

VISIONS

PORT TECHNOLOGY | NO. 5



HIGHLIGHTS

- Today and Tomorrow's Terminal Traffic..... 4
- Saving CO₂ on a Grand Scale at Ports 6
- The Next RTG Evolution: Battery Packs 10





CONTAINER HANDLING AT THE NEXT LEVEL

PORTS IN TRANSITION

Dear Readers,

Welcome to the latest issue of VAHLE Visions, your source for insights into the future of energy and data transmission in the industry. The global container handling industry is on the brink of change. Sustainability, automation and efficiency are the new guiding principles of this rapidly evolving industry. Stricter emissions regulations, rising energy prices and the constant demand for greater productivity require innovative solutions. VAHLE is addressing these challenges with cutting-edge technologies that are making container terminals more environmentally friendly, intelligent and efficient.

Of particular note is the increased automation and autonomization of container handling, which not only increases efficiency, but also significantly reduces energy consumption and emissions — not to mention ensuring comprehensive safety.

In this issue, we explore our latest innovations in sustainable and efficient port logistics. These include future-proof charging solutions for eTrucks, energy and data transmission systems for terminal cranes and the latest upgrade for RTG cranes: VAHLE Battery Packs. These packs enable completely emission-free electrification and fully self-sufficient maneuvering, even when changing aisles. This eliminates the need for additional diesel generators on the crane. This makes net-zero container handling possible.

Join us as we explore the future of port technology and discover how we are setting the course together for sustainable, digital and efficient logistics.

Your Vision. Our Solution.



AUTONOMOUS, AUTOMATED AND FULL OF ENERGY

TODAY AND TOMORROW'S TERMINAL TRAFFIC

Imagine a world in which not only is intra-terminal vehicle traffic autonomous, but it is also automated and fully electric – all without sacrificing efficiency. This vision is no longer just a distant dream for the future; it is already a reality today. This is made possible by innovative technologies and practical solutions that comply with relevant standards and regulations.

Change begins in operations

Changes in terminal traffic don't begin in the laboratory; they begin where it counts: in day-to-day operations. The focus is on solutions that harmonize with existing

infrastructure and vehicle fleets, and that can be flexibly adapted to future requirements. This is the only way to create real added value for operators and the environment.

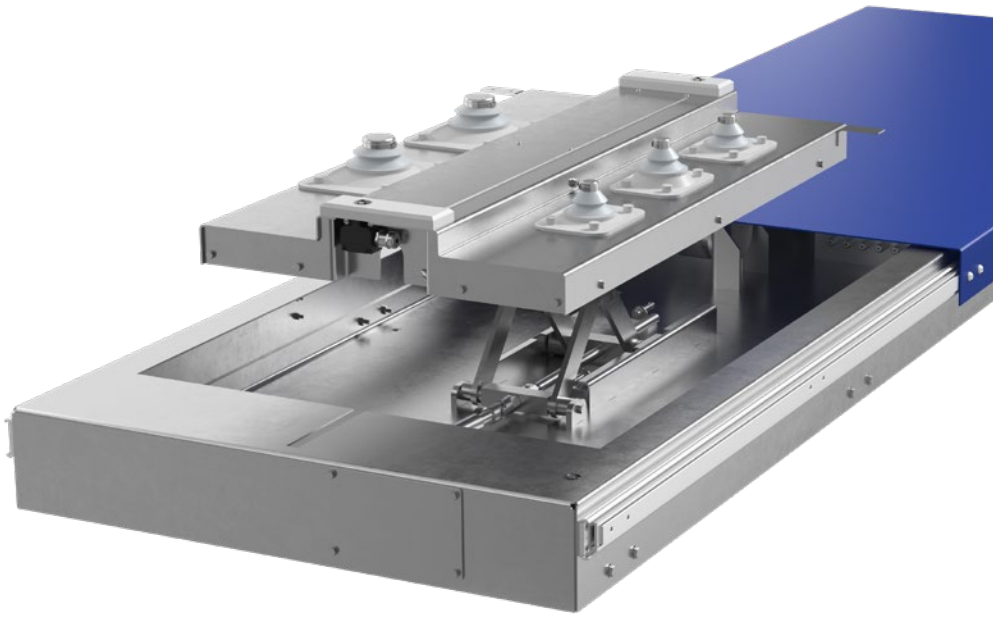
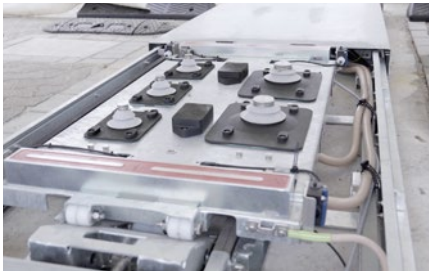
Charge where vehicles are already parked

