, and downstream logistics are key to making on-board carbon capture effective.

Carbon accounting

The Project CAPTURED report underscores some challenges when it comes to emission reporting under current laws and regulations. From a regulatory point of view, greenhouse gas accounting in shipping is still mostly attributional, which means that emissions are assigned step by step rather than after considering wider system effects. When on-board carbon capture is added, this accounting

boundary has to extend beyond the ship to include what happens to the captured CO₂ afterwards. If the CO₂ is permanently stored, it can be treated as a waste stream from fuel combustion, and the shipowner simply accounts for the emissions from transporting and storing it. Utilisation is more complicated because the CO₂ becomes a raw material for another industry, making it harder to decide whether the ship burning the fuel or the plant using the CO₂ is the ‘owner’ of the emissions and/or any emission savings.

Looking at the results from the shipowner’s perspective helps illustrate this problem. Using attributional LCA and real pilot data, on-board capture with utilisation actually increases reported emissions, because the emissions from CO₂ processing are counted – but the avoided emissions from displaced products are not. Even with an optimised value chain, the savings are marginal. If the system boundary is narrowed to ship operations plus CO₂ offloading and transport, the picture improves, and the emissions reduction is similar to that of a permanent storage pathway. When capture rates are higher,

Fig. 4. Accounting for GHG emissions from OCCS along the carbon value chain

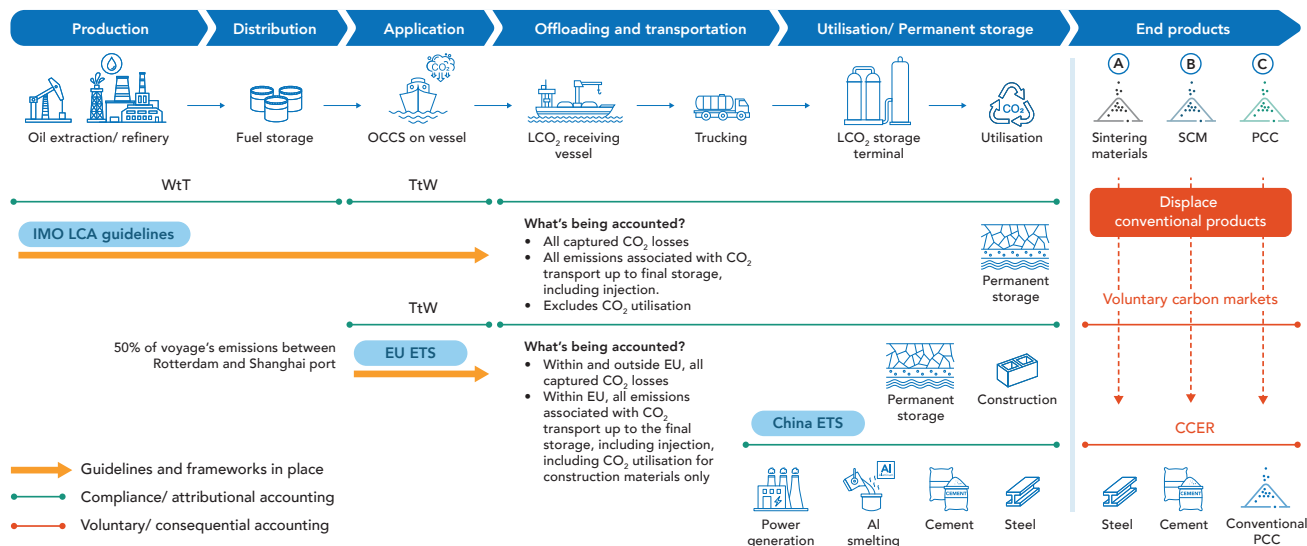
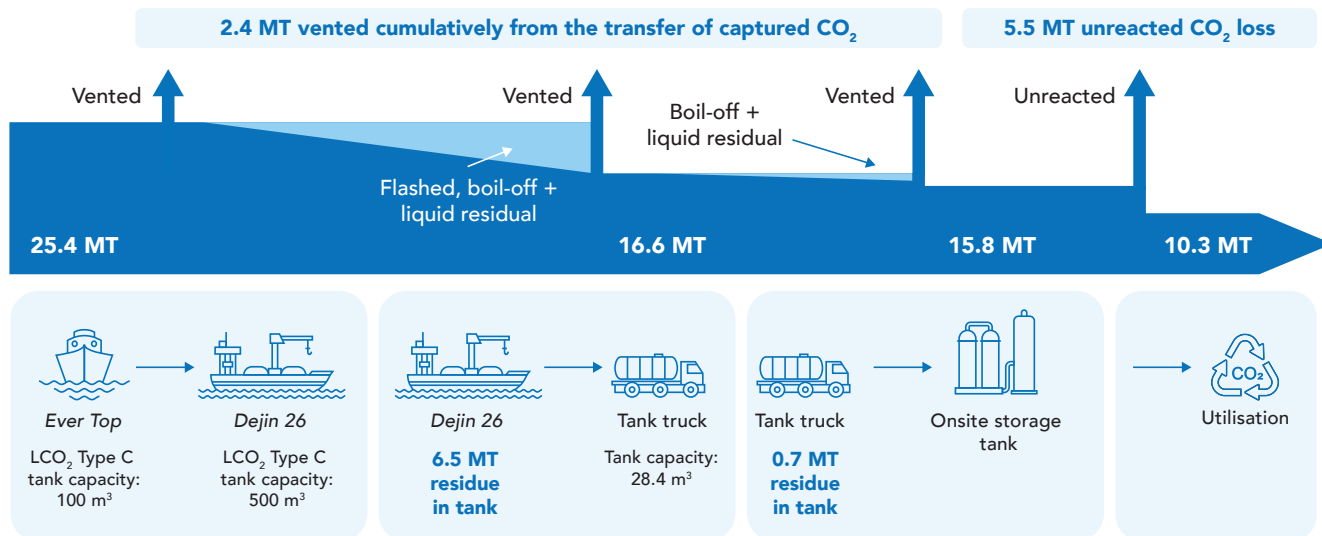


