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FROM THE EDITOR

Margherita Bruno,
Editor



Welcome to this new edition of PTI's maritime e-journal! As we mark the 150th edition of our journal, it's amazing to reflect on how much we've covered over the years, especially when it comes to tackling some of the biggest challenges facing the maritime industry today—namely, decarbonisation and sustainability. This milestone feels like the right moment to shine a spotlight on those topics, and we're thrilled to release this special edition in tandem with the GreenTech for Ports and Terminals Conference hosted in Gothenburg, Sweden.

The next couple of days are going to be a fantastic opportunity for everyone involved to meet, share ideas, and collaborate on how we can all contribute to decarbonising the maritime industry. We're really looking forward to seeing all the discussions unfold and, hopefully, making new connections that will drive the change we need.

Inside this edition, we've gathered contributions from trailblazing companies striving to reduce emissions and promote sustainability, eager to share essential insights for navigating the complex path ahead.

One of the highlights of this issue comes from CM Labs. They're showing how simulation training is a game-changer for both productivity and emissions reduction. By moving away from fuel-burning equipment during training sessions, they're helping ports cut down on emissions while improving how efficiently things run. Corpus Christi, for example, is using simulators to prepare for the shift to electric and automated equipment, which is helping them avoid the typical productivity dips that come with those transitions. It's a great example of how technology can make a real difference in driving decarbonisation while also supporting workforce development.

Compacer GmbH has also secured a spot in this new edition with its innovative use of Digital Twin technology. By moving older cranes to Estonia and leveraging a Digital Twin to optimise energy consumption, they've managed to boost both sustainability and efficiency. What's really exciting is how they're using AI and sensors to forecast energy usage with incredible accuracy. The way they're turning energy that would otherwise go to waste into something useful, like powering AGVs, shows just how far we've come in terms of energy recovery.

We further explore DP World's remarkable decarbonisation strategy, aiming for a 28 per cent reduction in Scope 3 emissions by 2030, together with a 42 per cent decrease in Scope 1 and 2 emissions. DP World's commitment to electrification, retrofitting, alternative fuels, and smart tools serves as a strong model for the industry. Their customer-focused solutions, including real-time CO2 calculators and GreenBox carbon-insetting tokens, empower clients to participate actively in decarbonisation efforts. This highlights the importance of collaboration with customers and suppliers in achieving meaningful progress.

Another standout contribution comes from Hyster, discussing the electrification of heavy-duty port equipment. Moving from internal combustion engines to electric systems has a whole host of benefits, from zero emissions to less maintenance and quieter operations. But as Hyster points out, electrification brings its own challenges, especially when it comes to safety. With different regulations around the world, it's crucial that ports have the right protocols in place to manage the risks of high-voltage systems. Hyster's insights are invaluable for ports looking to make the transition to electrification while keeping safety front and centre.

Jacobs takes a nuanced approach to decarbonisation, pointing out that there's no one-size-fits-all solution. They emphasise how important it is to understand each port's unique challenges, whether that's related to infrastructure, ownership models, or market needs. Jacobs' three-phase strategy for decarbonisation—optimising current operations, aligning infrastructure with emissions goals, and investing in digital systems and low-carbon fuels—offers a clear roadmap. Collaboration is key in their approach, pointing out how working together across sectors is critical if we're going to meet our climate goals.

Portwise rounds out this issue with a deep dive into the challenges terminals face as they move towards zero-emission operations. Making decisions about the right technologies to adopt, managing financial viability, and balancing the needs of various stakeholders isn't an easy task. Portwise advocates for a holistic approach, one that takes into account the specific needs of each port, from local circumstances to infrastructure requirements. Their insights into the trade-offs of electrification are especially helpful for ports trying to make the best choices while maintaining operational efficiency.

As we celebrate this 150th edition, it's clear that the maritime industry is on the cusp of some major changes. We hope that in these pages you'll find a wealth of knowledge and practical solutions that can guide ports and terminals through the journey toward decarbonisation and sustainability.

A sincere thank you to all our contributors and sponsors for their invaluable support, which has made this journal possible. We also want to wish everyone attending GreenTech an inspiring and productive event—together, we can drive the change to build a more sustainable and resilient maritime future!



CONTENTS

GREENTECH 2025

5. GREENTECH 2025 SPONSORS

8. GREENTECH 2025 SPEAKERS

13. SMARTER TRAINING, GREENER PORTS

Devon Van de Kletersteeg, Ports and Industrial Product Growth Manager, CM Labs

17. HOW A DIGITAL TWIN HELPS EUROPE'S PORTS SAVE ENERGY

Volker Hettich, Chief Strategy Officer, compacer GmbH

21. TACKLING THE SCOPE 3 EMISSIONS CHALLENGE HEAD-ON

Piotr Konopka, Group Vice President – Decarbonisation & Energy Programmes, DP World

PTI'S CORNER

25. IN CONVERSATION WITH: NOKIA. BRINGING PORTS INTO THE FUTURE

Dom Magli, Reporter, Port Technology International, interviewing **Willie Kopp**, Head of Private Networks–North America, Nokia

28. IN CONVERSATION WITH: PASSIFY. RETHINKING TRUCK ACCESS

Margherita Bruno, Editor, Port Technology International, interviewing **Marcel Lindemann**, Co-Founder and Managing Director, passify

31. A PRACTICAL GUIDE TO SERVICE REQUIREMENTS FOR HIGH-VOLTAGE MATERIALS HANDLING EQUIPMENT

Herman Klaus, Director, Big Truck Application Solutions, Hyster Company

36. HARBOURING CHANGE: THINKING FAST AND SLOW ABOUT PORT DECARBONISATION

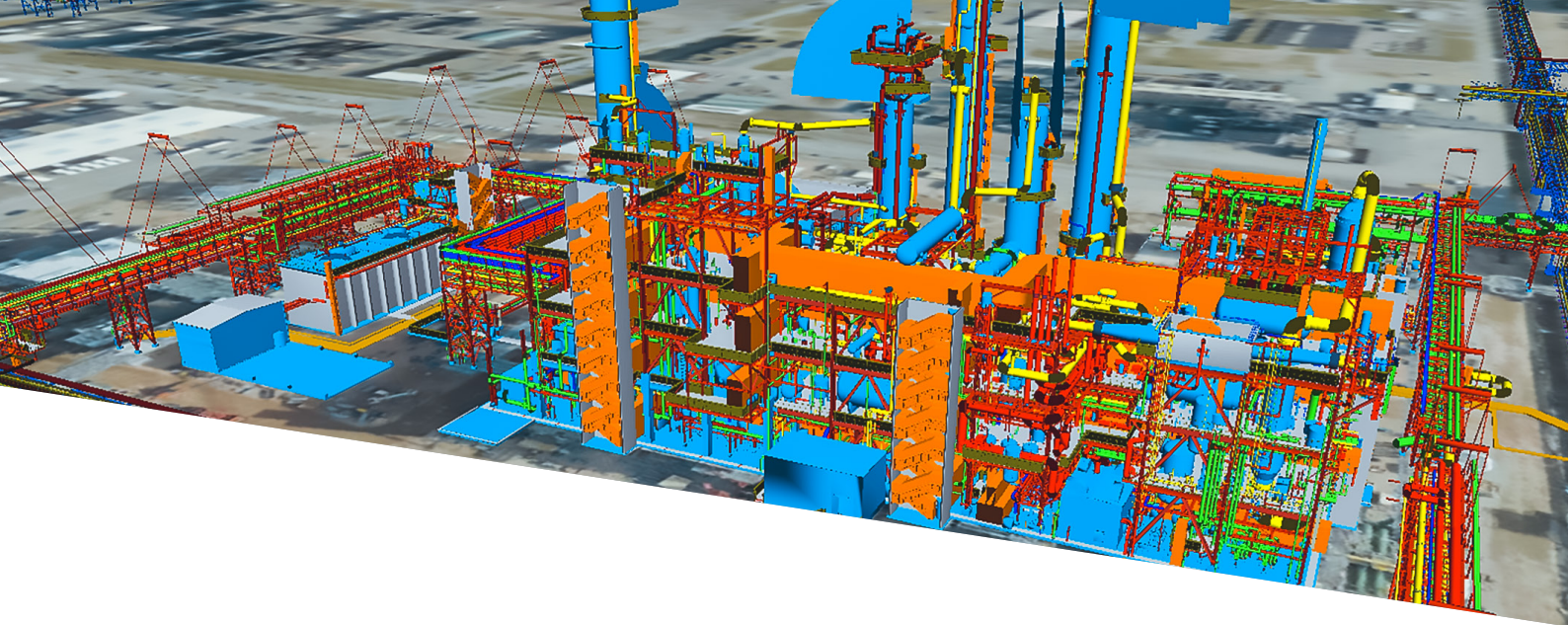
Laurence Banyard, Global Principal for Maritime Energy, Jacobs

40. ROADMAP TOWARDS ZERO EMISSIONS NEEDS A HOLISTIC VIEW

Dr Zack Lu, Senior Project Manager, Portwise, **Dr Isabelle van Schilt**, Project Manager, Portwise, and **Pim van Leeuwen**, Project Manager, Portwise

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Kalmar

Kalmar is recognised as the global leader in sustainable cargo and material handling for ports, terminals, distribution centres, and heavy industry. The company boasts an extensive electric portfolio and a worldwide service network, which enables it to assist its customers in transitioning towards safer, more eco-efficient, and productive operations. Collaboratively, Kalmar and its customers work towards developing innovative solutions that have the potential to shape the future of the industry, ultimately enhancing the efficiency of their customers' operations.



Kempower

Kempower is committed to reshaping the container port landscape. Their versatile distributed charging system supports the industry's shift to zero emissions while empowering operators to meet rising demands efficiently.

The company designs and manufactures reliable and user-friendly DC fast-charging solutions for electric vehicles. Their vision is to create the world's most desired EV charging solutions for everyone, everywhere. Kempower's product development and production are based in Finland and in the US, with the majority of materials and components sourced locally. The company focuses on all areas of e-mobility, from electric cars, trucks, and buses to machines, ports and marine. Their modular and scalable charging system and world-class software are designed by EV drivers for EV drivers, enabling the best user experience for customers around the world. Kempower is listed on the Nasdaq Helsinki Stock Exchange in Finland. www.kempower.com



NextPort

NextPort is the technology and innovation brand of Moffatt & Nichol, dedicated to transforming the maritime industry through advanced digital solutions. Building on more than 75 years of experience in port engineering, planning and operations, the company combines deep industry expertise with breakthrough technologies such as AI, machine learning, and operational Digital Twins. Their mission is to empower ports and terminals with smarter, more efficient, and sustainable solutions.

NextPort connects fragmented data across maritime ecosystems, providing real-time insights and actionable analytics to drive continuous improvement. Their holistic approach bridges operational silos, enabling seamless integration between infrastructure, assets, and teams, fostering collaboration and operational excellence.

With specialised applications tailored to address the unique challenges of ports and terminals, NextPort delivers tools that enhance decision-making, optimise workflows, and reduce environmental impact. By aligning advanced technology with industry needs, the company helps partners not only achieve efficiency but also set a benchmark for sustainability and resilience. At NextPort, expertise meets innovation to redefine how the maritime sector operates, paving the way for smarter, greener, and more connected ports.

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Awake.AI

Awake.AI is an optimisation platform company specialised in customised AI/ML models to optimise cargo flow through ports and reduce waiting times and emissions. Awake's AI-driven Logistics Platform is developed to bring together all maritime actors at sea, ports and land, making port operations more efficient, safe and sustainable.

Awake.AI optimises port calls with AI insights for port terminal operators and helps port authorities maximise the use of their existing capacity. For ship operators, the platform enables Just-in-Time (JIT) arrivals and faster turnaround times, while cargo owners benefit from full transparency across the sea-port-land cargo flow. The company provides a holistic AI-driven software platform that includes machine learning APIs, predictive and optimisation models, Port Call Planning and Optimisation Solutions, and a Smart Port Marketplace.



Compacer

For over 25 years, compacer has stood for expertise in data integration and process automation. As part of the eurodata group and an experienced IT service provider, they support large and medium-sized companies on their journey to digital transformation.

With over 200 employees worldwide and renowned clients such as DHL, Deutsche Telekom, and Europcar, they develop software products "Made in Germany" for corporations and medium-sized enterprises. Their headquarters are located in Germany, with additional locations in the Czech Republic, the Netherlands, Finland, and France.

compacer GmbH is one of Germany's leading IT service providers and software vendors for reliable and format-independent data exchange between IT systems, plants, and devices. They assist companies in automating and digitising their business-critical processes, ensuring that their IT structure evolves in an innovative and future-oriented manner.

Their central data hub, edbic, enables intelligent networking, data and process integration, ensuring seamless data exchange as well as improved automation and optimisation of business processes.

compacer positions itself as a trustworthy, independent technology partner and innovator, optimising its customers' value chains through the establishment and expansion of secure ecosystems.



Niras

NIRAS is a value-driven, multi-disciplinary engineering consultancy fundamentally committed to sustainable progress and service delivery. With nearly 70 years of expertise and a team of 3,000 specialists, they offer solutions across almost every field—from industry and construction to environment, infrastructure, water, energy, life sciences, and biosolutions.

Their strong local presence, combined with a global outlook, ensures we meet the evolving needs of our clients, making a meaningful impact in every project they undertake.

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Ffuel

Ffuel is a software company which provides a digital tool to give ports and terminals full control of all their energy infrastructure.

Their platform enables full visibility, planning, and coordination of energy delivery across port sites—helping to optimise energy usage, maximise operational uptime, and improve profitability from power sales. Ffuel's system integrates with both new and existing energy infrastructure to provide a real-time overview of consumption, production, and delivery, along with tools for efficient payment and Port Call Planning related to energy operations. Whether it's integrating new energy sources or supporting operators in day-to-day management, Ffuel empowers ports to become smart energy hubs.

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The Hitachi logo, consisting of the word 'HITACHI' in a bold, black, sans-serif font.

Hitachi Energy

Hitachi Energy is a global technology leader committed to advancing a sustainable energy future for all. The company is driving the transformation of the world's energy system to make it more sustainable, flexible and secure. The company collaborates with customers and partners to enable a sustainable energy future for today's generations and those to come.

Hitachi Energy has a proven track record and unparalleled installed base in more than 140 countries, serving customers in utility, industry, transportation, data centres, and infrastructure sectors. Its innovative technologies and services—including the integration of more than 150 gigawatts of HVDC links into the power system—help make the energy value chain more efficient, making electricity more accessible to all.

Together with stakeholders across sectors and geographies, Hitachi Energy enables the digital transformation required to accelerate the energy transition towards a carbon-neutral future. Headquartered in Switzerland, the company employs around 45,000 people in 60 countries.

SPEAKERS



Ambrish Bansal, Senior Vice President - Business Advisory & Consulting, Lloyd's Register

Ambrish has over 18 years of strong Industry & Consulting experience, primarily in Business strategy & Transformation, Sustainability/ESG, Project management & Operational excellence across the Energy & Maritime sectors. Currently, he leads LR Management Consulting and ESG advisory services globally. Prior to LR, he has worked with Strategic Consulting companies (KPMG & Accenture Strategy) and India's largest Private sector company, Reliance Industries. During his career, he worked across 5 continents and led multinational teams. He is a certified Project Management Professional (PMP) from PMI, USA and an MBA in Sustainability Management from SUMAS, Switzerland.



Ana Arévalo, Head of Shorepower Department, Port of Barcelona

Ana Arévalo is a Naval Engineer from the Polytechnic University of Madrid and holds a Master's Degree in Management Development – PMD® from ESADE Business & Law School. With 25 years of experience linked to the naval and port logistics sector, Ana is currently Head of the Shorepower Department at the Port of Barcelona, leading NEXIGEN, a strategic plan for the energy transition, electrification, and decarbonisation of the port. Her passion for collaboration, effective communication, continuous learning, and a multidisciplinary work approach are key to developing innovative projects and solving complex challenges. Ana participates as an expert in national, European, and international shore power associations and working groups on behalf of the Port of Barcelona and Puertos del Estado. She is also a regular speaker in technical forums and a lecturer at the Escola Europea Intermodal Transport.