VAHLE's PowerDock provides an infrastructure that supplies electricity to parked vehicles, such as at block entrances or waiting areas. The automated, contact-based charging process eliminates the need for manual plugging in. This saves time, increases availability, improves energy

efficiency and reduces the need for large battery packs.

Intelligent infrastructure for networked processes

PowerDock creates the conditions for networked processes by seamlessly integrating into existing processes and energy management systems. This makes the charging process part of an automated overall concept. This results in a new form of terminal operation that is quiet, efficient, emission-free and ready for autonomous transportation in the future.



CHARGE WITH POWERDOCK AT THE POINT OF USE WITHOUT DOWNTIME OR MANUAL PROCESSES

In terminal operation, reliability and robustness are what count. PowerDock does not require sensitive sensors or moving actuators. Its contact-based power transmission remains reliable even under heavy mechanical stress, making it ideal for harsh operating conditions. Closed contacts during charging eliminate the safety risks associated with open systems.

Maximum compatibility in the port

PowerDock is compatible with existing vehicle fleets. The charging infrastructure can be integrated into existing terminal environments without requiring major structural changes. Our goal is to enable charging via classic charging sockets or the PowerDock standard. Its modular design allows for flexible adaptation to new vehicle types, additional locations and existing fast-charging infrastructure. This makes it ideal for retrofitting and fleet concepts.

Fast, automated and networked

With charging capacities of up to 360 kW, the PowerDock significantly reduces charging time. Even during brief periods of downtime, enough energy can be transferred for the next steps in the process. An integrated traffic light system provides the driver with visual feedback. Automatic coupling requires no mechanical effort or vehicle modification. The LTE connection enables real-time monitoring, analysis and control of the charging process.

Ready for autonomous port operation

In the context of autonomous terminal operation, PowerDock is an intelligent hub for energy management, not just a loading unit. The system architecture can be integrated into higher-level control systems and forms the basis for an automated energy supply throughout the terminal.

PowerDock from VAHLE at a glance

- ⊕ **Robust and reliable:** Works even in harsh environments and with vibrations.
- ⊕ **Easy to integrate:** Compatible with existing charging infrastructure and can be retrofitted without major conversions.
- ⊕ **Fast charging:** With up to 360 kW of charging power, downtime is minimized.
- ⊕ **Automated and safe:** Fully automatic docking process with visual monitoring.
- ⊕ **Fit for tomorrow:** Networked system architecture for autonomous port operations of the future.

Ready for change: VAHLE as a development partner

VAHLE collaborates with terminal operators and vehicle manufacturers to shape the future of ports and intralogistics. The goal is to achieve fully automated, electrified and networked operations that are robust, efficient and sustainable.

PowerDock technology is a central element of this transformation.

ELECTRIFY INSTEAD OF REFUEL

TRIMOTION COMPACT: SAVING CO₂ ON A GRAND SCALE

TRIMOTION COMPACT has been in successful use at Khalifa Port in Abu Dhabi, which is operated by the AD Ports Group and CMA Terminals, since December 2024. The system is more than just a technical solution. It is essential for sustainable infrastructure and economical terminal operations, and it significantly reduces CO₂ emissions in global supply chains.



YC 12

CMA **TERMINAL**
KHALIFA PORT

CO₂ SAVINGS PER CONVERSION PER YEAR

Converting a diesel-powered RTG to an electric, automated system can reduce CO₂ emissions by up to 300 tons per year. This is equivalent to:



Around 110 flights
between Frankfurt and New York



About 1.9 million kilometers by car



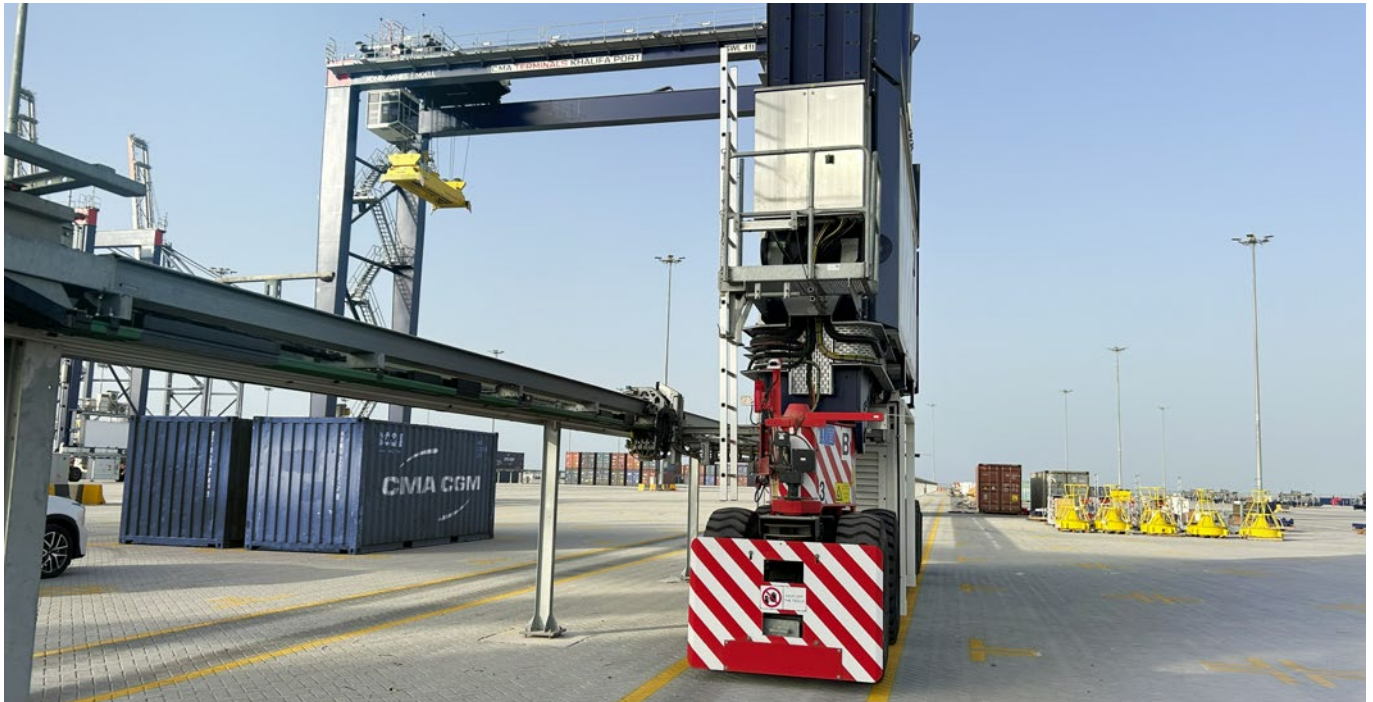
Annual consumption of approx. 45 families
(4-person household in Germany)



Around 9,000 kilograms of beef
(incl. production, transportation, feed)

CALCULATION BASIS

Diesel operation (30 l/h, 4,000 hours/year) | $30 \text{ l/h} \times 2.64 \text{ kg CO}_2/\text{l} \times 4,000 \text{ h} = 316.8 \text{ t CO}_2/\text{year}$ | **Electric operation** (200 kWh/day, electricity mix 2024) | $200 \text{ kWh/day} \times 250 \text{ days} = 50,000 \text{ kWh/year}$ | $50,000 \text{ kWh} \times 366 \text{ g CO}_2/\text{kWh} = 18.3 \text{ t CO}_2/\text{year}$ | **CO₂ savings per year** $316.8 \text{ t} - 18.3 \text{ t CO}_2/\text{year} = 298.5 \text{ t CO}_2/\text{year}$



THE NEW STANDARD FOR GREENER TERMINALS

Electrification and automation in terminal operations is no longer a dream of the future – it is a reality. What began over 20 years ago as a reaction to rising oil prices is now a crucial building block for economically viable and climate-friendly container handling. This development clearly shows that economic efficiency and sustainability are not opposites – they are mutually dependent.