Fig. 5. Mass balance of offloading, transport and utilisation of LCO₂



this contrast becomes even more obvious. Permanent storage consistently reduces reported emissions, all the while utilisation pathways appear to increase them under attributional rules, even though they deliver real-world benefits when assessed consequentially. This points to a mismatch between current International Maritime Organization-style accounting and how CO₂ utilisation actually works in practice.

From the CO₂ user's perspective, attributional LCA is more familiar and is used to compare product footprints. At Baorong, PCC made from captured CO₂ has a significantly lower carbon footprint than conventional PCC, and this advantage becomes much larger if credits for captured CO₂ are included. PCS, on the

other hand, has a higher attributed footprint than the materials it replaces, even when CO₂ credits are applied, largely because of the energy and materials needed for mineralisation.

In the end, assigning emissions and credits across the CO₂ value chain involves multiple parties, from shipowners to end-users, and how these impacts are shared will depend on future regulations and contractual arrangements designed to prevent double-counting.

Room for improvement

Project CAPTURED supplied real-world data that combining OCCS with CO₂ utilisation delivers greater emissions benefits than permanent storage. Although

emissions from capture, offloading, and transport are substantial, they are offset by avoided emissions from replacing very-high-carbon-footprint conventional PCC and sintering materials.

The pilot analysis shows opportunities to improve performance, particularly by recovering waste heat on board, reducing CO₂ losses during transfer, moving larger CO₂ volumes over shorter distances, and improving utilisation efficiency. According to the Global Centre for Maritime Decarbonisation's project, when these improvements are combined and capture rates rise to 40%, total emissions savings could reach around 68-71% compared with a conventional ship powered by heavy fuel oil. ■

DECARBONISATION BY REVOLUTION SYSTEMS ENGINEERING

by Philippos Ioulianou, *Managing Director, EmissionLink*

If 2025 was supposed to be the year shipping accelerated decisively towards a clean-fuel future, it never truly left the starting blocks. Instead, the industry closed the year in familiar territory: ambitious targets, nuclear routes, uneven enforcement, and a (regional vs global) mismatch between the regulatory agenda and fuel supply chains, port infrastructure, and commercial reality.

But 2026 will not simply be another year of delay. It will redefine the direction of shipping's decarbonisation path, not through a breakthrough fuel, but through a structural shift in how compliance, investment, and operational decisions are made. Rather than a technology-led transition, this year will mark the start of a systems-led transition: one driven by regulation, digital infrastructure, commercial pressure, and compliance economics.

A sip of realpolitik tea

The International Maritime Organization's (IMO) net-zero ambition will remain intact in principle, but the timeline will continue to slip beyond the 'one-year-delay' narrative currently circulating. This is not primarily a failure of climate ambition – it's 'just' the reality of the structure of global governance.

The IMO is not a fiscal regulator like the EU. It can set direction, but it cannot impose uniform enforcement across states with vastly different economic pressures, governance capacity, and political priorities. Integrating every flag state into one binding system requires consensus across economies that are not aligned on risk, cost, or urgency. Consequently, further IMO meetings are unlikely to deliver a single global fuel rulebook. Rather, they will produce politically workable compromises, incremental adjustments, and broad direction-setting – but sadly not operational clarity.

For operators, this creates a dangerous illusion of progress. Targets exist, strategies are published, but the mechanisms that

would make global decarbonisation predictable and investable remain fragmented. The current year will therefore be heavy on regulatory signals, but light on certainty. In the Baltic, this disconnect is felt even more sharply. Regional operators are fully exposed to EU regulation, while global frameworks remain unresolved, creating a compliance environment where Europe moves fast, and the global system moves slowly.

Where theory ends and operations begin

Unlike global policy frameworks, FuelEU Maritime (FEUM) and the EU Emission Trading System (EU ETS) are not theoretical. They are operational realities, and in the Baltic and North Sea trades, they are unavoidable.

FEUM has already changed behaviour. Emissions reporting has shifted from compliance planning to daily operational decision-making. Biofuels are being trialled (with demand for bioLNG as a marine bunker blasting off with gusto), pooling structures are forming, and slow steaming has re-established itself as the default low-CAPEX decarbonisation lever. The Baltic Sea Region's (BSR) ferry sector even saw one company takeover as a means of securing a FEUM 'compliance generator.'

But 2026 will push this further. Compliance will no longer be something managed annually; it will be handled voyage by voyage. As a result, this will accelerate the shift towards digital optimisation. Predictive emissions tracking, powered by digital twins of vessels and

voyages, will become essential for managing FEUM exposure. Secure, audit-ready monitoring-reporting-verification (MRV) data will no longer be a reporting obligation but a core operational requirement. Therefore, compliance becomes a control system, not a report.

Emissions as market currency

Decarbonisation pressure in 2026 will not be driven primarily by regulation but by contracts. Who pays for FEUM and EU ETS exposure will become a central commercial battleground between owners and charterers, testing long-standing charterparty structures and risk allocation models.

As this tension grows, vessel selection will change. Charterers will increasingly evaluate ships not only on freight rates but also on emissions performance, data transparency, the predictability of regulatory exposure, and the credibility of reported emissions data.