Arthur Neeteson, Head of Decarbonisation Enablement & Partnerships, APM Terminals

Arthur Neeteson is the Head of Decarbonisation Enablement & Partnerships at APM Terminals, part of Maersk Group, he is responsible for ensuring that APMT's decarbonisation programme creates value for stakeholders and for the business. Before joining APMT, Arthur worked at the Port of Rotterdam, at McKinsey and at a climate consultancy called Systemiq. He worked in or with companies in the Global South for about half of his career.



Ceren Turan, Pre-Sales Engineer, Hexagon

Ceren Turan is a Pre-Sales Engineer working in Hexagon's Safety Infrastructure and Geospatial division, based in Leuven, Belgium. With a degree in Computer Engineering, she has been working in GIS projects for almost ten years. In her current role, she is responsible for developing demos on Hexagon's wide product portfolio and taking roles in seeking out sales opportunities and providing technical support for HxGN Smart Sites.



Denise Sofia, Head of ESG, Contship Italia

Denise Sofia is the Head of ESG at Contship Italia, an intermodal logistics group that owns and operates La Spezia Container Terminal, the second-largest container terminal in Italy. She is responsible for Contship's ESG strategy, defining Contship's roadmap to Net Zero and embedding sustainability into all business units. She has over 15 years of experience in the sustainability, energy, and environmental sectors, developing and implementing green and circular economy initiatives. Before joining Contship, Denise was Head of Sustainable Development at a multinational company in the renewable energy sector.



Dirk Wagemans, Vice President for Commercial Industries, Hexagon

Dirk Wagemans is the vice president for Commercial Industries at Hexagon's Safety, Infrastructure & Geospatial division. He joined Hexagon in 2012, helping to drive geospatial software sales growth in Europe, India, and Japan and served as vice president for geospatial software in the Asia-Pacific region. Prior to joining Hexagon, he worked in the health, services, and energy sectors. He began his career in diplomacy. Wagemans holds degrees in history, international politics, geography, and management.


Ekaitz Lopez Amurrio, Chief Financial Officer, Bilbao Port

Ekaitz Lopez Amurrio (44) has been the Chief Financial Officer of the Bilbao Port Authority (BPA) since 2014. Graduated from Deusto Business School, he specialised in finance and logistics (2003), and completed the Executive MBA at IESE Business School (2010). He is part of the management committee of Bilbao Port Authority and responsible for the investment project economic analysis. Coordinator (LEAR) of the grant agreements between the Port Authority and the European Commission. He is a member of the Energy and Sustainability working groups at the European Seaports Organisation (ESPO). Board member at Bilbao Ría 2000 company since 2015. Ekaitz has supported since its foundation in 2019 the BilbaoPortlab project to build an open innovation ecosystem at the Port of Bilbao. He is strongly focused on supporting energy transition projects to deploy alternative fuels (BilbOPS CEF transport project) and renewable energies at the Port of Bilbao.


Gabriela Ruano, Sr Customer Innovation Advisor, CONROO

Gabriela Ruano is a Senior Customer Innovation Advisor specialising in the digital transformation of port and terminal operations. She helps operators, port authorities, and industry leaders bridge the gap between traditional logistics and scalable, data-driven solutions. With a strong focus on digitisation, smart truck flow optimisation, yard management, and digital security, she translates innovative technologies into tangible operational benefits for terminals.


George Robert Wagner, Chief ESG Officer, CoreX Holding BV

George Wagner joined YILPORT in 2021 as Global HSSE Director and is now the Chief ESG Officer at CoreX Holding BV, responsible for driving the company's ESG strategy and implementing initiatives that foster sustainability, inclusivity, and resilience across all operational facets. George has previously worked in various roles across sustainability and environmental management in the logistics and supply chain sectors.


Giulia Sforzi, Principal Engineer, HR Wallingford

During her career, Giulia has gained significant construction site experience, acting as client representative on-site and on dredging vessels, supervising the entire dredging cycle. She reviewed operations against plans, identified technical issues, and liaised with client management and engineering teams. Giulia has a strong interest in sustainability and supports the adoption of sustainable practices in civil engineering. At HR Wallingford, she helps implement the company's Sustainability Programme, focusing on climate change services and business development transition. She is also a member of the CEDA Decarbonisation Commission, dedicated to decarbonising the dredging industry, and tutors on the IADC Dredging for Sustainable Infrastructure (DFSI) Course. Before joining HR Wallingford, Giulia gained site experience working for an Italian offshore survey and positioning company.


Hanno Bromeis, Head of Port Energy Solutions, Hamburg Port Authority

Hanno joined Hamburg Port Authority (HPA) in 2020 to lead HPA's shore power activities, overseeing strategy, planning, construction, launch, and operation of shore power facilities. He later assumed leadership of HPA's newly founded Port Energy Division, driving energy transition activities focused on green electron delivery, green electron production, and green molecule delivery, aligned with EU requirements and the City/Port's sustainability targets. Hanno has a background in strategy consulting, specialising in go-to-market and growth strategies across industries such as tourism, transportation, and energy, with a recent focus on sustainability and renewables. He holds a business degree from the University of Cologne and the London School of Economics and lives with his family in the beautiful city of Hamburg.


Ilari Lehtinen, Sales Development Lead, Kalmar

Ilari Lehtinen is a Sales Manager at Kalmar, specialising in Horizontal Transportation solutions. With 4 years of experience at Kalmar and a Master's degree in Industrial Engineering and Management from Tampere University, Ilari brings a blend of academic knowledge and practical expertise to his role. He is dedicated to understanding customer needs, building strong client relationships, and contributing to Kalmar's success in the global cargo handling industry.

SPEAKERS Continued



Isabelle van Schilt, Project Manager, Portwise

Isabelle van Schilt (Dr) is a project manager and principal consultant at Portwise, a leading consultancy company located in the Netherlands with the mission to design smarter, more efficient, and more sustainable ports and terminals for future-proof logistics. Her expertise focuses on dealing with (deep) uncertainty, data sparseness, and robust decision-making in the ports, logistics, and supply chain industry. She holds a PhD degree in supply chain simulations from Delft University of Technology (Delft, Netherlands), in collaboration with the Dutch Police AI Lab.



Ishita Sharma, Research Manager, Port Esbjerg

As a Research Manager at Port Esbjerg and a researcher at Aarhus University, Ishita Sharma is at the forefront of transforming the maritime industry through sustainable energy solutions and digitalisation strategies. She is leading projects with a focus on green transition in the maritime industry to slash carbon emissions in port operations. Innovating how ports electrify and optimise energy for a carbon-neutral future. She is driving research on sustainable business models and transport decarbonisation. With a vision for smarter, greener ports, Ishita is shaping the future of sustainable logistics—one breakthrough at a time!



Jérôme Besancenot, Information Systems Manager, Haropa Port

Dr Jérôme Besancenot, PhD in Computer Science from Paris University, is Digital Transition Project Director for HAROPA PORT (Le Havre, Rouen, Paris). An expert in maritime IT strategy and single windows, he developed S-WING® (Single-Window Next Generation), a Port Community System facilitating vessel and cargo transit. This concept supports ports' digital transformation into "Smart and Connected Ports," integrating Big Data, AI, blockchain, 5G, and IoT through a digital twin approach. He also leads a cybersecurity platform project for HAROPA PORT, strengthening cyber defence culture across maritime and logistics activities. Dr Besancenot is Vice-Chairman of the international PROTECT Group within IPCSA, and a member of the International Association of Ports and Harbors (IAPH) and IMO FAL Committee. Dr Jérôme Besancenot has published papers in IT reviews and is also co-author of a book on transactional systems: concept, normalisation and products.



Jill Söderwall, Vice President Business Areas, Port of Gothenburg

Mrs. Jill Söderwall has worked for the Port of Gothenburg in different leading positions for almost 20 years. Today she is Vice President for Business Areas & Partner Management and her responsibilities include both the cargo terminals and the energy terminal of the Port of Gothenburg. Also, she is a long-term member of the company management board. Before joining the port, Jill had an extensive career in the energy sector, where she worked in different technical and management positions. Jill is committed to making the Port of Gothenburg the most competitive port in the world and an important part of sustainable logistic chains for the future.



Karno Tenovuo, CEO, Awake.AI

Karno Tenovuo has been in the marine industry since 2004, launching several groundbreaking solutions. He is currently CEO of Awake.AI. Karno holds an M.Sc. (Tech) from Helsinki University of Technology and an M.Sc. (Econ) from Turku University. He spent the first seven years of his career leading R&D and business development at Finnish shipyards before starting his own company. Rolls-Royce became a client and later offered him a global role in business development and strategy. As SVP of Ship Intelligence, he led projects including the world's first remotely controlled commercial vessel with Maersk & Svitser and the first autonomous ship demonstration with Finnferries. Recognising the need for digital handshakes across logistics, he founded Awake.AI.


Leo Greene Carlstedt, Head of Partnerships and Communication, APM Terminals

Leo Greene Carlstedt is the Head of Partnerships and Communications Nordics at APM Terminals Nordic. With a background in maritime transport and logistics, Leo focuses on strategic initiatives and managing key partnerships to enhance the company's market presence and communication strategies. Previously, Leo held roles at A.P. Møller – Maersk, including Senior Investment Manager and Sourcing Project Manager, gaining experience in port investments and business development. Leo's career also includes time at Novo Nordisk, SCA, and Volvo Group. Leo holds an MSc in Supply Chain Management and BSc in Business Administration.


Luisa Kempf, Senior Manager Sustainability & Energy Transition, Eurogate

Luisa Kempf is Senior Manager Sustainability & Energy Transition of EUROGATE Technical Services GmbH. EUROGATE is a shipping line-independent container terminal group with container terminals in 12 locations across Europe. Luisa supported the initiative from the start, and EUROGATE is one of the founding members of TIC4.0.


Marcus Defranceski, Team Leader, Fraunhofer

Marcus Defranceski is the CEO and Founder of Data Coffee GmbH (2021-Today), a spin-off of Fraunhofer IPA, focusing on software solutions for data acquisition and enhancement for machine and sensor data. As Group Leader at Fraunhofer IPA (2016-Today), Marcus leads a team of engineers, mathematicians, and computer scientists, concentrating on user-centred data provision from machines to humans and analysing interactions between the environment, man, machine, and product. Main sectors: battery, semiconductor, automotive. Previously, as a Researcher at Fraunhofer IPA (2008-2016), Marcus collaborated on national and European research projects related to data acquisition, pre-processing, and production analysis. He coordinated the European research project "Transparency" and worked on logistics simulation of production processes. Main sectors: semiconductor, photovoltaic, automotive.


Mattias Sandell, Port Development Strategist, Ports of Stockholm

Mattias Sandell is a Swedish Port Development Strategist at Ports of Stockholm, a position he has held since 2021. With a Master of Science in Civil Engineering from Chalmers University of Technology (1993), Mattias has an extensive career in port management. He served as Technical Manager at Ports of Stockholm from 2011 to 2021, and as a Project Manager at both Ports of Stockholm (1998–2011) and the Port of Gothenburg (1995–1998). Mattias has been an active member of PIANC (The World Association for Waterborne Transport Infrastructure) since 1996 and has represented Sweden in the MarCom (Maritime Navigation Commission) since 2013.


Miluše Tichavska, Green Ports & Sustainability Director, NextPort

Miluše Tichavska leads sustainability strategy and decarbonisation efforts at NextPort by Moffatt & Nichol. Her work focuses on helping ports and terminals take practical, data-driven steps towards reducing emissions and aligning with evolving environmental and funding requirements. With a background in environmental economics and maritime data, Miluše has worked on projects with international bodies such as the UNCTAD, UN CEFAC, and the IMO GIA, contributing to global initiatives on sustainability, innovation, and digital transformation in transport. At NextPort, she supports the development of smart port solutions and digital platforms that enable terminal operators to track, model, and act on carbon performance in cost-effective ways. Miluše brings deep expertise in linking operational insights with ESG, climate finance, and regulatory readiness - helping port stakeholders move from strategy to execution.

SPEAKERS Continued



Norbert Klettner, Vice President, TIC 4.0

Norbert has been working for more than 15 years in the port and terminal industry, implementing and integrating Terminal Operating Systems (TOS), initially for the terminal operator EUROGATE, and since several years as the managing director of the RBS EMEA Office implementing the TOPS Expert system. With akquinet port consulting as well, he has moved into the area of using data for simulation and emulation purposes on the CHESSCON suite. Norbert is a founding member of TIC4.0 since 2018 and is the Vice-President of TIC4.0, as well as a member of the Executive and Operation Councils of TIC4.0.



Volker Hettich, Chief Strategy Officer, compacer

As Chief Strategy Officer of compacer GmbH, Volker Hettich makes digital processes tangible and visible. With three decades of expertise, he advises renowned companies in data integration and process automation. His innovative strategies and business models help firms grow and flourish in today's dynamic digital landscape.



Zack Lu, Senior Project Manager and Consultant, Portwise

Zack Lu is a Senior Project Manager and Principal Consultant at Portwise (formerly TBA), a leading consultancy in the Netherlands dedicated to designing smarter, more efficient, and sustainable ports and terminals. With over 10 years of international experience, Zack has led a wide range of projects involving container terminal planning, design, simulation, operation, automation consulting, and TOS/ECS implementation. He is an expert in all types of terminal handling systems, from manual to fully automated operations, with extensive hands-on knowledge across terminal planning, equipment, and software development. Zack has worked with terminal operators across Asia, Europe, the Americas, Oceania, and Africa. In addition to his consultancy work, he contributes to Portwise's technology service development, company strategy, and personnel coaching. Zack holds PhD and MSc degrees in transport engineering and logistics planning from Delft University of Technology in the Netherlands.

SMARTER TRAINING, GREENER PORTS





Devon Van de Kletersteeg, Ports and Industrial Product Growth Manager, CM Labs

HOW SIMULATION ACCELERATES SUSTAINABLE PORT OPERATIONS

Cutting emissions during operator training. Shortening cycle times. Reducing dips in productivity when deploying new equipment. Digitalising training. Reducing berth times. Transitioning to electric and low-emission equipment.

Each of these improvements helps ports achieve sustainability goals by cutting emissions while fostering resilience, improving safety, addressing labour shortages, and boosting productivity—sometimes quite dramatically.

Another catalyst in the dedication to sustainable port management is the International Maritime Organization's (IMO) ambitious target to reduce emissions by 20 to 30 per cent by 2030 before reaching net-zero greenhouse gas emissions by 2050. To achieve this, ports have been investing in building alternative fuel infrastructure, integrating shore power, improving port call optimisation, and investigating other aspects of operation that can reduce emissions.

In the drive towards decarbonisation, one dimension of port operations might not immediately come to mind: workforce development. But how a port approaches its workforce development can—perhaps surprisingly—have a significant impact on emissions.

Tackling all of these goals to drive greener ports involves using a new approach to training that has already become the norm in aviation and increasingly adopted



in construction, mining, and healthcare: simulation training. These industries have turned to simulation as a more effective, safer, and greener option.

For ports, this approach has the potential to provide a significant competitive advantage. Early adopters have already found that simulation training can lead to substantial benefits and support decarbonisation.