Save up to 300 tons of CO₂ per year

Using electrified and automated systems instead of diesel-powered units in Rubber-Tyred Gantry Cranes (RTGs) can save up to 300 tons of CO₂ per year at the terminal*. The eRTGs at the Modern Terminal in Hong Kong, which have been in successful and reliable use for over 15 years, demonstrate that this is not just theory. Additionally, greater automation of the cranes contributes to a significant increase

in efficiency and improvement in safety, in terms of both personnel and operational processes.

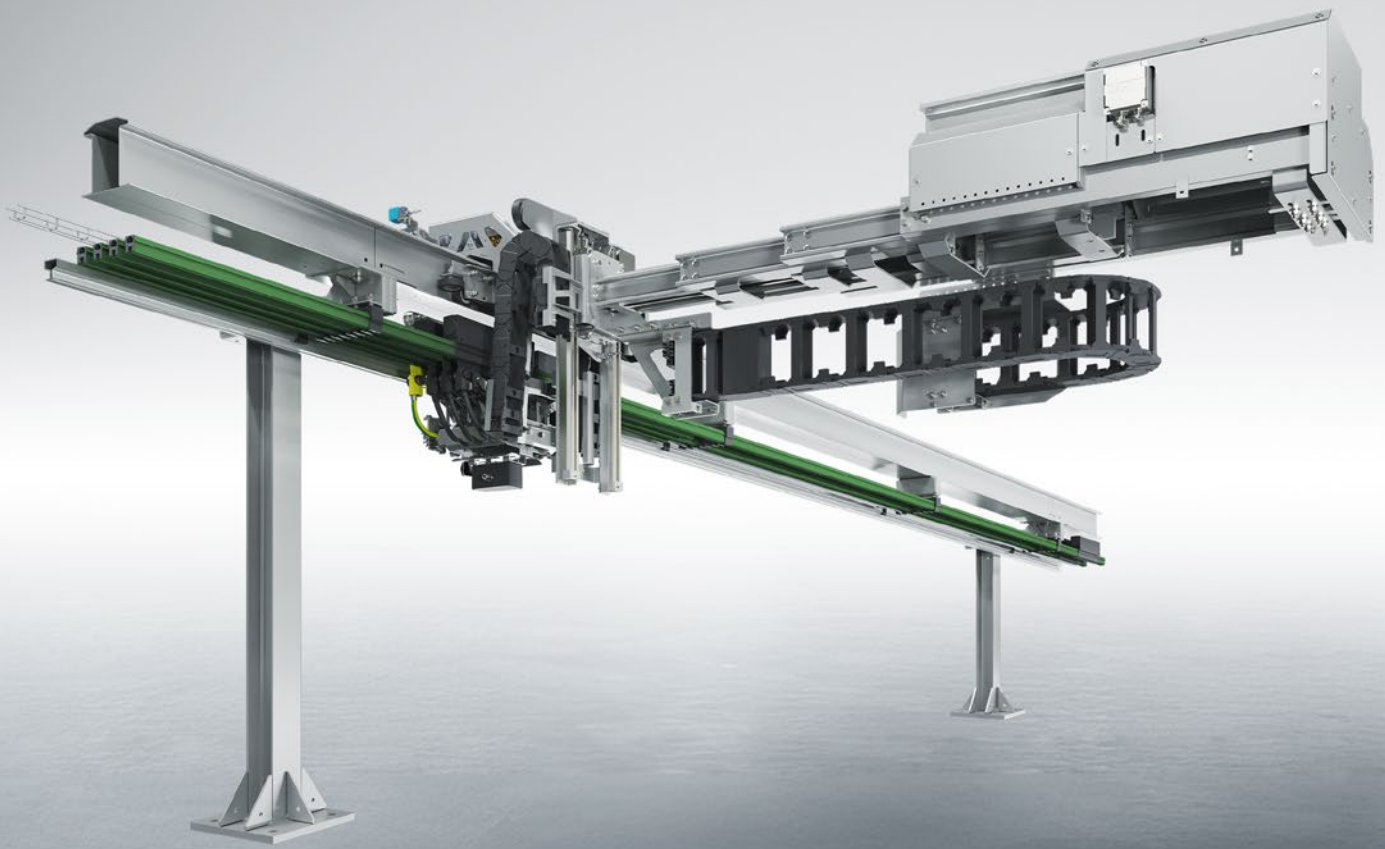
VAHLE as a technology partner in the terminal

For many years, VAHLE has been an active pioneer of electrification and automation in terminal facilities. VAHLE provides solutions that meet the challenges of container handling and terminal operation thanks to its extensive know-how and practical expertise.