In the Baltic trades, where short-sea density, frequent port calls, and regulatory exposure are high, this shift will happen faster than in deep-sea markets. This creates a structurally different market: vessels with verified, transparent, compliance-ready emissions profiles gain commercial advantage; those without them become higher-risk assets.

Politically contested but commercially relevant

Whilst this won't be a surprise, it is worth noting that 2026 will not deliver a clean global fuel consensus.

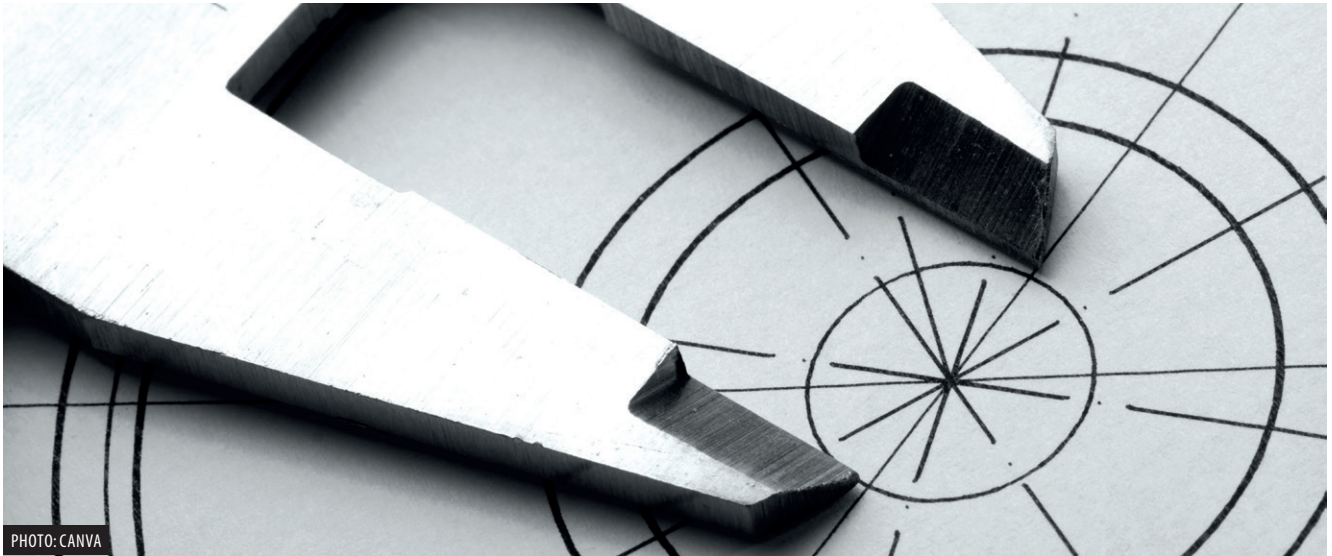


PHOTO: CANVA

Governments face rising fiscal pressure, defence spending growth, and, altogether, budget constraints. Carbon pricing offers politically acceptable revenue, which reshapes decarbonisation policy around fiscal logic as much as climate logic.

This will intensify disputes over fuel eligibility, credits, and classification. Liquefied natural gas (LNG), its bio version, and transitional fuels will remain politically contested but commercially relevant. At the same time, scope-3 reporting will speed up uneven decarbonisation pressures. In the BSR, forest products, steel, energy, agricultural bulk, and consumer goods supply chains are already under customer and investor scrutiny. These cargo owners need reductions now – not 2035+ narratives.

This does, in turn, drive demand for certified biofuels, pooling mechanisms, operational savings, and demonstrable emissions performance rather than theoretical future pathways. On a gloomier note, this may very well end in the closure of certain shipping services, particularly those already struggling to bring home the bacon (and operated by tonnage that remembers the Soviet Union) – as was also witnessed by the (Danish-Swedish part of the) Baltic ferry market quite recently.

Risk economics over abstract aspirations

So, all things considered, how does 2026 redefine shipping's decarbonisation path? Not through fuel transformation, that's for certain, but through behavioural change. The industry is moving away from bold

fuel bets and long-term visions, towards smarter compliance strategies. Companies are moving in the direction of tighter short-term control and predictive management instead of backwards-looking reporting, combined with a more practical focus on risk economics over abstract aspirations.

For Baltic shipping companies, the practical strategy becomes one of optionality where operators should consider measures such as pooling to manage regulatory exposure; selective biofuel use where supply is reliable; LNG and bio-LNG where rules and infrastructure allow; relentless operational efficiency; and digital compliance systems that enable predictive decision-making. This is not decarbonisation by revolution; it's decarbonisation by systems engineering.

Transition engine

In this environment, emissions management must move beyond spreadsheets and after-the-fact reporting, especially in high-regulation regions like the Baltic; operators need to shift from reactive compliance to proactive control.

By combining real-time vessel data, predictive modelling, and secure MRV infrastructure, EmissionLink allows owners, managers, and charterers to model regulatory exposure before operational decisions are made. This enables predictive FEUM and EU ETS exposure modelling, as well

as gives access to audit-ready, regulator-grade MRV data, smarter pooling strategies, emissions-aware routing and speed optimisation, and commercial transparency in chartering and contracting. In practical terms, emissions become a managed operational variable, not an unpredictable cost.

Europe is already collecting significant revenue through the EU ETS and FEUM. For the Baltic region, the credibility of decarbonisation policy will depend on whether this capital flows back into fuel supply chains, port infrastructure, retrofit programmes, or alternative fuel availability. If it does, the system becomes a transition engine. If it does not, it becomes a cost layer without a viable pathway.