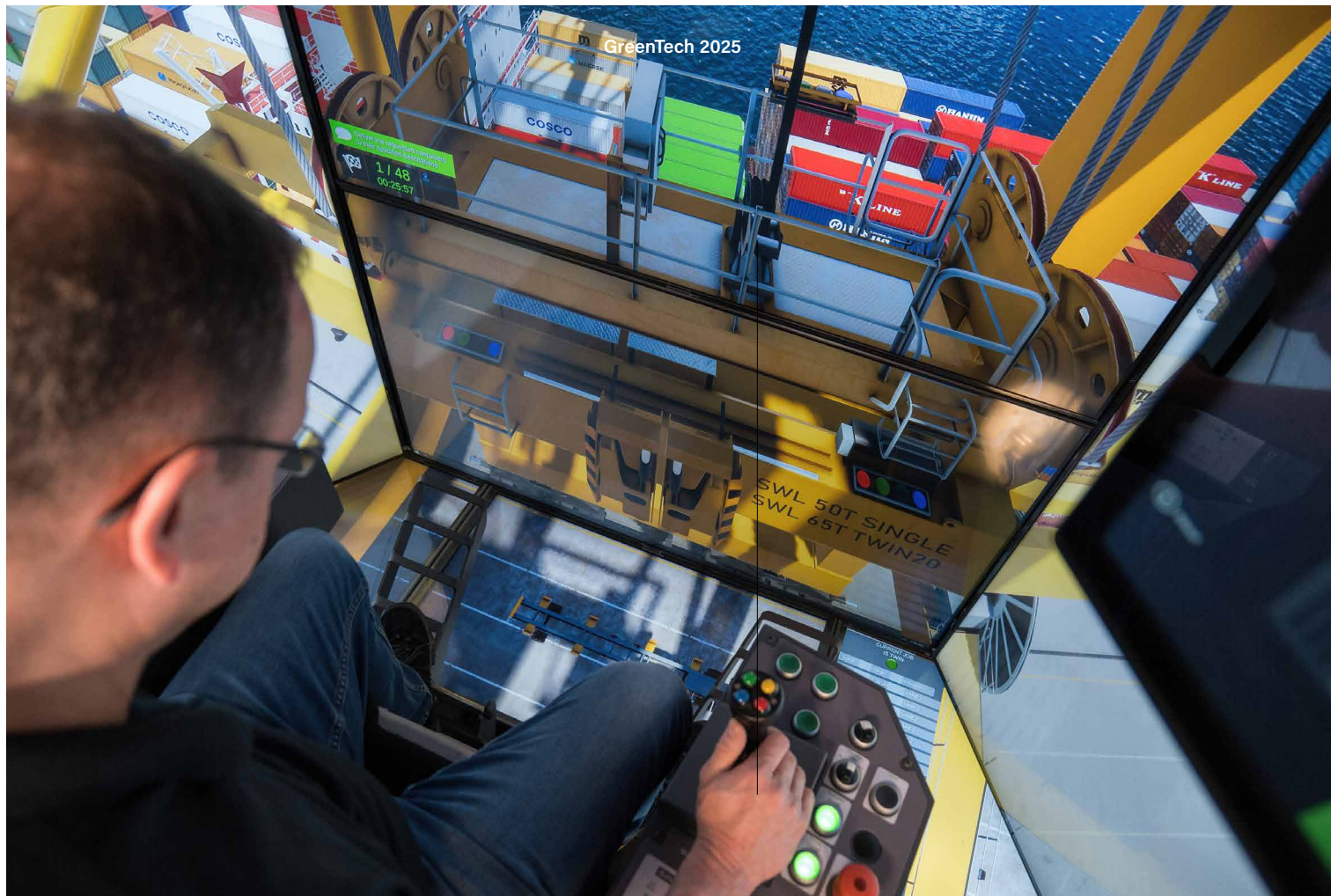
A GREENER WAY TO TRAIN OPERATORS

Whether a port uses diesel-powered equipment or is making the transition towards an all-electric fleet, simulation provides training that supports decarbonisation. That's because when an operator trains on a simulator, they're reducing emissions in several key ways. To start with, as they practice manoeuvres in a simulated yard

and complete different exercises, they're reducing the amount of time spent and fuel burned training on real equipment. For ports that cannot easily transition away from diesel-powered equipment, this allows them to cut emissions during training. In addition, simulators also help reduce drops in productivity caused by inexperienced personnel taking longer to unload and move cargo—drops that keep equipment running and ships idling, and burning fuel, for longer.

The Port of Corpus Christi Authority (PCCA)—one of the largest seaports in the United States—has been using simulation training for years. The initial push to make the change happened in preparation for the arrival of new equipment, as simulator-trained operators are faster and safer at transitioning to new machinery.

"Productivity is a big driver behind bulk operations," said



Eric Battersby, the Bulk Terminal Manager at PCCA. "When you put somebody unfamiliar with the machinery up there, it's not long before you start getting questions as to why productivity is falling or why it's taking longer than it had before." By training operators on simulators ahead of deploying new equipment, the port was able to minimise disruptions and keep operations productive.

For ports making the transition to electric, semi-automated, or automated equipment, using simulators for operator training ahead of new equipment deployment can be especially useful. In a report titled "The future of automated ports", McKinsey found that ports typically experience a 7 to 15 per cent dip in productivity when making the transition to automated and semi-automated equipment. But careful training and preparation can help reduce and even reverse the trend. That same report found that when carefully planned for, automation was able to boost productivity by 10 to 35 per cent.

Remote operating stations (ROS) and other equipment simulators can be a big part of that change. With their help, it becomes easier for ports to support automation and semi-automation in their operations, as well as transition their fleets to electric without disrupting operations too much.

REDUCING EMISSIONS BY INCREASING PRODUCTIVITY

While simulation technology reduces emissions during training, its effects extend much further. That's because simulation digitalises training, providing a concentrated and data-driven approach that can dramatically improve training outcomes and operator efficiency.

Simon Harper is the Group Learning & Development Manager and Director at Tilbury on Thames Trust, where simulators have been revolutionising operator training for the Port of Tilbury—the largest port on the River Thames and London's principal port. After

adding simulators to his training programme, Harper found that the objectivity and hard data they provided made it easier to identify and correct mistakes.

"With [a] simulator, you can generate a reporting graph that shows how many times a trainee pulled back and forth to try and get a box into the guides of the ship," Harper said. "A lot of people like to think, 'I was quite smooth on that.' But the graphical evidence is a powerful tool for disabusing them of that view! That's the benefit of the assessment capabilities of the simulator. It's objective, whereas clearly humans are subjective."

With a simulator, trainers can use data to identify and address weaknesses, and even track a trainee's progress as they improve over time. They can also customise training to give an operator concentrated practice on a particular skill. As a result, training is not only faster—it is more effective, which can in turn lead to dramatic improvements in operator efficiency.



ZHD Stevedores, an independent, family-run company operating port terminals in the Netherlands, has found that simulation training very rapidly improves operator productivity.

"I notice that people come in, and their increase in production on the simulator is quite rapid," said Alain Bornet, who heads ZHD's business development. "They come in at 40 minutes to an hour for 550 tonnes [of bulk material moved], and after a couple of sessions, they're already in the 20- to 30-minute range. I can see that the skills are improving."

When an operator can dramatically improve their productivity, the ripple effects on overall productivity—and berth times—can be substantial. For example, if a ship-to-shore crane operator completes 19 moves per hour instead of 15, they reduce the amount of machine time needed to move 184 containers by 2.5 hours while simultaneously saving approximately \$58,050 per operator in the first 15 shifts after training.

This type of productivity gain can reduce fuel use, lower costs, and bolster a port's reputation for efficiency.

REDUCING TRAINING TIMES

Productivity can suffer with staff shortages, which translates to longer berth times and higher overall emissions.

At the Port of Halifax—one of Canada's largest container terminals—training times were often at the mercy of shipping schedules, which delayed training and affected productivity.

"A 14-day training course could sometimes take a month to complete just because we had to wait for a vessel to become available," said industry veteran Robert Bonnar, the former Training Advisor at Halifax Employers Association (HEA), the port's training partner. Given the current labour shortage many ports are grappling with, training more operators to proficiency faster is a top priority.

Simulation training bypasses these delays by removing the need for real equipment availability. A trainee learning how to operate a ship pedestal crane, for example, doesn't have to wait until one arrives at the port. As a result, training times can remain consistent. After adding simulation to its training programme, the Halifax Employers Association noticed a dramatic change in operator training times.

"Today, a 14-day training course actually takes closer to 14 consecutive days," observed Bonnar.

New operators can join worksites faster, keeping productivity high and simultaneously lowering emissions.

CONCLUSION

The IMO set the ambitious goal of achieving net-zero GHG emissions by or around 2050. For ports, reaching these goals means taking a look at every aspect of operations, including workforce development.

For ports replacing their fleets, simulation makes the transition smoother and helps improve productivity, which can in turn help reduce berth times and the amount of fuel burned by ships at port.

Even ports without the infrastructure to transition to greener fleets can still use simulation to reduce emissions. Ports can use simulators to increase operator productivity—and port productivity—to reduce fuel consumption.

ABOUT THE AUTHOR

Devon Van de Kletersteeg is a Product Growth Manager at CM Labs who leverages his engineering background to drive market expansion and product alignment. He focuses on addressing real-world training needs with simulation technology, ensuring CM Labs' solutions continue to evolve and drive measurable results across industries.

ABOUT THE COMPANY

CM Labs stands apart through its commitment to pioneering the most realistic simulation-based heavy equipment training solutions on the market, tailored to address and solve real-world challenges. With more than 25 years of experience, numerous awards, and 300+ academic papers to its name, CM Labs has achieved worldwide recognition for the quality of its solutions. CM Labs' simulations are the only ones in the industry capable of accurately replicating the true movement of cables, the realistic feel of the equipment, and other aspects of authentic machine behaviour.

HOW A DIGITAL TWIN HELPS EUROPE'S PORTS SAVE ENERGY





compacer
Member of rscg Group

Volker Hettich, Chief Strategy Officer,
compacer GmbH

Energy efficiency has become a significant focus for the German economy, particularly since the Greens entered the federal government. Many companies, including ports and terminal facilities, have been exploring ways to make their operations more energy-efficient and CO₂-neutral. The development of Digital Twins plays a crucial role in this endeavour, and this is just the beginning of a transformative journey.

To understand the importance of Digital Twins, we must first recognise the prerequisites for the success of ports and terminals. These include the safe, efficient, and intelligent maximisation of capacity and throughput. Logistical and digital hubs along critical transport flows—as well as the seamless transition between ship, road, and rail—should have minimal environmental impact. To remain competitive in the international arena, ports must prioritise innovative technologies and sustainable solutions. While sustainability projects are becoming more widespread, establishing a Digital Twin for energy optimisation is considered the gold standard.

FROM OLD TO NEW

One notable example comes from a northern German port, where two container cranes, whose capacities were no longer sufficient for use at this port, were dismantled and shipped across the Baltic Sea to Estonia. Upon commissioning at the new location, the opportunity was seized to create a Digital Twin of the energy management



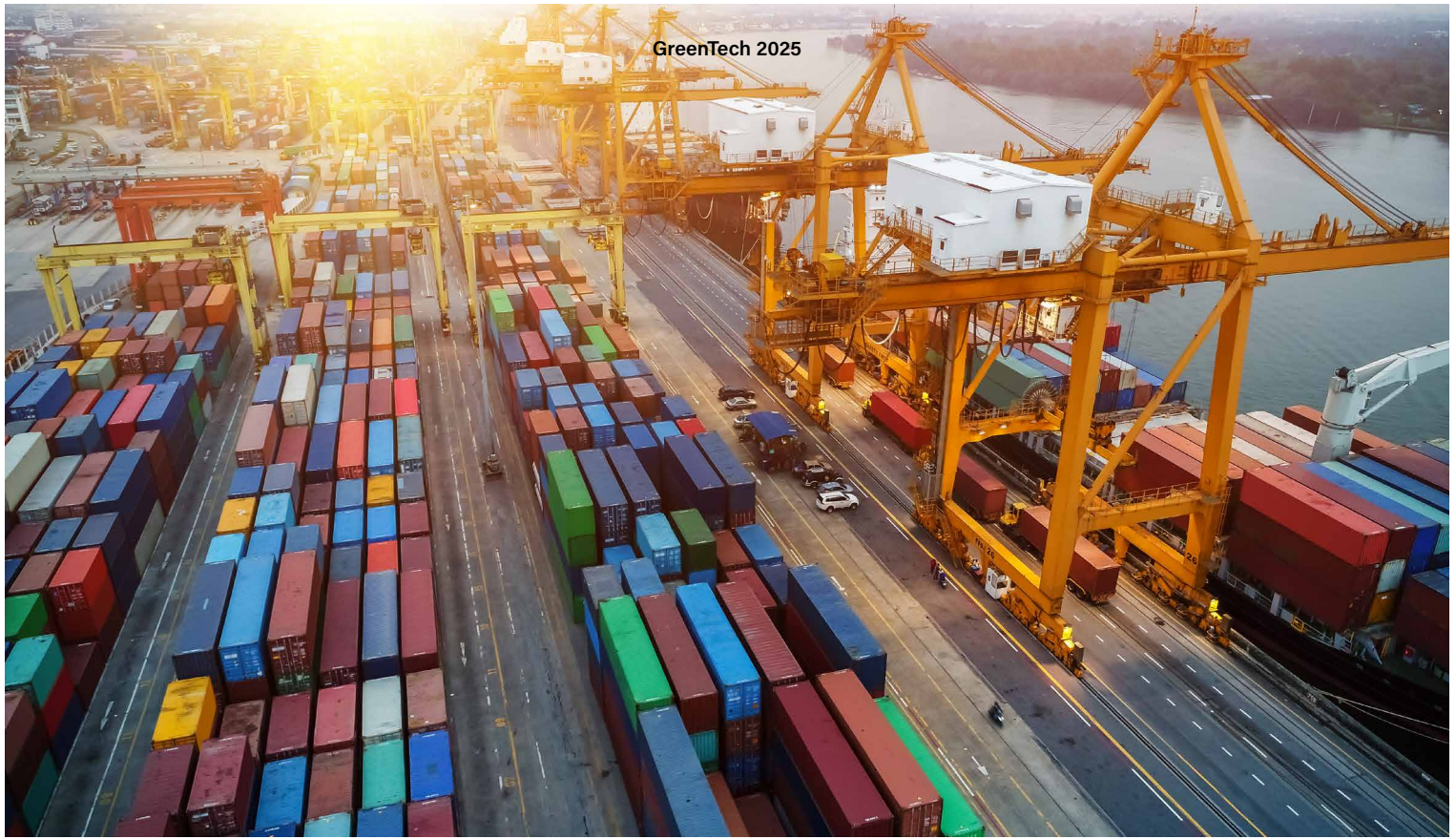
system for these cranes, aiming to enhance their energy efficiency in future operations.

These cranes had served their original port well for over 15 years, handling vessels carrying up to 14,000 containers. However, as the global shipping industry evolved, freighter giants with capacities of up to 23,000 containers became the norm in major ports. Consequently, the use of these cranes in their old home became less lucrative. Their reach and arm length could no longer match the demands of the larger container ships.

To accommodate new container terminals with greater processing volumes, the decision was made to relocate the two existing ones. Since the cranes were still in good condition, they found a new home at a smaller Estonian partner port. Transporting the 1,400-tonne cranes resulted in a logistically challenging endeavour that required careful planning, including consideration of tidal schedules.

But this project exemplified a masterful achievement in sustainability.

From the idea of repurposing the container cranes, further projects emerged to optimise processes, costs, and energy consumption. It quickly became clear that digitisation and automation of the various hardware and software components required for crane operation would play a central role. These cranes, composed of countless components from a multitude of manufacturers, had been in operation for over a decade and a half—meaning their original design was nearly 20 years old. As a result, it is understandable that the level of digitisation of these complex crane structures was outdated. Therefore, it was crucial not only to reassemble the cranes after their transfer but also to find a way to equip the hardware components with modern sensor technology, enabling reliable and future-oriented control by the port operator.



