AELER

Smart containers
## a comprehensive guide

November 2024

Content

A message from the co-CEOs

"As we stand on the brink of a new era in logistics, it's clear that the future belongs to those who embrace innovation, sustainability, and efficiency. At AELER, we believe that the shipping container—a symbol of global trade—has the potential to be much more than just a box. It can be a catalyst for change; a tool for transformation.

This eBook explores how smart containers, with their advanced materials, integrated technologies, and sustainable design, can redefine the logistics landscape. We're proud to be at the forefront of this change, and we invite you to join us on this journey towards a smarter, more connected world."

David Baur & Naïk Londono
Co-CEOs, AELER
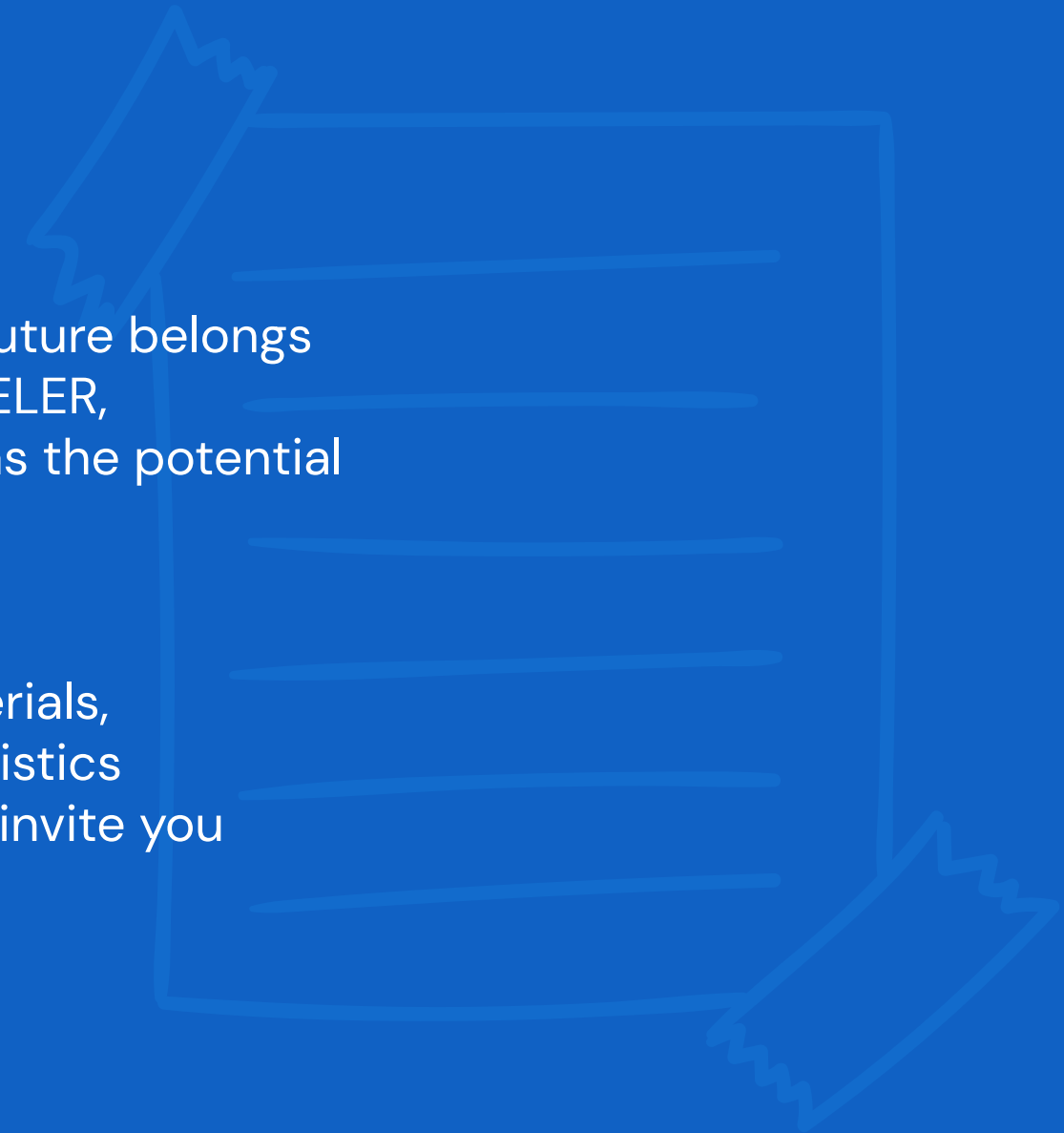
01
Introduction:
The 'smart' age

The logistics and shipping industry is undergoing a significant transformation, driven by the push for efficiency, sustainability, and technological integration. At the heart of this shift is the "smart container"—an evolution beyond the traditional, box for transporting goods.