Stop waiting for perfection

This year will not be the year of ammonia. It won't be the year of methanol. Alas, it will not be the year of the global fuel accord.

But 2026 will be the year shipping's decarbonisation path is redefined. Not by fuel choice but by systems, data, contracts, and compliance economics. The future will belong to operators who stop waiting for the perfect fuel and start building resilient, flexible, compliance-safe operating models.

This year, and for the foreseeable future, decarbonisation will no longer depend on what fuel you plan to use; it will be about how well you control risk, data, exposure, and decision-making. ■



**EMISSION
LINK**

EmissionLink is a digital emissions intelligence and compliance platform built specifically for the operational realities of maritime shipping. Designed to support shipowners, managers, and charterers in a fragmented regulatory landscape, EmissionLink transforms emissions compliance from a reporting burden into a controllable business function. Sail to emissionlink.com to learn more.

THE RAW REALITY

by Ewa Kochańska

One of the latest reports from the European Court of Auditors (ECA) analyses the strategic importance of critical raw materials (CRMs) to the EU's goals towards climate neutrality – unsurprisingly revealing a too heavy dependence on imports, with supply chains concentrated in a handful of non-EU countries. This situation exposes the bloc to geopolitical risks and trade disruptions, significantly weakening efforts to strengthen its strategic autonomy. Although recent policy initiatives, including the Critical Raw Materials Act, have provided clearer direction, issues related to data, targets, and implementation still need more attention.

The EU's objectives of reaching net-zero emissions by the middle of this century and significantly expanding renewable energy by 2030 have rapidly increased the demand for wind turbines, batteries, and photovoltaic panels. As these technologies depend on a small group of key raw materials – including lithium, cobalt, nickel, and rare-earth elements – raw material supply security has become the core of both energy and industrial policy. As consumption rises sharply, ensuring reliable and sustainable access to these materials is emerging as one of the defining challenges of the energy transition.

However, ambitions to expand domestic production and improve resource efficiency face persistent structural obstacles. Financial, regulatory, and technological challenges suppress mining, processing, and recycling activities within the EU; permitting procedures are also slow and complex. Circular economy measures and recycling targets offer a pathway to reduce reliance on primary extraction, but market and regulatory constraints hinder their full realisation. Strategy-based projects designed to accelerate progress may ultimately bring about positive outcomes, but they are unlikely to contribute meaningfully before the end of this decade.

Before you build, lay the foundation

The EU's approach to securing strategic raw materials sets a clear direction, but its foundation is uneven. Although the policy is based on solid data and clear justification, problems show up in how key materials are identified, how targets are defined, and how progress is measured.

The lists of critical and strategic raw materials help prioritise resources needed for the energy transition, but data limitations and methodological issues affect both the selection of materials and the forecasts of future demand. Gaps in trade data and modelling also undermine confidence in the overall picture, meaning the system for identifying and tracking CRMs is still not fully reliable.

Similar issues appear in the targets and funding that support the policy. The EU has set benchmarks for extraction, processing, recycling, and import diversification, but it is not always clear how these targets were determined or how they link to broader energy and industrial goals. At the same time, significant EU funding has been allocated to raw materials projects, yet its impact on supply is difficult to measure because funding is spread across different programmes and results are not systematically tracked. ECA's *Critical raw materials for the energy transition* report therefore recommends improving data quality, making targets more transparent and better aligned with EU objectives, and monitoring funding more closely to understand whether it is actually strengthening the bloc's raw materials supply.

Results you can hold

The EU remains highly dependent on imports for most of the raw materials needed for the energy transition, and in certain instances, completely dependent. To deal with this, the Critical Raw Materials Act sets a target to limit dependence on any single non-EU country, but current supply patterns show






a long path ahead. In some cases, sourcing is still heavily concentrated, particularly at the processing stage, where a few countries dominate key materials such as lithium and rare-earth elements. This leaves supply chains exposed to disruption and underlines the scale of the diversification challenge.

Efforts to secure access through trade policy and external cooperation have intensified, but the results are difficult to measure. Free trade agreements and other initiatives should improve access to resources and create more stable conditions for investment, yet there is little evidence so far that they have increased the flow of materials into the EU.

Meanwhile, global trade conditions are continually worsening. Among other pressures, export restrictions, licensing systems, and growing geopolitical tensions continue to affect availability, with recent limits on rare-earth exports and the disruption of supplies from Ukraine. As a matter of fact, CRMs are becoming at least some of the reasons for geopolitical aggression, such as the attack on Ukraine, and they have been used as tools of economic warfare, such as China vs Japan/US/EU. These developments highlight how external factors can quickly reshape access to critical materials.

As such, strategic partnerships with resource-rich countries have been important in the EU's policy. These agreements are meant to create long-term cooperation along the value chain, from extraction to processing, instead of just focusing on imports. While they have helped build relationships and set out areas for

Fig. 1. Which critical raw materials are needed for which renewable energy technologies

	 Electrolysers	 Wind turbines	 Lithium-ion batteries for renewables	 Heat pumps	 Solar photovoltaics
Aluminium/bauxite	●	●	●	●	●
Copper	●	●	●	●	●
Nickel	●	●	●	●	●
Silicon	●	●		●	●
Manganese	●	●	●	●	
Boron	●	●		●	●
Heavy rare earth elements	●	●		●	
Light rare earth elements	●	●		●	
Cobalt	●		●		
Natural graphite	●		●		
Platinum group metals	●			●	
Baryte	●				
Magnesium	●				
Scandium	●				
Strontium	●				
Tantalum	●				
Tungsten	●				
Vanadium	●				
Niobium	●	●			
Antimony					●
Arsenic					●
Lithium			●		
Phosphorus			●		●
Fluorspar			●	●	●
Gallium					●
Germanium					●