MORE TRANSPARENCY: YOU CAN ONLY CONTROL WHAT YOU KNOW

Recognising that retrofitting could not be uniformly applied across all areas of the crane, the port operator prioritised the digitisation of energy management due to its importance for environmental protection. During the loading and unloading process, energy is both consumed and generated. For instance, lifting a container requires significant energy, while the horizontal movement from the ship to the shore consumes less energy, and during the unloading process, energy is even generated. The goal was to integrate electricity demand and generation into port operations.

One idea was to supply the energy generated during unloading to power the automated guided vehicles (AGVs) used for landside transport. The advantage of this approach lies in the fact that the operational loading management of these vehicles already corresponds to a high level of digitisation, making it easy to track where electricity is needed.

The biggest challenge was the visibility of the data. To overcome this, additional power measurement sensors—or power metres—were

installed on the cranes that were re-commissioned in Estonia to obtain data on electricity demand and energy production. To effectively evaluate and utilise the generated data, the port turned to Digital Twin technology.

But what exactly is a Digital Twin? While there are various interpretations, Wikipedia describes it as the digital representation of a material or immaterial object from the real world in the digital world. Digital Twins are well-known in the production environment—especially in the automotive industry—where they are typically used to develop new products, improve manufacturing processes, or simulate specific situations. They primarily operate in testing environments.

In the context of the mentioned port project, 'Digital Twin' refers to the digital representation of the crane's sensor data.

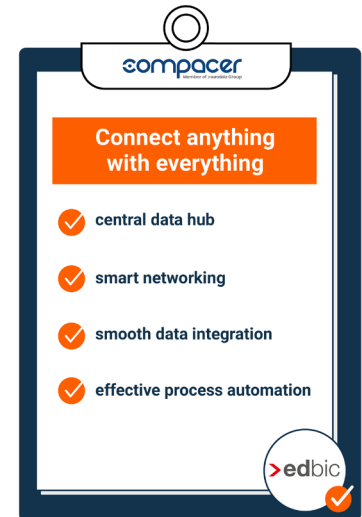
DIGITAL TWIN

The next question is how to collect and visualise the sensor data. Can information be structured and evaluated? Can the data be integrated into existing port management and be connected

to other partner systems, such as SAP or the terminal operating systems (TOS) commonly used in ports? Can the Port Community System (PCS) and other order management systems be included? These questions were raised before searching for a digital data hub that would not only facilitate data exchange, but also provide a solution for condition monitoring through the data.

The hope was to generate a Digital Twin with broad evaluation and connection possibilities. And it worked. Using the edbic Business Integration Cluster from compacer as a data hub, the port was able to unlock and visualise previously hidden data. In addition, the data from the new sensors was also represented in a uniform structure—known as the meta format—which can be easily integrated into the existing software landscape.

The result is a comprehensive collection of 'old data' and new energy sensors that provides a concrete representation of the energy demand and the energy produced by the two container cranes. The data is detailed and meaningful, enabling the port operator to manage energy efficiently.



While in the past the energy generated during unloading was carelessly released as heat into the air, today it is possible to store it and use it for other purposes. A software supported by artificial intelligence methods provides a forecast of future consumption. In combination with data from other trades, applications, and cloud services, this forecasting software is capable of predicting the electricity flow up to a week in advance with an accuracy of between 96 per cent and 98 per cent.

In the long term, the aim is to establish an optimally designed energy cycle, which will proactively recognise the point of demand for electricity and software-supported reuse of the produced energy in a continuous process.

COPY AND PASTE: HOW SUCCESSFUL CONCEPTS CAN BE MULTIPLIED

The benefits don't stop here. Other European ports within the same group now want to scale and utilise this approach. Drawing on the experience in Estonia, they aim to improve energy management in other container terminals and save CO₂.

There are also plans to extend the principle of the Digital Twin to other areas—such as monitoring cable lengths. This would be a step into predictive maintenance activities, as monitoring cable lengths and the associated cable quality could help identify and thus avoid downtimes and failures of container cranes in advance.

Ultimately, on the way to energy-saving and resource-efficient port management, the connection of horizontal and vertical processes is the key to success. Only by extracting a maximum of data from the operational port components and making it visible for further processing can modern ports operate in an energy-saving manner and become 'greener'.

CONCLUSION

In conclusion, the integration of Digital Twins in port operations represents a significant advancement in energy management and sustainability. By leveraging modern technology, ports can optimise their processes, reduce energy consumption, and contribute to a greener future.

The journey towards energy-efficient port management is just beginning, and the potential for innovation and improvement is vast. As more ports adopt these practices, the collective impact on the environment and the economy will be profound, paving the way for a more sustainable maritime industry.

ABOUT THE AUTHOR

As Chief Strategy Officer of compacer GmbH, Volker Hettich makes digital processes tangible and visible. With three decades of expertise, he advises renowned companies in data integration and process automation. His innovative strategies and business models help firms grow and flourish in today's dynamic digital landscape.

ABOUT THE COMPANY

For over 25 years, compacer has stood for expertise in data integration and process automation. With over 200 employees worldwide and renowned clients such as DHL, Deutsche Telekom, and Europcar, compacer develops software products "Made in Germany" and supports companies on their journey to digital transformation.

TACKLING THE SCOPE 3 EMISSIONS CHALLENGE HEAD-ON



Piotr Konopka, Group Vice President –
Decarbonisation & Energy Programmes, DP World

Businesses today operate in an increasingly complex sustainability landscape, shaped by tighter regulations and expectations from partners and consumers, often wanting to make more informed purchasing decisions.

In this context, it is essential that businesses draw on their full suite of assets to cut not only their Scope 1 and 2 emissions, but emissions in their supply chain too. While Scope 3 emissions are difficult to reduce, they hold significant potential for meaningful progress and automatically entail the support of suppliers who are often equally committed to improving their own sustainability profile, as well as those of their partners.

DP World has gladly recognised that responsibility. We have set some of the most ambitious emissions

targets in the supply chain industry. We are working to reduce Scope 1 and 2 emissions by 42 per cent by 2030 from a 2022 base year, fully aligned with the 1.5-degree trajectory set out by the Paris Agreement. We've also committed to cutting absolute Scope 3 emissions by 28 per cent in the same timeframe. These targets have been validated by the Science Based Targets initiative (SBTi), placing DP World among a select group of operators aligning with the most rigorous global climate standards and making us the first logistics company in the Middle East to have our 2030 target validated by the SBTi.

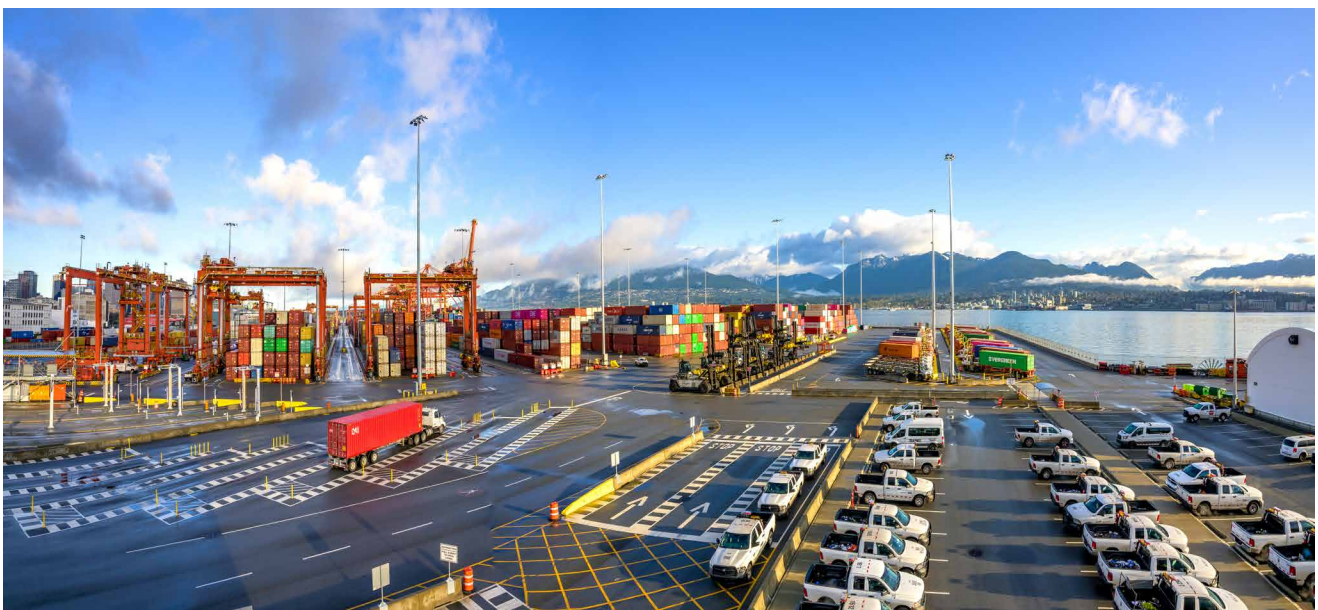
Our Ports & Terminals business plays a central role in delivering against our ambitions and is working to decarbonise our operations so our customers can do the same.

We're making practical investments in five key focus areas across our global Ports & Terminals network to reduce emissions across the entire cargo journey.

1. ELECTRIFICATION AND CLEAN PORT POWER

Our work with the [Zero Emissions Port Alliance](#) (ZEPA) is driving the transition to electric port-side equipment. This is a long-term shift, but one that addresses 50-60 per cent of our sector's Scope 1 and 2 emissions. Meanwhile, in Callao, Peru, we are integrating shore power into our newly expanded quay, which will offer vessels a supply of 100 per cent renewable energy and mean a significant reduction in our CO2 emissions from this year onwards.

BELOW
Port of Vancouver





LEFT
Port of Callao

2. EQUIPMENT UPGRADES AND RETROFITS

We use our reporting and data collection to identify the places in our supply chain, particularly those that contribute most to our Scope 3 emissions and where we can make the most impact. Our well-to-tank emissions of fuel and energy is one example, making our transition away from fossil fuels to electric equipment powered by renewable electricity a key focus.

Rather than wait for total infrastructure overhauls, we're using new technologies to transform existing infrastructure. In Callao and Vancouver, we've retrofitted Rubber-Tyred Gantry (RTG) cranes with cleaner fuel systems. In Peru alone, this has saved 1,860 tonnes of CO₂e since 2020. In Southampton, we've installed more than 40 hybrid

straddle carriers, eliminating fossil fuel use across terminal operations since 2023.

3. ALTERNATIVE FUELS

Alongside electrification, we're also integrating lower-carbon fuels across our fleet. Biofuel—in the form of Hydrogenated Vegetable Oil (HVO)—now powers all terminal equipment in Southampton that isn't electrified, delivering immediate reductions without waiting for asset replacement.

In keeping with our ambition to encourage greater use of these fuels, we have launched 'GreenBox,' a trial carbon insetting solution to help our customers decarbonise the seaborne sections of their supply chains.

GreenBox tracks our shipments that already rely on lower-carbon fuel and allows our customers

using these services to access tokens for the carbon saved. Customers can purchase the tokens, or 'insets,' for use in their sustainability reporting, while DP World uses the proceeds to buy more alternative fuels.

GreenBox is currently in operation on the Northern European network of Unifeeder, a subsidiary of DP World. If 50 per cent of import volume participates in the trial at DP World's UK ports, we estimate that it will replace over 11,000 tonnes of traditional fossil fuel with lower-carbon marine fuels within the global shipping industry, equivalent to the reduction of 10,000 tonnes of carbon dioxide.

4. SMART TOOLS AND EMISSIONS TRANSPARENCY

We're equipping our customers with tools to track and report their emissions reductions. In Southampton, real-time CO₂ calculators give cargo owners visibility into the carbon impact of their modal choices, therefore offering them greater control of their total emissions. In Callao, our supplier tendering process now demands decarbonisation plans as a compulsory requirement, too, helping positive change extend further into the world's value chains.

At the same time, we are also focusing on our own supply chain. We are working on enhancing our data capture capabilities from all our suppliers, as well as planning an extensive supplier engagement programme, which has been in testing with selected suppliers since 2023.

5. REPOSITIONING INTERMODALITY

Intermodality has long been a logistics staple. But as decarbonisation pressures rise, DP World is exploring the overlooked value that this service can offer. In practice, intermodal networks can do so much more than reduce friction in cargo handovers, increase flexibility, or reduce



LEFT
Port of Southampton

congestion—they also provide ease of access to lower-emission transport modes like rail or barge.

In Southampton, our Modal Shift Programme incentivises customers to move cargo from road to rail, saving both carbon and cost. In the year since the scheme launched, it has already saved over 25,000 tonnes of CO₂e. Meanwhile, in Canada, we're building on that success by collaborating with CN Rail and short-sea shipping partners to reduce long-haul road freight. Our goal: to cut emissions by up to 75 per cent through smarter modal integration.

PARTNERING FOR SUPPLY CHAIN AND SCOPE 3 PROGRESS

Today's businesses need more than just capacity in their supply chain partners. They need allies who understand their sustainability

pressures and who are actively working to reduce emissions across the board. From next-gen yard equipment and fuels to smarter modality use, DP World's Ports & Terminals business is investing in the solutions our customers need to be accountable and compliant in the path to decarbonisation.

We know this is ambitious. But going public with such bold targets makes us accountable—and accountability is key to driving measurable progress.

At DP World, we're focused on practical steps that can support our customers and partners in making meaningful progress. The road ahead is long, but by aligning our efforts and investing in scalable solutions, we can work together to accelerate the transition to more sustainable supply chains.

BELOW

Antwerp Gateway
Terminal

ABOUT THE AUTHOR

Piotr Konopka is Group Vice President – Decarbonisation & Energy Programmes at DP World, leading its drive toward net-zero carbon operations by 2050. An expert in energy, sustainability, and engineering, he oversees decarbonisation strategy, sustainable fuels, and climate resilience. Piotr also serves as Lead Coordinator at the Mærsk McKinney Møller Centre.

ABOUT THE COMPANY

Trade powers the global economy, creating opportunities and improving lives. DP World exists to make trade flow better, transforming possibilities for customers and communities. With over 114,000 employees across 78 countries, we're building a smarter, more efficient global supply chain that's ready for the future.



IN CONVERSATION WITH: NOKIA - BRINGING PORTS INTO THE FUTURE

Dom Magli, Reporter, Port Technology International, interviewing **Willie Kopp**, Head of Private Networks–North America, Nokia



As global trade grows and ports face increasing pressure to boost efficiency, safety, and sustainability, digital transformation has become a vital part of modern port operations. In this conversation, Dom Magli from Port Technology International chats with Willie Kopp, Head of Private Networks–North America at Nokia, about how the company is helping ports tackle these challenges. From private 5G networks and edge computing to drones and Digital Twins, Willie shares how Nokia's tech is enabling smarter, more connected port operations and shaping the future of maritime logistics.

What role does Nokia's technology play in enabling digitalisation in the maritime industry?

Port operators today are under growing pressure from the increasing volume of global shipping trade, demands for improved productivity and efficiency, ensuring worker safety in highly congested yards, and meeting stringent sustainability targets. Digitalisation emerges as a critical enabler in this context, offering the tools and technologies needed to address these multifaceted challenges effectively.

Our technology plays a transformative role in the digitalisation of the maritime industry by providing robust and reliable connectivity, industrial edge and AI

solutions that are essential for modern port operations. Through the deployment of high-performance 4.9G and 5G private wireless networks, port operators can ensure seamless communication and data exchange across all their workers, machines, equipment and systems.