While smart containers were initially defined as containers with IoT sensors for tracking location and conditions, this eBook proposes a broader view.

Just as the concept of "smart cities" evolved to include sustainability and improved services, a truly smart container encompasses more than connectivity. It integrates innovative materials, operational efficiency, and sustainability to meet today's complex logistics demands.

This eBook explores each element that makes modern smart containers essential for a future-ready supply chain.

Smart container

A shipping container designed with cutting-edge materials, robust insulation, seamless digital integration, and built with sustainability in mind to delive an efficient and comprehensive logistics solution.

<1960   1960   2024
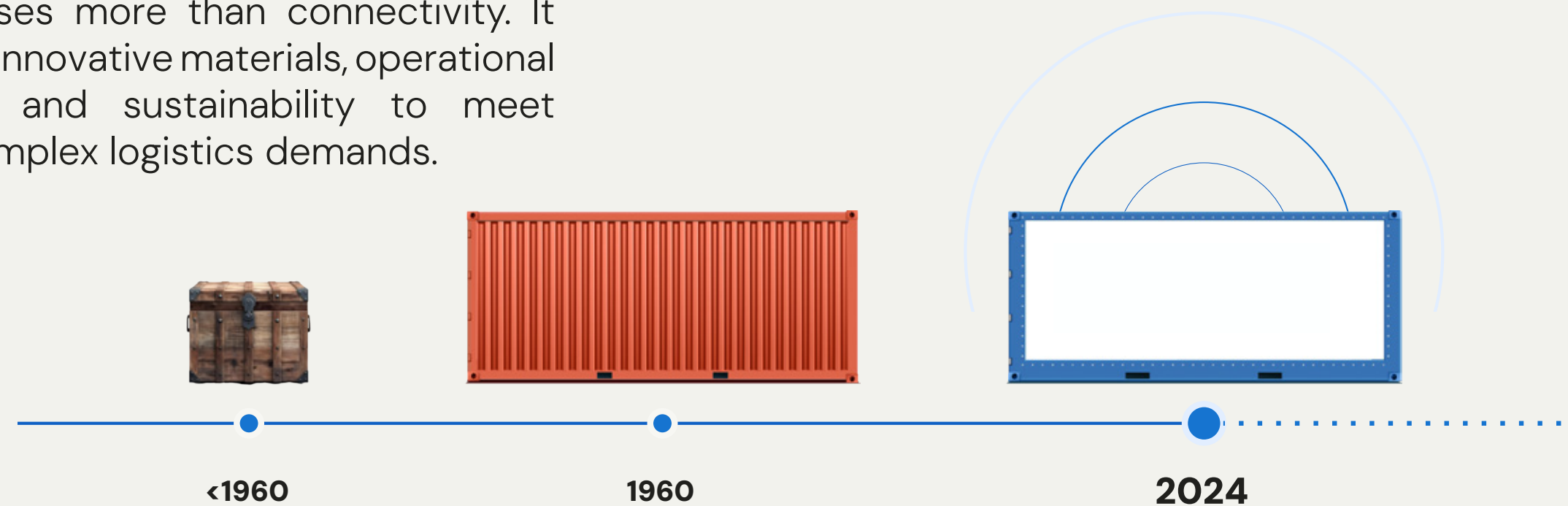
From wooden crates to steel boxes, shipping containers have evolved into cutting-edge smart containers.

02
Designed for robustness:
a reinvented structure

Shipping containers have barely evolved over the last 60 years. Making them truly smart begins with rethinking how they are built.

The challenge of structural integrity for safe shipping

Traditionally, steel has been the preferred material for shipping containers because of its strength, durability and relative affordability. However, despite its benefits, steel also has notable limitations, such as the tendency of steel container walls to deform and bulge when filled to maximum capacity with liquid cargo. These bulges occur for two reasons: because traditional containers were designed to withstand pressure on their corner posts rather than their side panels, and market demand for lower costs, which has driven manufacturers to reduce the thickness of the walls.

As a result of the risk of bulging, operators are often forced to underutilise container capacity, typically limiting loads to up to 24 tons, even when additional space is available. This practice leads to inefficient and costly shipping operations.

Moreover, containers with sidewall deformations can cause damage during handling, a severe concern for logistics operations. As a result, vessel and rail operators may refuse to transport deformed containers, adding to logistical challenges and increasing downtime as these containers need repair or replacement.