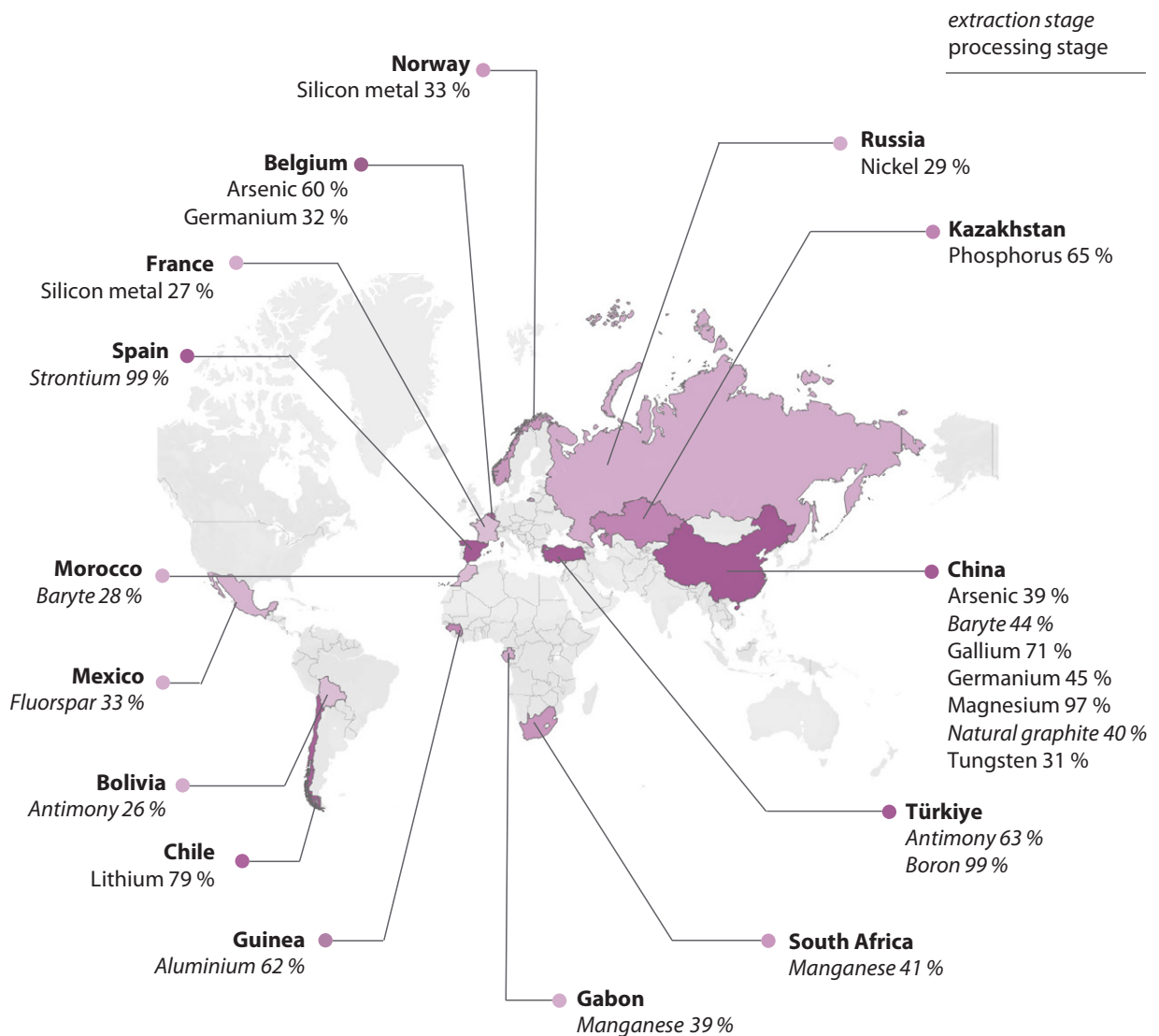
Source: JRC, Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study (2023)

working together, their effect on actual supply has been limited. Many are still at an early stage, with roadmaps lacking

clear timelines or measurable outcomes. In practice, trade data show little consistent improvement in import patterns,

suggesting that these partnerships, while useful for engagement, are not yet delivering the level of supply security the EU seeks.

Fig. 2. Main EU suppliers of selected raw materials¹



¹ The figure shows the main EU suppliers for 18 out of 26 critical raw materials that are important for the energy transition, for which over 25% of EU supply (2016-20) is concentrated in one country
Source: ECA (based on information from COM)

Here, the ECA report suggests that the European Commission (COM), in order to ensure that its efforts to diversify imports actually result in a more reliable supply of CRMs, must evaluate whether trade agreements that include raw materials provisions are genuinely improving supply security; these findings should then be used to strengthen future agreements. It is also recommended to regularly review strategic partnerships with resource-rich countries to determine whether they are delivering concrete results in terms of supply. By identifying which co-ops or initiatives work best, the EU could replicate successful approaches and make its external raw

materials strategy more effective overall. The suggested implementation date for these changes is 2026.