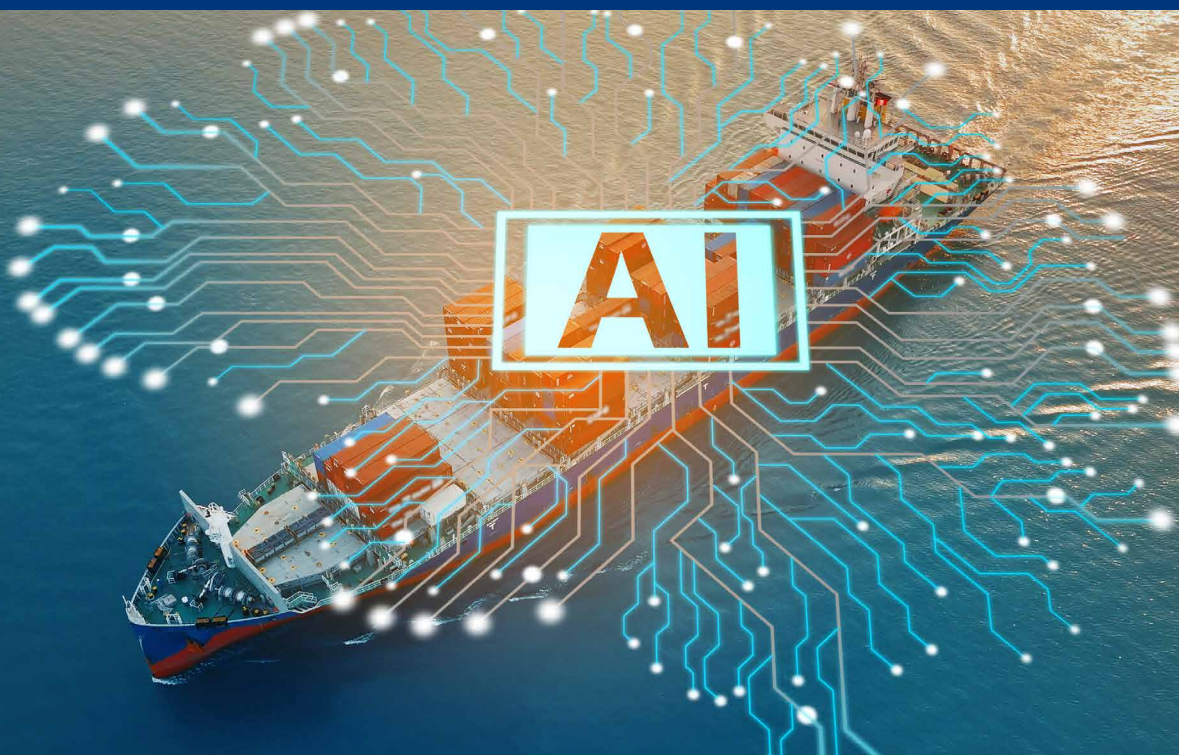
An on-premises edge compute platform enables real-time data processing and analytics. When combined with business-critical private wireless connectivity, this enables the deployment of innovative use cases to help operators achieve their business goals. For instance, connected worker solutions enhance communication and coordination among staff. Workers can access real-time data, receive instant updates, and use push-to-talk and push-to-video services to communicate effectively, even in challenging environments. This not only improves collaboration and efficiency but also enhances safety and sustainability by reducing the need for on-site travel, truck rolls, fuel consumption, and unnecessary worker movement in busy yards.

A port customer in Finland implemented real-time Digital Twin technology and video-based situational awareness, resulting in fuel savings per vessel and per port call, as well as safer working conditions due to reduced manual intervention. Vessels can now adjust their speed, minimising offshore waiting times and associated fuel

consumption. Additionally, sensors within the same port facilitate remote asset monitoring, reducing costs and the risk of injuries by limiting the need for manual intervention.

Another benefit of an on-premises industrial edge is that it functions as a launch pad for real-world AI applications. For example, autonomous straddle carriers rely on AI to analyse their environment, navigate, and make decisions in real-time. Business-critical operations such as these require high bandwidth and low latency, which are delivered through real-time data processing and analytics on an on-premises industrial edge. Port operators also often struggle with data being siloed across diverse systems, complicating the usage of that data. These data silos are a significant stumbling block on the way to AI-driven operations. However, with an industrial edge, all operational data, including data from legacy systems, is collected and integrated in a single location. This allows new AI applications to access large, precise, and real-time data sets needed to perform at expected thresholds, facilitating advanced analytics and automation.

Overall, our technology not only drives operational efficiency and productivity in port terminals but also enhances safety and sustainability, paving the way for a more connected and automated maritime industry.



How does Nokia see the role of private 5G networks in maritime operations, especially with respect to automation and safety?

Ports are complex environments, highly dynamic with thousands of moving containers, vehicles, and workers. In such dynamic settings, the underlying network infrastructure needs to be both flexible and extremely reliable to ensure that worker safety applications and automated processes run uninterrupted and at their expected thresholds, 24/7.

Traditional Wi-Fi struggles in these agile environments and is also highly susceptible to interference from walls of steel containers, making downtime and disruption a common challenge. Port operators can add a private 5G network as an additional connectivity layer to work in unison with Wi-Fi and to overcome this challenge. Private 5G networks provide the high bandwidth, low latency, and reliable connectivity required for advanced applications in complex environments. We see first-hand with our customers how this added connectivity stability eliminates downtime, reduces truck queues and wait times, and boosts overall productivity and efficiency of the port.

Robust connectivity is critical for reliable worker communication and to ensure safety in a busy port terminal. Wearable sensors and smart personal protective equipment (PPE) can monitor

environmental conditions and alert supervisors to potential hazards, ensuring timely interventions. Similarly, AI-powered video cameras can analyse hazardous areas, detect potential worker safety incidents—such as man-down situations or near-collisions with vehicles—and send instant alerts for timely emergency responses. This proactive approach to safety helps prevent accidents and injuries, creating a safer working environment for port staff, contractors, and visitors.

Advanced automation is key for port operators to handle increasing container volumes. Automated systems can operate with high precision and efficiency, reducing the need for manual intervention and minimising the risk of human error. For example, autonomous straddle carriers can navigate and perform tasks independently, optimising the flow of goods and reducing operational delays. However, this requires high bandwidth, low latency, and high reliability as well as pervasive coverage in highly dynamic and harsh environments. Port operators need assurance that their autonomous vehicles won't lose connectivity—as is often the case with legacy technologies—which would inadvertently impact productivity and cause potential knock-on effects.

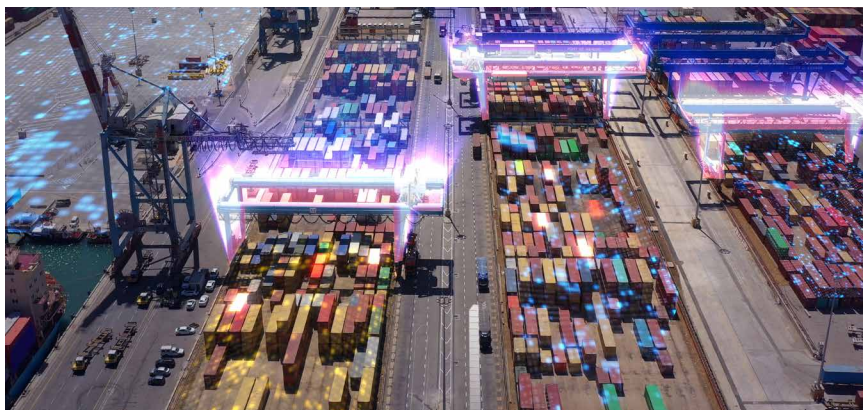
By leveraging private 5G networks and industrial edge, the maritime industry can achieve a more connected and automated

future, paving the way for smarter, safer, and more efficient port operations.

In terms of maritime, what innovations is Nokia exploring to support smart ports?

The next wave of digital transformation will come from a combination of edge computing, business-critical connectivity, and real-world AI use cases. Our flexible edge compute and AI platform enhances connectivity, automation, and operational efficiency, empowering ports to implement innovative use cases like drone inspections and laying the foundation for AI-driven port operations.

Remote crane control is a key solution for improving operational efficiency and worker safety in a Port 4.0 environment. Cranes equipped with 360° view cameras and 3D spatial audio capabilities provide operators with reliable real-time situational awareness, enabling precise and efficient control from a safe distance. This significantly improves container handling efficiency while keeping workers away from dangerous and congested areas. However, operating efficiently and safely requires multiple cameras on remote-controlled cranes, often 4K for maximum quality, which can put a lot of pressure on the network in terms of data throughput. In such cases, combining the 5G private wireless network with Wi-Fi in



certain areas of the yard adds significant network capacity while retaining the reliability and business-criticality of 5G. This innovative multi-layer connectivity approach allows operators to choose how connectivity is delivered, leveraging the best attributes of both technologies and optimising network performance for different use cases.

MX Workmate enables natural language interactions between workers and connected assets by leveraging Generative AI (GenAI) and large language models (LLM) technologies. This provides port workers with instant access to contextually relevant information, such as real-time machine status, maintenance schedules, and safety protocols. Workers can automatically receive relevant electronic documentation without the need for a manual search. In case of emergencies, instant alerts and messages are sent to the workforce to ensure a rapid and coordinated response.

4G/5G-connected drones are another excellent example of how innovation can drive port efficiency, safety, and sustainability. Equipped with sensors, these drones can monitor greenhouse gases or toxic pollutants. With HD cameras, thermal cameras, and LiDAR sensors, they can perform security surveillance or remote inspections of dangerous and hard-to-reach locations. This significantly reduces the need for vehicle-based inspections, cutting down on fuel consumption and emissions, while keeping personnel away from dangerous heights. Drones can also be used for remote vessel navigation, reducing the amount of waiting times and efficiently directing vessels to an available berth.

How does Nokia's involvement in Industry 4.0 contribute to the optimisation of maritime logistics and supply chains?

Any disruption to port operations can quickly lead to significant breakdowns in the supply chain. Enhancing container handling times, increasing throughput, reducing port congestion, and decreasing vessel waiting times offshore are critical optimisations that contribute to a more efficient port operation. These improvements lower the risk of unexpected bottlenecks or delays, thereby ensuring a more seamless overall supply chain. Such advancements are made possible through digital innovations like automated container handling, remote reefer monitoring, real-time asset tracking, Digital Twins, and predictive maintenance. These are tremendous benefits for ports, not just in terms of optimising the broader supply chain, but also improving their on-site efficiency and productivity.

Nokia real-time asset tracking solutions, for instance, provide port operators with significantly improved visibility of physical assets such as containers, goods, machines, and workers, both indoors and outdoors. This enhanced visibility allows port operators to monitor the movement of goods in real-time, optimise logistics, and reduce operational delays. By tracking containers and handling equipment, port operators can quickly locate containers, thereby reducing unnecessary delays and dwell time. Additionally, they can gain insights into storage times, optimise container movements across the port, and facilitate fast retrieval for loading or inland distribution, maintaining tight timelines across the logistics supply chain.

ABOUT THE AUTHOR:

Willie Kopp is the Head of NAM Enterprise Campus Edge Business for CNS Cloud and Network Services at Nokia. With over 15 years of experience in sales leadership, Willie has made significant contributions to the networking and wireless sectors. His career began at Cisco Systems, where he developed cutting-edge sports and entertainment solutions and most recently led the Americas Industrial IoT Sales. As a visionary leader, Willie has held key roles, including Director of Sales, IoT Americas, and CTO of Cisco Sports and Entertainment Solutions. He holds a Bachelor of Arts in Electrical Engineering from Cal Poly, San Luis Obispo.

ABOUT THE COMPANY:

Nokia creates technology that helps the world act together. As a B2B technology innovation leader, the company are pioneering networks that sense, think and act by leveraging their work across mobile, fixed and cloud networks.

Nokia creates value with intellectual property and long-term research, led by the award-winning Nokia Bell Labs, which is celebrating 100 years of innovation. With truly open architectures that seamlessly integrate into any ecosystem, the company's high-performance networks create new opportunities for monetisation and scale. Service providers, enterprises, and partners worldwide trust Nokia to deliver secure, reliable, and sustainable networks today—and work together to create the digital services and applications of the future.

IN CONVERSATION WITH: PASSIFY - RETHINKING TRUCK ACCESS

Margherita Bruno, Editor, Port Technology International, interviewing **Marcel Lindemann**, Co-Founder and Managing Director, passify



*At PTI's sold-out CTAC Europe 2025, I had the pleasure to catch up with **Marcel Lindemann**, Co-Founder and Managing Director of passify, to talk about how his team is streamlining truck handling at terminals. From ditching physical ID cards to enabling secure, app-based access, passify is helping terminals and drivers work smarter. Marcel shared the thinking behind the platform, how it's rolling out across Europe, and why it could become the digital backbone for intermodal logistics.*

Let's start with the origins of passify. What gap in the market did you and your Co-Founder identify, and what motivated you to take action?

When we started passify, we quickly realised that security for terminals was not being solved in a manner suitable for the state-of-the-art technology we have today. In many terminals around the world, there are still physical cards or manual identity checks. When we realised this, we started exploring a more digital approach. We also wanted a solution that would offer greater benefits to both the terminals and the drivers. That's where we started. Soon after, we realised that, in order to make it feasible to implement across terminals worldwide, we needed to leverage mobile applications for drivers and deep integrations into terminal systems to

enable more automation throughout the entire truck handling process.

In your previous contribution to our e-journal in December 2024, you described passify as a "bridge-builder" connecting drivers and terminals. Do you see it evolving into the standard digital access layer for intermodal hubs, supporting terminal operators and port authorities?

Yes, I do. If we look at it logically, every driver has their smartphone with them at all times. The smartphone is all they need to check in, validate their order, and make sure they are guided through the process. This removes any language barriers, among other benefits. From a driver's perspective, this makes perfect sense.

From the terminal operator's side, the benefits are clear too. There's no need for additional hardware, yet you gain an upgraded level of security, digitalisation, and automation throughout the entire truck handling process. So, it's a match: it benefits both the driver and the terminal, and it's the logical next step in our evolution.

A key strength of passify is its ability to quickly deliver value, as you highlighted in the same journal. What factors have contributed to its successful implementation at HHLA—

is it the tech itself, the team, or the alignment of stakeholders?

When looking at that question, I'd say yes, all of the above played a significant role. To make it clearer: part of it is our team, who are very empathetic towards the drivers. This helps a lot, especially in understanding their challenges and ensuring a smooth onboarding. Beyond our empathy for the end users, our team has a lot of experience within the terminal industry. My Co-Founder and I have worked with terminal systems for quite some time, so we understand the challenges terminal operators face and how to drive change.

Additionally, our software has been designed to integrate well with terminal operating systems, thanks to our experience in this field. We've worked extensively with these systems, so we know the processes that run through terminals. This ensures the system can operate 24/7 without interruptions, which we're very proud of.

Driver experience is central to your platform, from native language support to reducing time spent outside the truck. What's been the most surprising piece of feedback from drivers during the rollout?

Driver experience is absolutely central to our platform. One of the obvious things we



knew we had to do was to provide great support, especially during the early stages of implementation. The hyper-care phase after going live was very important for us, and we received great feedback from the drivers and trucking companies. Many of them were not used to being valued and supported to this extent during a change, and they were quite appreciative. We were pleasantly surprised by this as it had always been our intention to provide this level of support from the very beginning.

What was even more surprising was how well the drivers and trucking companies guided us through additional steps to improve the processes within and beyond the terminals. Despite the usual frustrations with change, most drivers were constructive and supported the process, which was very encouraging.

With your expansion into Romania, how do you evaluate new markets or terminals to work with? What makes a location the right fit for passify?

One important factor is the volume of truck handling. Only when there's a certain volume does it make sense to automate and digitalise processes. Another factor is the decision-making speed of potential partners. We want to work with terminals that can act quickly, because we pride ourselves on delivering value quickly.

Lastly, it's crucial that our vision for truck handling aligns with that of the terminal. We don't want to convince terminals to change if they're not already interested in continuing their automation journey. For a partnership to work, we need to share a common vision of the future of digitalised truck handling.

Beyond Europe, where do you see the greatest potential for growth? Are there markets that could leapfrog ahead in digital transformation?