Compact, efficient and retrofittable

Consider, for example, the new TRIMOTION COMPACT, a compact electrification system designed for automated RTG applications. Suitable for new systems and retrofit projects, it increases the efficiency of electric RTG operations in a sustainable way.

* Assuming an RTG use of 4,000 hours per year and a diesel consumption of approximately 30 liters



TRIMOTION COMPACT – advantages at a glance

- ⊕ **Fully synchronized:** control several eRTGs on one line
- ⊕ **Compact design:** perfect for retrofitting
- ⊕ **Combined energy and data transmission in one system**
- ⊕ **Plug and Play:** easy installation and quick commissioning
- ⊕ **Faster availability:** standardized (ISO/EN) hardware and therefore optimized localized procurement options
- ⊕ **Fully remote-capable:** providing complete control from a operator desk

ENERGY EFFICIENCY AND ZERO EMISSIONS

THE NEXT EVOLUTION OF RTG: MODULAR BATTERY SYSTEMS

The industry is subject to constant change, sometimes evolutionary and sometimes disruptive. This is also true in container handling, the pulse of the global economy. More than two decades ago, the electrification of RTGs signaled a paradigm shift away from diesel generators and toward sustainable energy. However, this step is only the beginning. Today, innovative terminal operators are focusing on the next stage of this development: a consistent transition to net-zero terminal operation made possible by integrating modular battery systems.





BATTERY PACKS: INTELLIGENT BUFFER SYSTEMS FOR MAXIMUM ENERGY EFFICIENCY

A battery-supported energy module, such as the VAHLE Battery Pack, supplies electric RTGs (eRTGs) with energy independently of the grid. This enables emission-free and fully autonomous operation of defined driving profiles, such as aisle changes between the blocks. The continuous energy supply remains relevant in the container blocks, but the system architecture is significantly simplified, and operational flexibility increases noticeably.

Battery systems as the energy storage system of the future

Modern battery systems act as high-performance buffers that meet short-term mobility needs and complex energy demands. They enable peak shaving, which is the targeted relief of the local power grid during peak loads. They can also temporarily store locally generated renewable energy – from photovoltaic systems, for example – and supply it as needed.

An added benefit is that using recovery potential (recuperation) and decoupling from the power grid supports the integration

of renewable energies into the grid – and therefore the overall strategy for reducing CO₂ emissions at the terminal level.

Economic efficiency and sustainability in step

In addition to its ecological benefits, a battery-based energy supply offers economic advantages. Energy consumption can be controlled intelligently, load profiles can be smoothed and energy costs can be reduced. Uniform movement profiles and controlled driving dynamics minimize wear and maintenance costs.

Customized solutions instead of standard ones

The decisive factor is not a single system, but rather a tailor-made solution precisely geared toward actual terminal processes. Efficiency is created when technology meets real operating requirements.

The requirements for energy supply systems in container terminals are complex and vary greatly depending on infrastructure, operating

models and sustainability strategies. This could mean self-sufficient movement sequences, off-grid continuous operation or the integration of existing energy sources.

VAHLE as a partner for sustainable terminal concepts

VAHLE does not offer standardized off-the-shelf solutions. Instead, we offer customized modular, scalable concepts informed by years of experience, proven technology and our motto, „Your Vision. Our Solution.“

Whether as a retrofit component for existing eRTG fleets or as a future-proof energy architecture in new construction projects: The VAHLE Battery Pack turns ambitious decarbonization goals into real success models – and modern terminals into real net-zero pioneers.

VAHLE SERVICE – FOR A TROUBLE-FREE FUTURE

MAXIMUM AVAILABILITY, MINIMAL DOWNTIME

Whether eRTG Cranes, STS Cranes, Straddle Carriers, RMG Cranes or Automated guided vehicles (AGV) – regular maintenance, professional cleaning, and precise inspection ensure reliable and future-proof port operations.

With preventative and predictive service, seamless spare parts supply and our protect programs, we keep your systems efficient, safe and consistently powerful.



Schedule a System Check Now!

Simply scan the QR code or visit vahle.com/globalservice



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