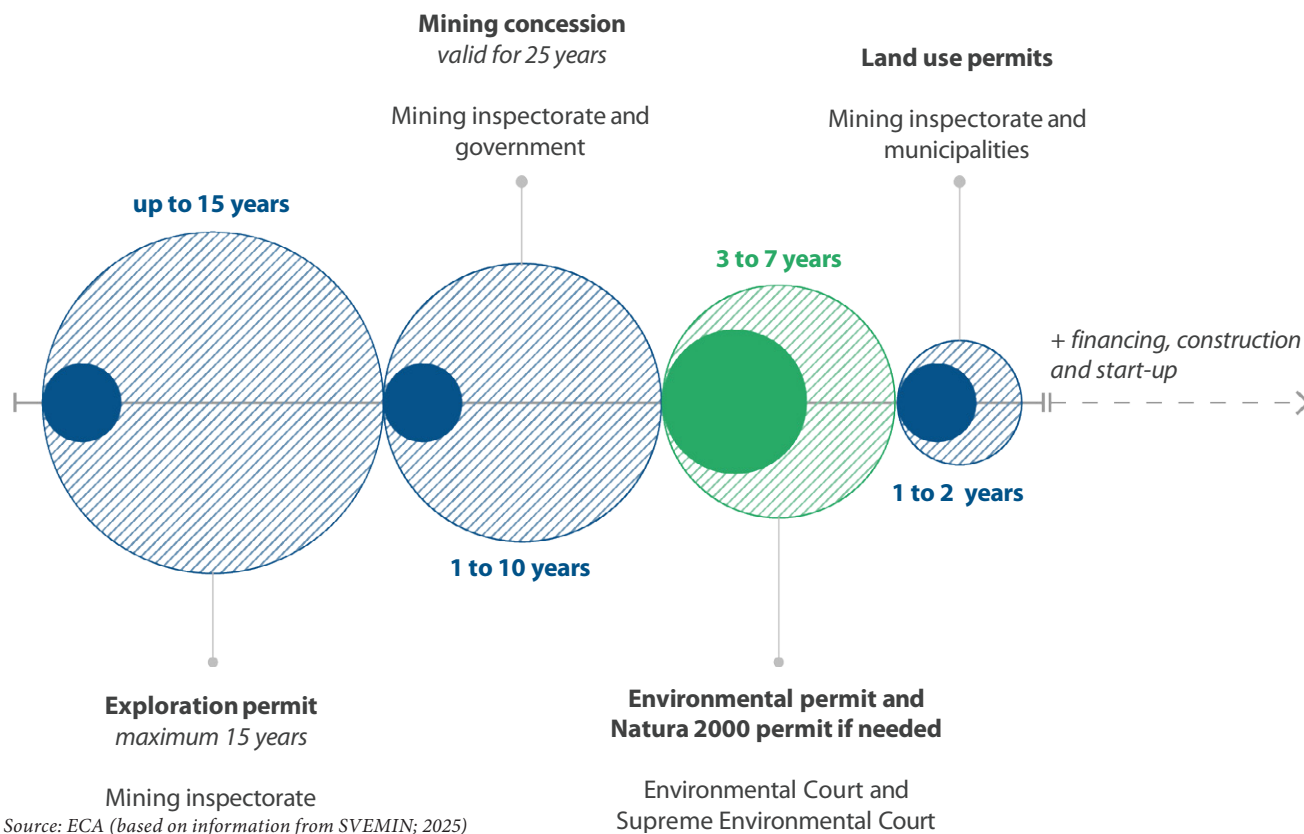
Oversupply... of red tape

Efforts to build up domestic production of CRMs in the EU continue to face a number of fundamental obstacles. While the Critical Raw Materials Act sets targets to increase both extraction and processing within the bloc, current production remains limited and far below global levels. A key issue is the lack of exploration. Many areas in Europe still need to be properly assessed for their resource potential, and early-stage exploration has seen little investment for

years. Even when deposits are found, turning them into successful mining projects is uncertain, expensive, and risky, which slows progress from the very beginning.

Processing presents a similar challenge. Much of the value chain is still outside the EU, particularly for complex materials such as rare-earth elements, where processing capacity is almost entirely concentrated elsewhere. Within Europe, facilities have declined in number, and high energy costs continue to weigh on competitiveness in energy-intensive industries, like smelting and refining. Although new policy initiatives aim to support industrial capacity and reduce energy costs, it is too early to judge

Fig. 3. A long road to a new mine in Sweden: 30 years and counting



Source: ECA (based on information from SVEMIN; 2025)

whether they will reverse this trend. The lack of a secure and stable raw material supply makes it harder to justify investment in processing, a cycle that is difficult to break.

Financing and regulation add more challenges. Many see investment in mining and processing as risky, which makes it hard to attract private money. Public funding is just beginning to grow. Unclear sustainability rules and a want of clear financing guidelines have also slowed progress. On the regulatory side, permitting procedures remain long and complex, with environmental assessments and administrative requirements significantly extending project timelines. In many cases, it can take more than a decade (or a few) for a mining project to move from discovery to production. Recent measures, such as one-stop shops, are intended to simplify the process, but implementation has been rather rough around the edges, and delays continue to hold back the expansion of domestic supply.

According to the ECA report, COM should launch a consultation process to gather evidence and develop practical recommendations on how to make investments easier. Based on the findings, the EU executive should then consider policy

measures that could help reduce financial risks and encourage more investment across the raw materials value chain; the recommended target date is 2027.

Untapped (sustainable) potential

Sustainable resource management is expected to play a larger role in reducing the EU's reliance on primary raw materials, but its potential is still only partly realised. Current policy recognises the importance of improving how materials are used, reused and recovered across their life cycle, and the Critical Raw Materials Act introduces measures to support recycling, efficiency, and substitution. However, there are omissions in how these elements are addressed. In particular, substitution, as in the replacement of critical materials with alternatives, is not fully covered in existing legislation, and delays in implementing key measures are holding back progress. National circularity plans, intended to guide action at the EU Member State level, have yet to materialise because of delays in supporting rules.