There are a couple of regions that are very interesting for passify. North and South America, for example, both have a high truck-to-terminal ratio, meaning there's a lot of truck handling taking place. These markets, especially North America, are ahead in some areas of digitalisation, but they still have significant potential to improve efficiency and terminal utilisation through digital truck handling.

Another market that stands out is India. The country has shown a strong ability to adapt to change quickly and is experiencing significant growth. It's a huge market with a lot of potential, and I believe India could be a very interesting market for passify.

Considering the recent developments on the West Coast of North America, do you foresee any challenges when

implementing your digital solutions in that market?

In North America, automation cannot be the primary driver for change, as labour unions are hesitant about this aspect. The challenge is to find the right benefits that resonate with North American terminals, beyond automation. Some of the points that passify addresses, such as improving safety and security, are more relevant to the North American market. Our solution can also make it easier to train truck drivers, which is another key benefit.

Looking ahead, you mentioned your interest in integrating sea and rail freight, as you detailed in PTI 148 in a paper discussing your collaboration with RailSynch. What's your vision for passify's role in enabling true synchromodality, and how do you see this collaboration shaping future intermodal operations?

Beyond digital truck handling, enabling the synchronisation of different modes of transport plays a huge role, especially for intermodal terminals. These terminals often don't have the large buffer zones that marine terminals have, so it's vital to keep operations fast and efficient. passify's role as the interface between trucking companies and terminals is crucial to enable synchronisation.



By connecting the truck-side information with rail-side operations, we ensure that all stakeholders, including rail operators, are informed about real-time cargo tracking and updates. This collaboration helps provide the best possible experience for all parties involved.

Security is critical, and passify has built in ISPS-compliant two-factor authentication. As digital platforms become more embedded in port operations, how do you balance robust security with the need for speed and ease of use?

Security is at the core of what we do. We ensure that the identity of the driver

is properly verified before allowing access, and we make sure that security is maintained throughout the process. While we focus on security, we also aim to deliver efficient truck handling, alignment between stakeholders, and real-time updates. As security is a core part of the product, there's no compromise on this. We ensure that drivers are authenticated properly and that they can access the system securely.

ABOUT THE AUTHOR

Marcel Lindemann, Co-Founder of passify, brings over 10 years of experience in transport and terminal logistics. Together with Nico Marks, he founded passify to tackle industry challenges like long wait times and manual processes by introducing innovative tech solutions.

He previously worked for container depot operator HCCR and Hamburger Hafen und Logistik AG (HHLA).

ABOUT THE COMPANY

Passify is a Hamburg-based logistics startup that digitalises and automates truck handling through a self-service app. This app enables drivers to book slots, check in digitally, and identify themselves securely via two-factor authentication. By streamlining these functions, passify makes truck handling more secure, simpler, and synchronised, contributing to more sustainable and cost-effective logistics processes without requiring additional hardware investment.

www.passifyapp.de

A PRACTICAL GUIDE TO SERVICE REQUIREMENTS FOR HIGH-VOLTAGE MATERIALS HANDLING EQUIPMENT





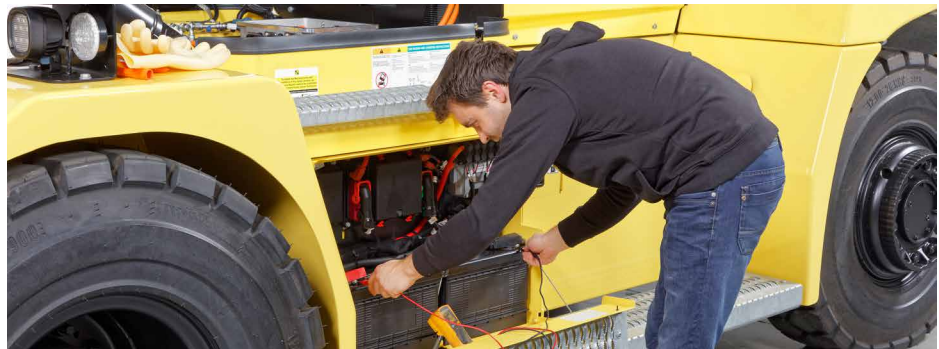
Herman Klaus, Director, Big Truck Application Solutions, Hyster Company

Heavy-duty forklifts and even bigger machines—including port equipment like empty or laden container handlers, ReachStackers, and terminal tractors—are increasingly powered by electric sources like batteries, rather than internal combustion engines (ICE). To meet the requirements of demanding duty cycles and heavy loads, this high-capacity electric material handling equipment relies on high-voltage¹ battery systems to achieve the necessary charging speed and power.

There are important safety considerations for maintaining and servicing high-voltage equipment that operations must understand and comply with to prevent electrical danger or injury.

ELECTRICAL SAFETY RESPONSIBILITIES

Different parts of the world have different governing bodies and regulations concerning electrical safety. In the United States, the Occupational Safety and Health Administration (OSHA) has requirements based on the National Fire Protection Association (NFPA) 70E, Standard for Electrical Safety in the Workplace. For member and affiliate countries in Europe, the Middle East and Africa (EMEA), the European Committee for Electrotechnical Standardization (CENELEC) defines the EN 50110, however, individual countries may also have their own legislation, so it is important to investigate the laws applicable in each operating location.



NFPA 70E

Owner of premises
(Host employer)

Equipment dealer
(Contract employee)

Equipment manufacturer

Site-specific or company policies must address:

- Electrically safe work condition policy
- Lockout/tagout policy
- Safe work practices
- Risk assessment
- Training
- Personal protective equipment (PPE) and tools
- Audit policies
- Investigation plans

- Provide product training and product certification for dealers

EN 50110

Owner of premises

Equipment dealer

Equipment manufacturer

- Provide a safe space for maintenance and service activities

- Properly train technicians and personnel in electrical safety

- Provide product training and product certification for dealers

- Minimise distractions and noise to support focus

- Have an assignment policy with appropriate practices in place

- Consider towing capabilities in case the truck must be removed quickly

- Provide a clear, written work order

- Equip employees with PPE



A common theme from both the NFPA 70E and EN 50110 is that there is a shared responsibility for electrical safety. The owner of the premises where equipment is being maintained or serviced, their equipment dealer, and the manufacturer must work together with a shared interest in the safety of work being performed.

TRAINING AND CERTIFICATION REQUIREMENTS

While many operations service their own handling equipment like forklifts and container handlers,

maintenance or repair work on high-voltage circuits—often identified by orange cables—requires individuals who are certified to work with these kinds of systems. While NFPA 70E only specifies one level of certification and EN 50110 identifies three, both regulations:

- identify the technical knowledge required by individuals in order to work with high-voltage equipment;
- require individuals to be recertified every three years. (*NFPA also requires annual field work audits.)

Product training

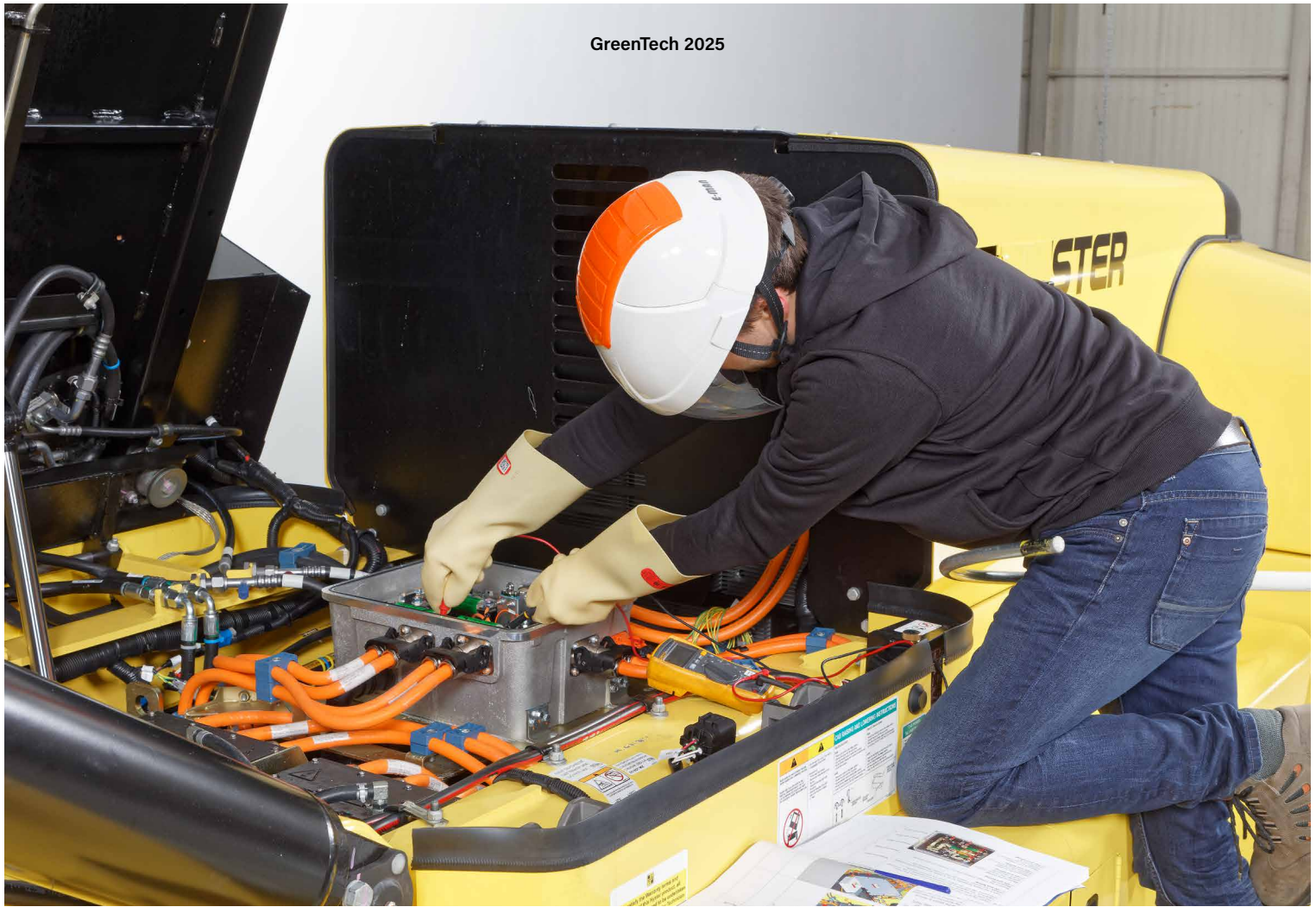
In addition to electrical certification, individuals must also have training and certification specific to the materials handling equipment they will be working directly with to familiarise themselves with systems specific to those models. The frequency with which individuals must be recertified in product-specific training may vary based on the equipment manufacturer and the frequency of equipment design updates.

What does this mean for operations?

Businesses must be aware of these requirements so that only individuals with proper certification participate in maintenance or repair work that requires specialised training. To that end, businesses should confirm that their authorised dealer's technicians are current on the certifications required in that location and for that equipment.

Businesses can also consider having their in-house technicians certified to reduce potential wait times for work on mission-critical equipment. Two technicians are

ELECTRICAL CERTIFICATION	
NFPA 70E (U.S.)	EN 50110 (EMEA)
Qualified person One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations, and has received safety training to identify the hazards and reduce the associated risk. A qualified person must be familiar with and demonstrate an ability to use the following: • Special precautionary techniques • Electrical policies and procedures • PPE • Insulation and shielding materials • Insulated tools and testing equipment Training must also cover: • Lockout/tagout procedure training • Emergency response training, including contact release, first aid and resuscitation	Electrical instructed person (EIP, also known as VOP/EUP) One who is allowed to pull the master service disconnect (MSD) but not to measure 0-volt in the system. They assist the high-voltage technician (HVT) in working on high-voltage components and are able to assess the risks of the task at hand and deny work if in doubt about the situation. High-voltage technician (HVT, also known as VP/EFK) One who is allowed to pull the MSD and allowed to measure 0-volt in the system. They are able to work on high-voltage equipment independently or with the help of an EIP. They must understand when procedures are not clear and are able to consult with the high-voltage work supervisor (HVWS). High-voltage work supervisor (HVWS, also known as WV/VEFK) One who is responsible for defining procedures and seeing to it that procedures are followed.



required when disconnecting and reconnecting high-voltage systems: one technician working on the truck and another in a support role to immediately intervene if necessary. For operations that are sensitive to equipment downtime, this certification may be particularly valuable.

Some facilities have industrial alternating current systems that are also subject to NFPA 70E requirements, and for which they have a facility electrical safety programme. Such an operation may be able to include truck technician certification in the facility's existing electrical safety programme. Dealers themselves are not qualified to certify candidates, but some may be able to help businesses with instructions on the certification process.

Maintenance or repairs on systems that are not powered by high-voltage circuits may not require technicians who are certified in electrical safety. This could include components such as:

- Mast
- Carriage
- Wheels and tires
- Parts of the cooling system
- Parts of the operator compartment
- Some hydraulic components
- Light bulbs
- Windshield wipers

Operations and their technicians should carefully review the service manual for the particular forklift or container handler they plan to conduct service or maintenance on to understand whether certified individuals are required for specific work.

In the US, for work that requires a qualified individual to deenergise the system, a different technician—including mechanics who are non-qualified individuals—can complete the service tasks after the qualified individual has measured 0-volts. Similarly, in EMEA, once a high-voltage technician (HVT) has measured 0-volts, a mechanic who is only an electrically instructed person

(EIP) could perform the service tasks. The HVT would then evaluate the work before reconnecting the high-voltage system.

SAFETY PRACTICES

In addition to using trained personnel or working with dealers who can provide trained technicians, there are other important steps and systems businesses with high-voltage equipment should understand:

1. **Establish your chain of command and procedures.** Under EN 50110, this is considered an assignment policy. Operations must communicate high-voltage safety requirements to everyone in the organisation, not just those doing the work.
2. **Designate and clearly mark an area for high-voltage work.** The space in which equipment is maintained must be clearly marked every time



high-voltage components could be exposed. The area should also have a short escape route to the outdoors in case of a thermal runaway event.

3. **Prepare a risk assessment form for the service mechanic.** Among other items, the form may include procedures and checkpoints concerning the support technician, the site and the truck. Businesses that are not performing the electrical work with their own certified individuals must inform any contract employees, such as dealer technicians, of any changes to the truck that could affect the electrical system. The business, also known as a host employer, should also report any violations of NFPA 70E or the relevant local electrical safety considerations to the contract employer.

GIVEN THE RISKS AND EXTRA CARE, WHY GO ELECTRIC?

There are a variety of benefits that can make electric-powered materials handling equipment an attractive solution for certain operations. For one, battery electric forklifts and container handling equipment produce zero

tailpipe emissions. Compared to ICE models, electric alternatives produce less noise and vibration, offering a more comfortable experience for the operator.

Electric equipment can also be less expensive to maintain. For example, diesel engines require regular oil changes, usually every 500 or 1,000 hours of use, with each typically requiring multiple gallons or litres of oil. Not only does electric equipment eliminate the need for oil changes, but it also reduces or eliminates many of the other service requirements associated with ICE equipment for the engine, fuel and air filters, transmission and brakes.

The draw of high voltage

High-voltage battery systems are used on heavy-duty equipment like high-capacity forklifts and container handlers because they offer productivity benefits that can be advantageous for some operations. Higher voltages allow for faster charging compared to lower voltage systems and provide very responsive performance.

When evaluating whether high-voltage electric equipment is right for your operation, working with experienced experts can help you make an informed decision, understand safety considerations, and access certified technicians for maintenance or repairs.

ABOUT THE AUTHOR

Herman Klaus is responsible for providing solutions that align the company's technology and big truck equipment with the needs of high-intensity operations, including electrification options for port terminals. He brings over 40 years of materials handling experience to his role.

ABOUT THE COMPANY

Hyster is a leading worldwide provider of forklift trucks and container handling solutions for the toughest, most intense industries on Earth. The company designs and manufactures a comprehensive range of material handling equipment for industries ranging from industrial warehouses and manufacturing facilities to ports and terminals.

FOOTNOTE

1. Distinctions between low voltage, higher voltage and high voltage vary across different parts of the world. The National Fire Protection Association (NFPA) 70E Standard for Electrical Safety in the Workplace regulates all voltages over 50 volts and designates high voltage as 1000 Volts Direct Current (VDC), but again, the classifications vary for different countries and regions.

HARBOURING CHANGE: THINKING FAST AND SLOW ABOUT PORT DECARBONISATION





Jacobs

Laurence Banyard, Global Principal for Maritime Energy, Jacobs

Ports are where global trade meets climate action. While they may not earn the attention of passenger-heavy modes like aviation or rail, their commercial footprint and supply chain connectivity are even more significant.

About 80 per cent of global merchandise trade is transported by sea, with shipping capacity steadily increasing. Efficient, resilient ports are therefore vital for economic growth and global trade. Their influence, however, extends far beyond commerce, and we are now seeing ports play a pivotal role in the energy transition.

But how to decarbonise them? Emissions reduction is a system-wide shift that impacts how ports operate, invest, and work with the broader supply chain.

It's complex, but not impossible. With the right questions, clear priorities, and a phased approach, progress is already happening.

START BY ASKING THE RIGHT QUESTIONS

The first question every port operator should ask isn't what to do, but where to start. That starting point depends on each port's footprint, ownership model, infrastructure, and market demands. There is no one-size-fits-all strategy. Few ports are owned or operated by a single entity. Instead, there's usually a mix of public and private stakeholders, third-party tenants, and infrastructure arrangements that span decades.

Before anything else, be clear on scope boundaries. That may sound simple, but it's often one of the most complex parts of the



process. We work with clients to set realistic boundaries. For some, this might mean focusing initially on assets under their direct control. For others, it requires building consensus across a regional or global terminal network.

Ports also need to build an emissions baseline, defining Scope 1 (direct emissions), Scope 2 (energy use), and Scope 3 (supply chain) emissions. For ports with complex ownership structures, this is no small feat, but it's the foundation for everything that follows.

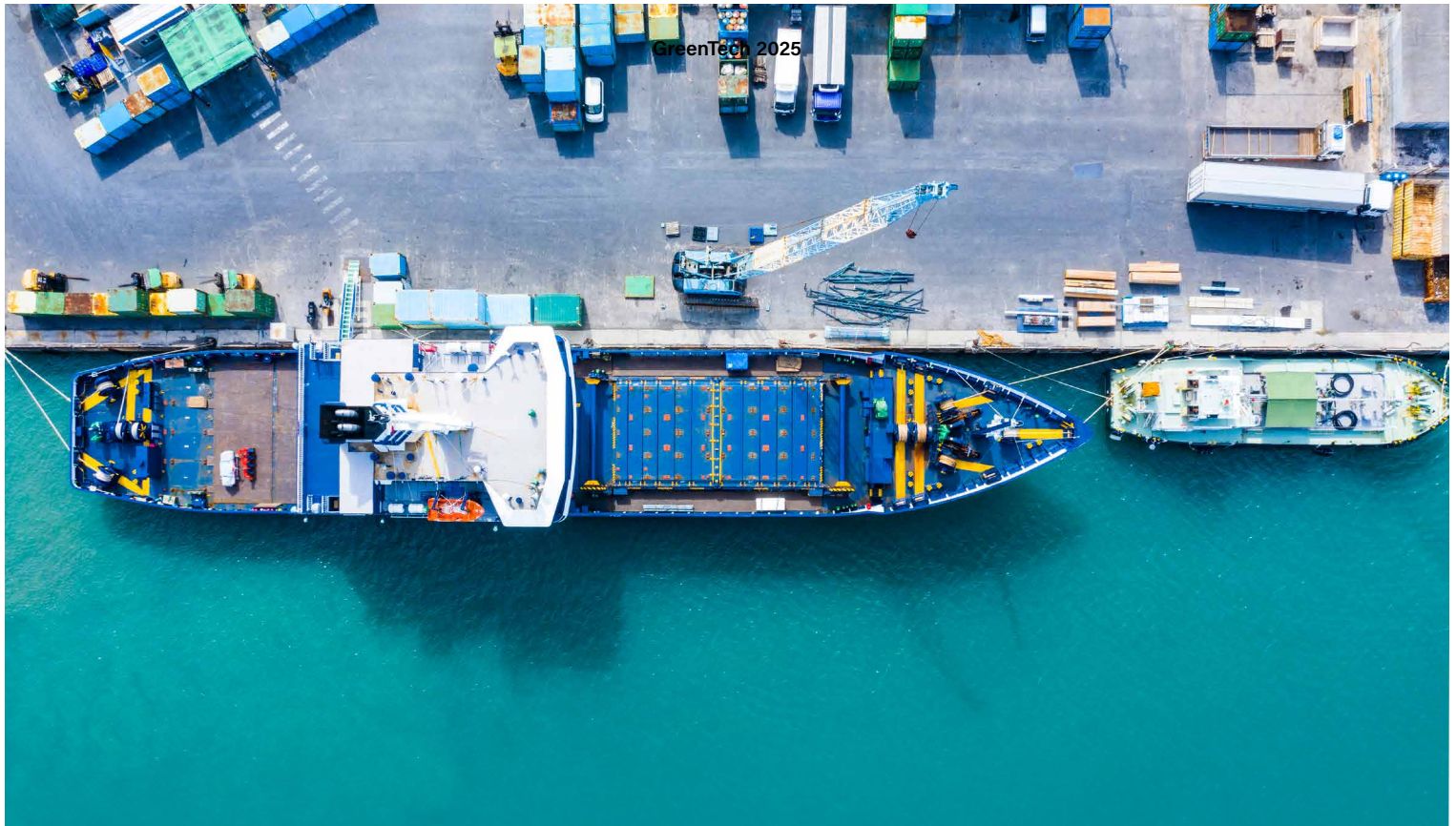
It also pays to cast the net wide early by exploring multiple options and stress-testing assumptions before narrowing in on a strategy. Step back and consider a wide range of inputs—regulatory requirements, energy mix, market positioning, and stakeholder priorities. And it's not just about engineering, it's also about governance, funding, and timing.

At the Port of Cleveland, we worked with the authority on infrastructure planning tied to emerging fuel technologies and regional energy strategies. This involved assessing what was technically feasible and working through regulatory and financial implications with broader stakeholders. It's a good example of how upstream decision-making—supported by both engineering and advisory input—can shape downstream investment with fewer surprises.

The next step is to consider your organisation's planning horizons: setting short-, medium-, and long-term goals. Decarbonisation is a timeline of fast wins and slower, structural shifts, not just a single milestone.

SHORT-TERM: FOCUS ON WHAT YOU CAN CONTROL TODAY

Targeted operational changes can improve efficiency and reduce



emissions without requiring major capital spending. For example, optimising the terminal operating system to reduce equipment moves can lower fuel consumption, which can add up to significant savings over a single year. Tackling it early is low-cost and high-return.

At the Port of Oakland, we helped deliver the Freight Intelligent Transportation System, which included smart traffic signals, dynamic message signs, and vehicle detection systems to optimise truck movements. These upgrades reduced congestion-related emissions and laid the groundwork for more predictive freight logistics, all of which helped connect operational improvements to emissions targets.

Decarbonisation is as behavioural as it is technical. At several ports, we've seen strong results when operational changes are paired with staff engagement, fresh KPIs, and performance-based incentives to help connect daily decisions to emissions outcomes.

MEDIUM-TERM: ALIGN INFRASTRUCTURE WITH EMISSIONS GOALS

This is where more capital-intensive measures start to take shape: retrofitting equipment,

electrifying fleets, upgrading lighting systems, and integrating solar or wind where viable.

In Australia, on the western Cape York Peninsula, we designed the Amrun Chith export facility, including a jetty and wharf system with energy-efficient design features. The project included early engagement with Indigenous stakeholders and environmental planners for sensitive coastal zones. Working on this project reinforced what we already knew: sustainability goals and low-carbon infrastructure can be embedded from the outset, even in heavy industrial and export-focused settings.

Within container ports, yard planning is also an important consideration. Reconfiguring stacking layouts to minimise horizontal container movement—especially for empty containers—can significantly cut equipment run times without a big capital spend.

In locations with limited grid capacity, we've also worked with clients to explore renewable energy procurement strategies, including long-term agreements and power purchase options. These types of decisions often sit at the intersection of commercial strategy and technical design, requiring early cross-disciplinary coordination.

Harnessing no-idling solutions offers significant savings.

Equipment idling can account for up to 20 per cent of a port's energy consumption. According to research by the U.S. Department of Energy, a heavy-duty truck consumes roughly 0.8 gallons (3 litres) of fuel per hour while idling. Idling wastes fuel, increases wear, and degrades air quality. Solutions include automatic engine turn-off software or incentivising operators to manually shut down engines. Auxiliary batteries supported by renewables—like flexible solar panels—provide air conditioning and heating without relying on the vehicle's main engine.

LONG-TERM: PREPARE FOR WHAT'S COMING NEXT

For long-term planning, focus switches to digital systems, shore power, fuel switching, and aligning business models with carbon goals. The most forward-looking ports are already investing in analytics and modelling to improve forecasting and track emissions in real time.

Some ports are also going further by creating Digital Twins to simulate real-world port operations. These models can test different equipment configurations, forecast



emissions impacts, and help prioritise infrastructure upgrades using real-time data.

As new fuels and technologies become more readily available, ports must evolve to better reflect the energy intensity and carbon cost of their services. At the Port of Alaska, Jacobs is modernising a critical energy and goods hub with full lifecycle services. This includes planning for the adoption of lower-carbon fuels like hydrogen and ammonia, and upgrading ageing infrastructure that supports military, energy, and logistics operations across the state. The work addresses both immediate structural needs and long-term decarbonisation pathways.

CONNECTING ACROSS SECTORS

Ports are not isolated assets. They are and always have been integral to broader energy and infrastructure systems. This is particularly evident in California, where we're working with port operators to manage climate-related risks alongside energy system constraints. Resilience strategies in these cases must consider water conveyance, storage, and energy reliability together—an area where our end-to-end capability in environmental

infrastructure has proved essential.

In San Francisco, for example, Jacobs is supporting the multi-phase Waterfront Resilience Program, focused on adapting 7.5 miles of shoreline infrastructure to seismic and sea-level rise risks. The programme's integrated approach considers transport, energy, climate adaptation, and public space—all crucial as ports plan long-term resilience. Decarbonisation, adaptation, and community infrastructure planning must be approached as a single challenge.

Ports are vital transport and storage hubs with the potential to provide green energy generation and transmission. However, this all comes with an asterisk. Success relies heavily on global collaboration, avoiding short-term thinking, and backing the right technologies. This involves early commercial insight—especially when defining emissions baselines or shaping capital plans. It also requires a portfolio-wide view, not just single terminals, and using data to tie short-term improvements to long-term gains.

There's no single template for port decarbonisation, but there is a formula that works: ask the right questions early, define emissions boundaries clearly, phase the work,

and link operational changes to bigger infrastructure and policy shifts.

Done right, decarbonisation makes ports greener, smarter, and more resilient. That work is already underway—terminal by terminal.

ABOUT THE AUTHOR

Laurence Banyard is a Chartered Civil Engineer and Jacobs' Global Principal for Maritime Energy. He leads the company's worldwide efforts to promote decarbonisation, resilience and new energy technologies. His expertise includes port facilities for shipping lower-carbon fuels, energy efficiency and resilience for ports, and designing maritime infrastructure for offshore renewable energy generation.

ABOUT THE COMPANY

With approximately \$12 billion in annual revenue and a team of almost 45,000, Jacobs provides end-to-end services in advanced manufacturing, cities and places, energy, environmental, life sciences, transportation and water. From advisory and consulting, feasibility, planning, design, programme and lifecycle management, the company is focused on creating a more connected and sustainable world.

GreenTech 2025

ROADMAP TOWARDS ZERO EMISSIONS NEEDS A HOLISTIC VIEW



Dr Zack Lu, Senior Project Manager, Portwise,
Dr Isabelle van Schilt, Project Manager, Portwise,
 and **Pim van Leeuwen**, Project Manager, Portwise

1.1 CHALLENGES FACED BY TERMINALS IN PREPARATION FOR ZERO EMISSIONS

The road towards zero emissions is fraught with a wide range of challenges and unanswered questions. In our daily conversations with terminals, there are so many unknowns, underestimations, and concerns—for example:

- What technologies and solutions to consider.
- What should be the roadmap and priorities.
- Transition risks to existing operations and terminal performances.
- Lack of economic viability due to more expensive equipment and additional infrastructural investments.
- Insufficient grid capacity for increasing power demand.

Equipment OEMs, solution providers, and other stakeholders are making efforts to address these challenges by offering their services and contributions. However, when all these come to the terminal's table for final decision-making, this

becomes a complex puzzle and a complicated task for terminals to plan their roadmap to achieve the zero-emission goals.

1.2 A HOLISTIC APPROACH TO ADDRESS CHALLENGES IN PREPARATION FOR ZERO-EMISSION OPERATIONS

To address these challenges effectively, a holistic approach is key to success. The first important step is setting the *right* starting points per case in objective and inputs (e.g., terminal's operational characteristics, local circumstances, layout footprint, demand patterns, etc). Once the right starting points are defined, the relevant and most suitable potential solutions—whether technology and hardware related or various optimisation measures—can be properly identified.

Comparing various possibilities involves difficult operational and design decisions across a broad range of aspects, including operations, layout, technology, equipment, performance, infrastructure, supply, financials, and more. Investigation on *all* these

variables as a whole is required to understand the dynamics and interrelation between these variables and their intertwined impacts. Therefore, a holistic approach becomes essential to ensure the *right* decision on the best solution. While no single solution can apply to every case, the holistic principle itself is universally applicable (Figure 1 shows this stepwise holistic approach and examples of decision variables).

In the remainder of this section, we will use selective case studies from our work to showcase why it is important to adopt such holistic views to determine the solutions that best meet terminals' operational needs, business viability, and zero-emission targets.

1.2.1 HOW TO DECIDE ON TERMINAL ELECTRIFICATION: TRADE-OFFS

The selection and prioritisation of key variables can significantly shape the decision-making process. A simplified case study where we analysed the requirements of fleet and charger numbers showcases the required trade-offs.