Recycling plays a key role in this effort, but current targets and systems do not deliver consistent results for all materials. Some sectors, like battery development,

have stricter requirements, but many important raw materials still do not have clear incentives for recovery. Recycling rates remain low for several materials used in the energy transition, and sometimes they are not recycled at all. Valuable materials embedded in electronic waste are often lost 'thanks' to low collection rates and inefficient recovery processes. Existing targets tend to focus on overall volumes rather than individual materials, which limits the incentive to recover smaller or more complex components.

Even where recycling is technically possible, market conditions continue to constrain its development. High processing costs, limited access to feedstock, and technological challenges make it difficult for European recyclers to compete, particularly against larger, more integrated players in other geographies.

Regulatory factors also play a role, with differences in how rules are applied across the EU Member States and restrictions on waste movement reducing economies of scale. Although recent measures aim to improve product design, labelling, and permitting for recycling projects, these steps are still working their way through

Fig. 4. The patchwork of EU recycling, recovery, and waste collection targets

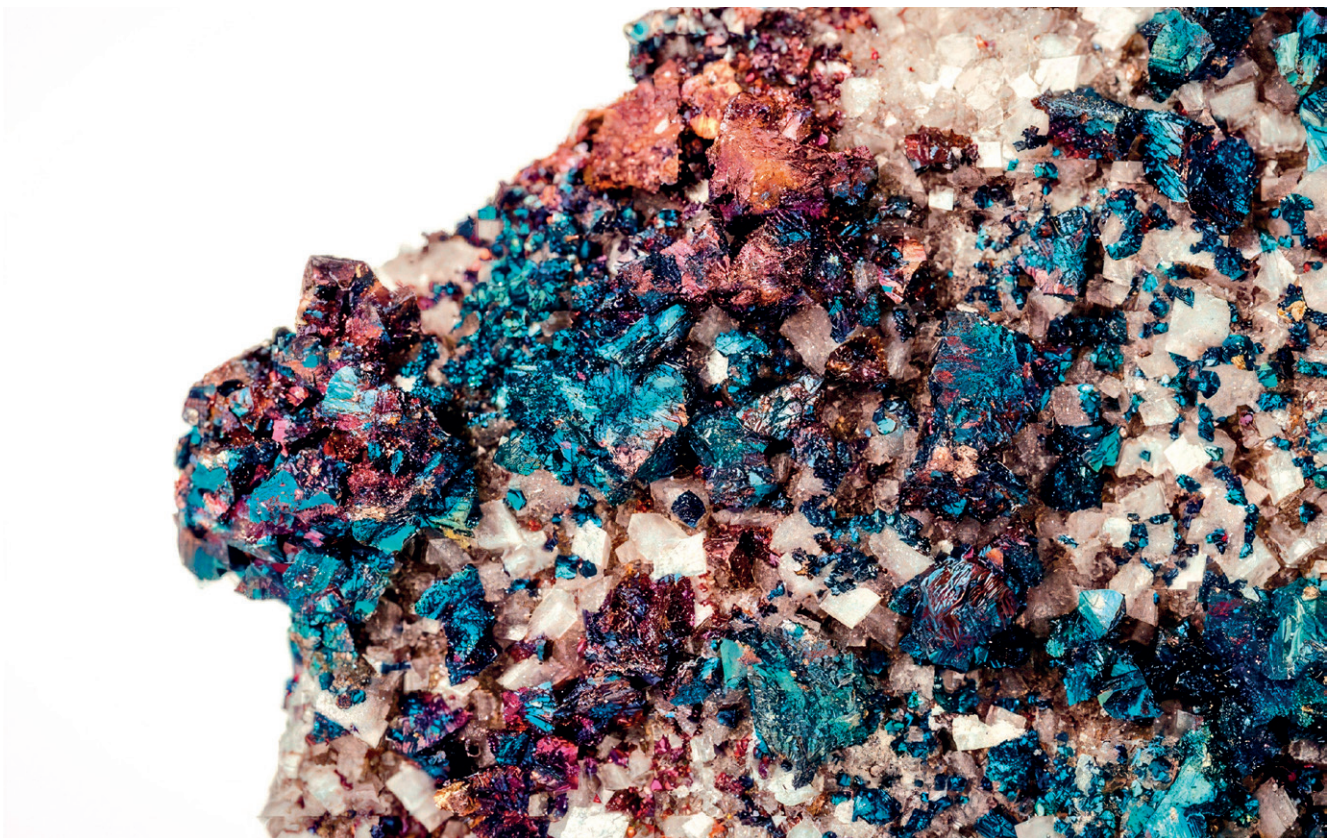
Regulation/policy (deadline)	Material/ waste	Material-specific targets		General SRM target	General recycling and waste collection targets		
		Recovery of materials	Recycled content in new batteries		Recycling- based consumption	Recycling efficiency	Waste collection
CRMA (2030)	Strategic raw materials			✓			
Batteries Regulation (2026, 2028, 2031, 2032)	Cobalt, lithium, nickel, copper (recovery target only)	✓	✓				
	Lithium-ion batteries nickel-cadmium batteries				✓		
Waste Electrical and Electronic Equipment Directive (From August 2018 onwards - annually)	Household appliances, IT and telecommunication, photovoltaic panels					✓	✓
Waste Framework Directive (2025, 2030, 2035)	Municipal waste						✓

Source: ECA (based on EU legislation)

the system. For now, the business case for recycling many CRMs spells uncertainty, which slows its expansion as a meaningful source of supply.