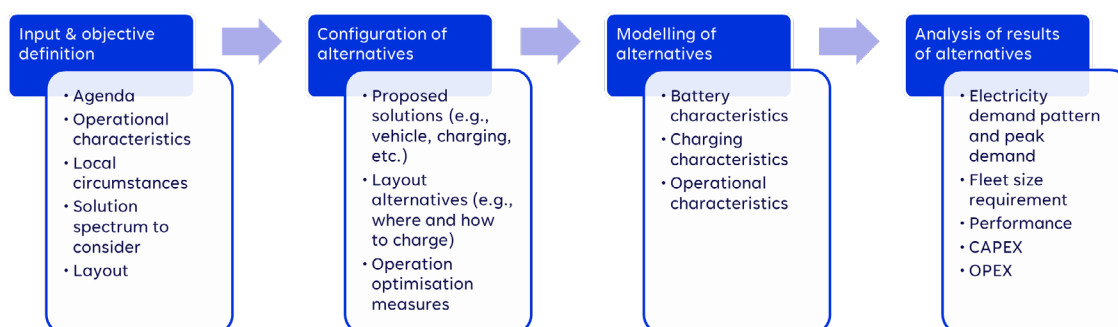
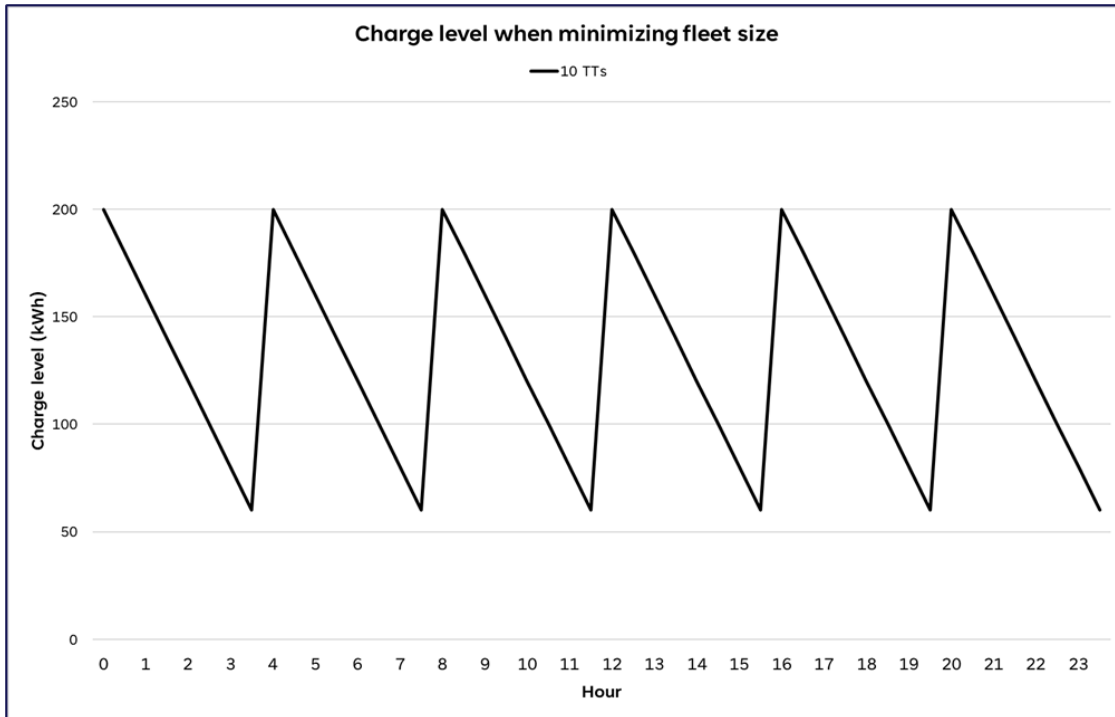


FIG 1.
 Stepwise approach to
 holistic design.

**FIG 2.**

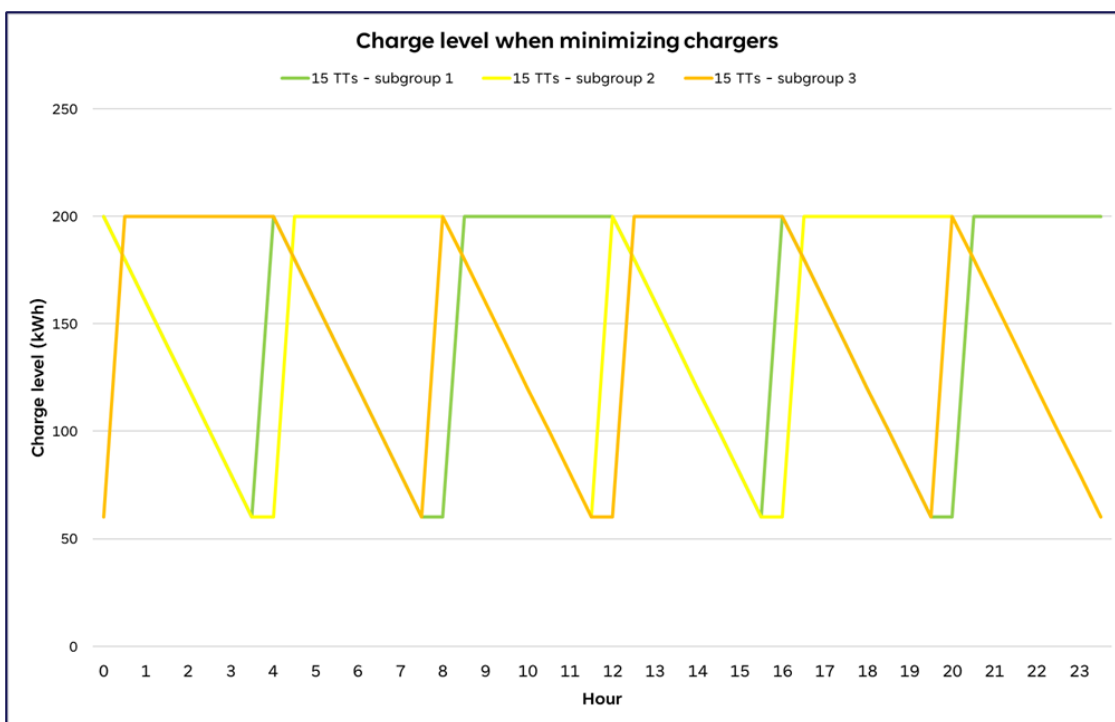
This figure shows the charge level of a single truck's battery in case trucks only charge during breaks (option 1).

In this example, a terminal requires 10 battery-electric terminal trucks (eTTs) for a continuous operation with a 4-hour working shift and 30-minute breaks per shift. The trucks for each shift should operate for 3.5 hours without charging, with no spares considered. The trucks have a

nominal battery capacity of 200 kWh and consume ~40 kWh per hour of operation. Charging happens at 300 kW/hour on average.

Different decisions can be made regarding the number of trucks versus chargers. **Option 1** involves purchasing 10 trucks and 10

chargers. Each truck could consume 140 kWh (3.5h*40kW) per shift and charge 150 kWh (0.5h*300kW) (Figure 2). This avoids the need for extra vehicles, as they are charged in each break, but charging all 10 trucks simultaneously results in a peak power demand of 3,000 kW.

**FIG 3.**

This figure shows the charge level of three trucks belonging to different subgroups in case the charging peak is reduced by purchasing additional trucks and fewer chargers (option 2).

FIG 4.

Figure 4: Factors to consider when designing a zero-emission solution.



Option 2 considers purchasing only five chargers but 15 trucks. Each truck will have one idle shift for every two operational shifts, allowing charging outside the scheduled breaks. The peak charging power demand equals $300\text{kW} \times 5 = 1,500\text{ kW}$ only. Battery charge levels in this option for each subgroup of five trucks are shown in Figure 3. When the charge level is constant for some time, this means that the truck is idle.

From an investment perspective, option 1 has lower CAPEX, since chargers cost less than trucks. However, once we factor in other possibly influencing aspects—such as different battery lifetime and replacement costs—option 2 may have a lower total cost of ownership, because of the increased depreciation period from the idle times and enabled slower charging rates. Additionally, limited grid capacity may make full-fleet charging (option 1) unfeasible given its more significant power spikes. Alternatively, limited grid capacity may need upgrading, resulting in higher overall CAPEX.

Yet again, the decision might become different if the terminal considers using the same

chargers for other mobile terminal equipment. How these variables are considered shapes decision preferences. In this example, the terminal might choose differently if it considers options like battery swapping or opportunity charging.

1.2.2 WHAT SOLUTIONS FIT OPERATIONAL NEEDS BEST: IT IS A DELICATE BALANCING ACT

Simply adopting the technology itself does not guarantee maintaining the performance levels. Instead, it must be carefully integrated to meet specific requirements. To continue with the eTT case, the chosen charging strategy highly impacts the operational performance and requires decisions on many factors (Figure 4) such as:

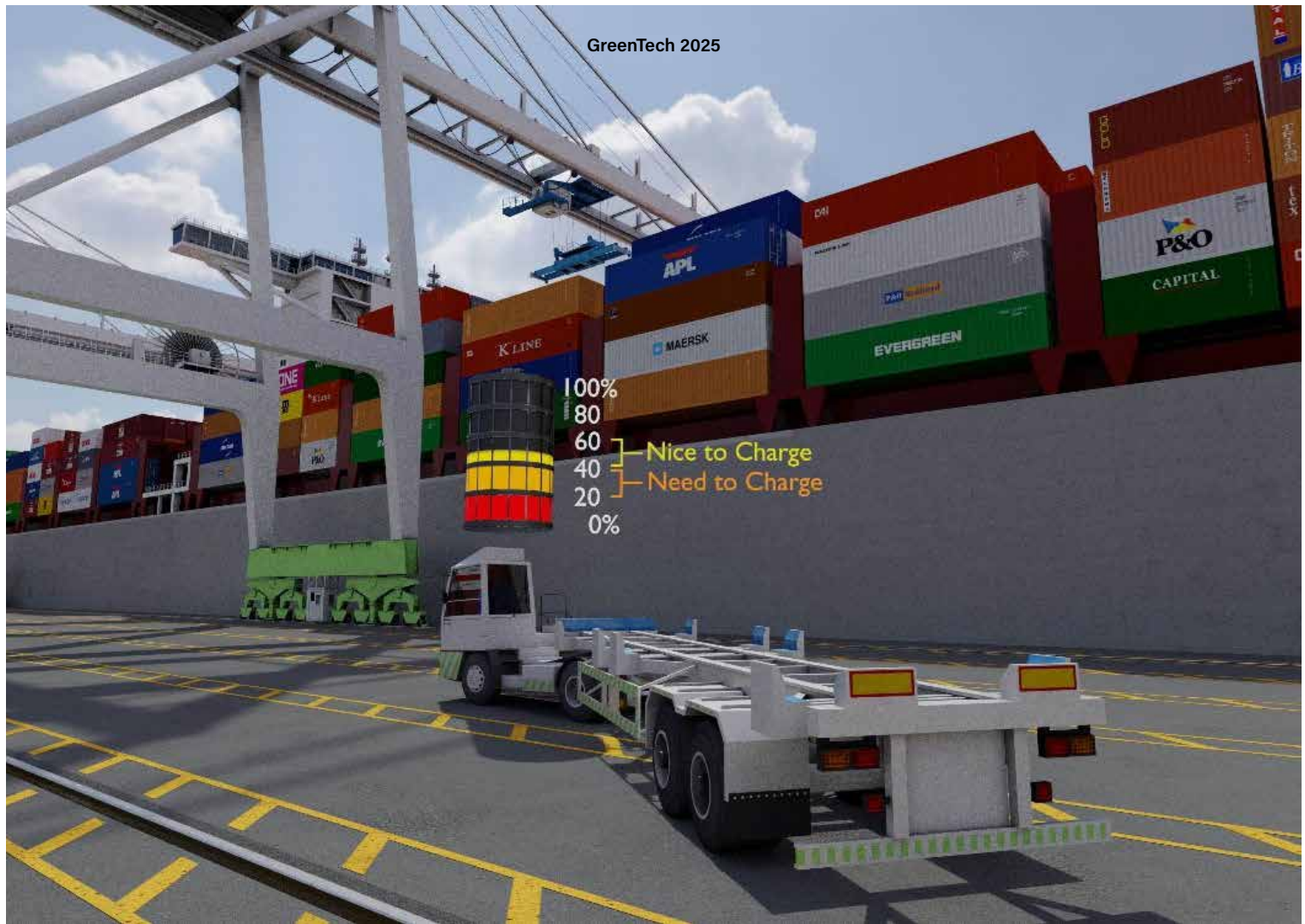
- Charging solutions, e.g., wired or opportunity charging, or battery swapping.
- Battery size and charging capacities, e.g., AC/DC or mega-watt charging speed.
- Charging locations, e.g., centralised vs. decentralised.
- Charging timing, e.g., % of eTTs

are charged during or outside shift, or need-to-charge vs. nice-to-charge depending on the battery level.

- Charging duration, e.g., fixed vs. variable charging time.

The most suitable charging strategy will depend on the terminal's operational needs. In the above terminal example with breaks/frequent off-peak hours, the breaks can be used for wired charging. However, in a different case of intensive 24/7 terminal operation with limited breaks, opportunity charging during the continuous operation can become the preferred solution to prevent downtime and limit the need for spares.

It is a delicate balancing act between maintaining stable battery levels and operational performance. Frequent or longer charging—even during productive moves—can inevitably lead to performance losses and impacts on productivity. A recent simulation study showed that a mere two-minute difference in opportunity charging duration led to a significant difference in quay crane performance and fleet battery level



at the end of one shift operation.

While two minutes may seem minimal, it actually constitutes a significant proportion of the typical 10-15 minute eTT operating cycle. The two-minute charging duration could also mean a significant difference in whether the energy loss per TT cycle can be offset. Similar dynamics were observed when we tested simulations with, for example, different thresholds for need-to-charge of eTTs, different charging speeds, alternative location setups, or implementing smart intelligence in managing energy use and charging schedules.

Such dynamics are further complicated by new innovation developments such as mega-watt charging, inductive/conductive charging, and automated charging solutions. Our experience shows that advanced tools like simulation (Figure 5) can be effective to quantify the dynamics between these relevant variables.

1.2.3 WHERE THE BUSINESS CASE LIES: HOLISM, PRAGMATISM, AND CREATIVITY ARE NEEDED

As discussed, the dynamics of a terminal's condition and operations affect the terminal's decision-making. Ultimately, the final decision-making still largely depends on the business case. Despite the mandate and needs driven by policies and regulations, CAPEX/OPEX and ROI remain decisive factors.

The biggest hurdle terminals face is still the substantial extra investment for electrification. We could arguably expect future technology developments in cost reduction and more industrial adoption for favourable business undertakings. Yet, the extra CAPEX still outweighs the potential OPEX savings from less energy and maintenance cost, at least per current market price levels, limiting direct business viability of electrification (reflected also

FIG 4.
3D simulation of eTT
on site.

in ZEPA's publication "Reaching a tipping point in Battery-Electric Container Handling Equipment", October 2023). This unavoidably causes dilemmas and hesitations among terminals, especially those with limited financial resources, on whether, when, and how to meet approaching zero-emission regulation deadlines.

To address this, financial support via government subsidies and contributions from external stakeholders, such as shipping lines and port authorities, will remain the key facilitator in the foreseeable future. Still, within a terminal's own scope, taking holism, pragmatism, and creativity into planning can lead to a viable business case that balances operational needs, environmental aims, and financial viability.

To broaden the discussion with a few other examples: when planning a site's shower power demand, while the IEC 80005-1 international standard recommends

a high-voltage system of 6.6 kV or 11 kV at 60 Hz, with a 2-7.5 MW capacity, our experience actually shows that container vessels mostly need between 2-4MVA.

In vessel berthing planning, designating different vessels to specific berths enables optimisations on shore power demand and usage, without compromising vessel service levels (verified via berth simulations).

In another study, we used simulations to size the electricity demands under various operational conditions across all the electricity consumers at a terminal. The results revealed that there is no need to design absolute peaks for grid demand. Instead, it is possible to still meet the needs by combining current sources by switchgears or reducing electricity consumption (e.g., reefers, subset of grid-connected CHEs, mobile equipment charging) at the proper time without impacting operation and performance.

There are many similar examples from our experiences showing such a holistic systematic approach in creating or finding out viable business cases.

1.3 CONCLUDING AND LOOKING AHEAD

The road to net-zero still needs substantial progress and more action and collaboration from various stakeholders. Yet, time is ticking and already calls for the immediate commencement of preparation and planning.

From our experience, it is clear that a holistic view and systematic approach are essential in sorting out various complexities to form a sensible and economically viable roadmap. There is no doubt that more challenges are still ahead along the bumpy road before the industry reaches the final destination. Such a holistic view will remain as one essential key to success.

ABOUT THE AUTHORS

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ABOUT THE COMPANY

Portwise is a world-leading consultancy and simulation firm that combines extensive automation and operational knowledge with proven simulation tools to create a future-proof plan for your port, terminal, or warehouse operation.