Consequently, to reduce the EU’s reliance on newly extracted CRMs, there must be a focus on making better use of recycling, recovery, and substitution. The ECA

report suggests that when the Net-Zero Industry Act is reviewed, COM should give more attention to replacing CRMs with alternative materials, especially by





encouraging innovation in product design so that fewer scarce inputs are needed.

The ECA report also proposes introducing binding recycling targets for individual CRMs where this is technically possible, along with realistic targets for collecting and recovering waste that contains these materials. Finally, it stresses the need to make recycling more economically viable by making it easier to import relevant waste into the bloc and to transport it between the EU Member States, improving recycling operations. The suggested target date for these improvements is 2029.

The 2030 supply gap

The introduction of the new strategic project label in the Critical Raw Materials Act aims to speed up projects that will help the EU secure important materials. The label brings benefits, like quicker permits and more attention, which has already caught the interest of many in the industry. The first round of applications covered a broad range of activities, from extraction to recycling, and both EU and non-EU projects were selected. However, the roll-out has been up-and-down, with fewer calls for projects than originally planned, and the overall framework still evolving as implementation progresses.

On the ground, however, the benefits of the strategic label are constrained by familiar challenges. While permitting

procedures may be streamlined, delays linked to appeals and administrative processes are still present. Financing is another weak point, as the label does not come with dedicated EU funding, leaving many projects to rely on external capital. Furthermore, the scheme's scope is limited to strategic raw materials, excluding others, though they are important for the energy transition too. Questions have also been raised about project selection, as financial viability is not a requirement, and some projects have faced difficulties even after being granted strategic status.

In the big picture, many of these projects are unlikely to make a meaningful contribution to supply by the next decade. A large share is still at an early stage of development, with uncertain timelines and, here and there, no secured buyers for their output. Although a handful of more advanced projects are expected to move forward, they would likely have done so without the strategic designation. The link between these projects and wider EU partnerships with resource-rich countries also appears weak, limiting their role in reducing supply risks. As a result, while the strategic project instrument may support longer-term development, its impact on near-term supply is uncertain.

The ECA report's recommendations in this area suggest that COM, during the

evaluation of the Critical Raw Materials Act in 2029, should widen the range of CRMs that can qualify, particularly those important for the energy transition. Priority should be given to projects that already have buyers in the EU, as this would increase the likelihood that the materials actually support European industries. Also, projects with longer development timelines should be allowed, recognising that many raw materials projects take years to become operational.

The EU's raw materials strategy points the way forward, but its effects will not be immediate. Key issues – among them import dependence, slow project development, recycling limits, and investment risks – are still not solved. A sizeable gap remains between what politicians hope for and what industry can deliver, so the EU will likely stay vulnerable to global markets and geopolitical risks for some time.

The need for speed

Turning strategy into the reality of tangible and secure supply will require better data, clearer priorities, faster permitting, stronger financing, and more effective recycling, as well as the development of complete value chains within Europe. The *Critical raw materials for the energy transition* report found that without faster progress, raw materials will remain one of the key weak points in the energy transition. ■

ONSHORE POWER SUPPLY: JOIN THE STUDY VISIT AND SEMINAR AT THE PORT OF HAMBURG

by Andrzej Urbaś

The Port Gear Team is excited to invite decision-makers, senior technology leads, and infrastructure developers to an exclusive OPS Seminar & Study Visit at the Port of Hamburg on 26 June 2026.

Unlike standard industry conferences, this seminar prioritizes technical depth over marketing narratives. We are gathering experts with profound technical know-how to ensure you can engage in a rigorous discourse, obtaining the precise data required to drive your port projects forward. This is your platform to ask complex technical questions and receive the transparent, detailed answers necessary for successful infrastructure deployment.

Agenda highlights

The study visit will tackle the most pressing technical and operational hurdles facing Onshore Power Supply (OPS) today:

- OPS for container vessels at the Port of Hamburg.
- Addressing technical and operational hurdles at large-scale container hubs.
- Expanding shore power for the cruise vessel market in the North and Baltic Sea regions.
- Standardizing automated cable management for multi-berth cruise terminals.

Hamburg, Europe's OPS capital

The Port of Hamburg has established itself as a global leader in the cold ironing technology, driven by the commitment to the "Air Quality Maintenance Plan." By successfully deploying large-scale OPS solutions for both container

and cruise vessels, the port has navigated the immense complexities of high-voltage implementation at major hubs.

For the European Union, the rapid adoption of OPS is no longer optional but a strategic imperative. Under the "Fit for 55" package and the FuelEU Maritime regulation, major EU ports are required to provide shore-side electricity for container and passenger ships by 2030. This push is vital for meeting the EU's climate neutrality goals, as it targets "Scope 3" emissions and helps protect the health of millions of citizens living in coastal urban centers. As the regulatory deadline approaches, the technical insights shared at the Hamburg seminar will be more relevant than ever. ■



PHOTO: UNSPLASH/WOLFGANG WEISER

DISTINCTLY HYSTER, BUILT FOR YOU



Your port needs tailored solutions that dial in performance and shed inefficiencies – not generic equipment or overbuilt extras. At Hyster, our broad lineup of purpose-built trucks and flexible options give you the freedom to find the solution that actually works for your operation, and our team's right there with you to make sure you've got the right setup for the long haul.



**Don't just get a truck for the job.
Get the right truck for *your* job.**

TOC
EUROPE

VISIT US AT **STAND E20**
OR ONLINE AT **HYSTER.COM**

Moves a lot. Changes everything.

With a maximum lifting capacity of 1,600 tons,
our travelling cargo crane TCC 78000 will drive
your heavy-duty projects to success.

www.liebherr.com

LIEBHERR

Maritime cranes