# Rethinking container design with modern composite materials

The use of composite materials— combinations of two or more materials with different physical and chemical properties— to manufacture smart container walls is an innovative solution to the bulging challenge. These materials offer exceptional strength, making smart containers up to <u>65% stronger than traditional steel containers</u> while preserving internal space. This added strength allows composite containers to carry <u>up to four tons more liquid in a flexitank</u>, improving efficiency, reducing shipping costs, and increasing container availability for other shipments.

Beyond strength, the composite sandwich structure of smart container walls provides robust protection against physical damage, moisture, pest, and temperature f uctuations.
With the right technology and <u>methods,</u> risks are reduced, efficiency is enhanced, and standards in bulk liquid shipping are elevated, ensuring sensitive or high–value goods arrive in optimal condition.

Designed for robustness: **a reinvented structure**

AΞLER

Case study: cutting costs and maximising efficiency in bulk liquid transportation

One of the world's leading multinational consumer goods companies utilised smart containers built with composite materials to increase payload capacity by up to four tons per shipment and reduce cost per ton of cargo transported by up to 10%, all the while enhancing cargo protection and maintaining product quality.

Read the full article

27 tons
24 tons
Up to +17%
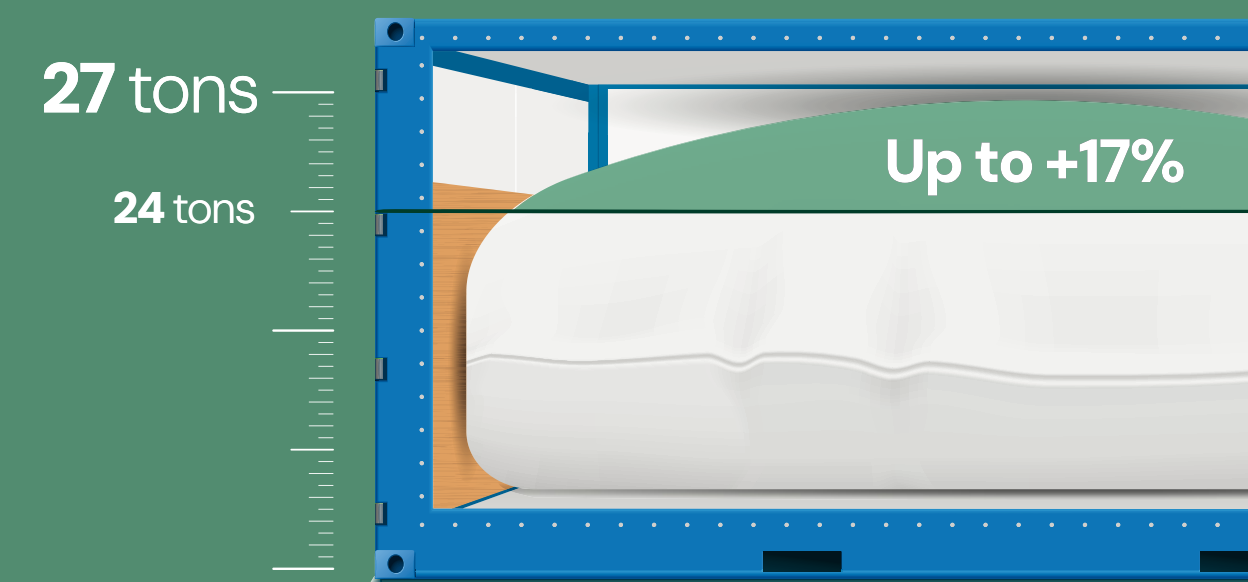
Reinforced composite walls allow flexitanks to carry up to 17% more bulk liquid

03

Designed for efficiency:
native insulation

Smart containers are designed with built-in, native insulation to ensure optimal cargo integrity. This innovative feature makes transporting temperature-sensitive goods more efficient and secure.

Shipping temperature-sensitive goods: a new alternative

Traditional temperature control in shipping has relied on three main types of containers: refrigerated containers (reefers), non-operating reefers (NORs), and insulated standard steel containers fitted with single-use insulation like spray foam, liners, or blankets. While each of these methods serves its purpose, they come with notable drawbacks.

Reefers are effective but costly to operate, requiring a ship's power supply to operate a refrigeration unit. NORs are more economical as the unit is switched off, but are an inefficient use of space due to the large refrigeration unit. Moreover, they are limited in supply as operators would rather lease them as reefers for economical reasons. Finally, standard dry containers with single-use insulation offer flexibility but at the expense of environmental sustainability, leading to increased waste and higher costs.
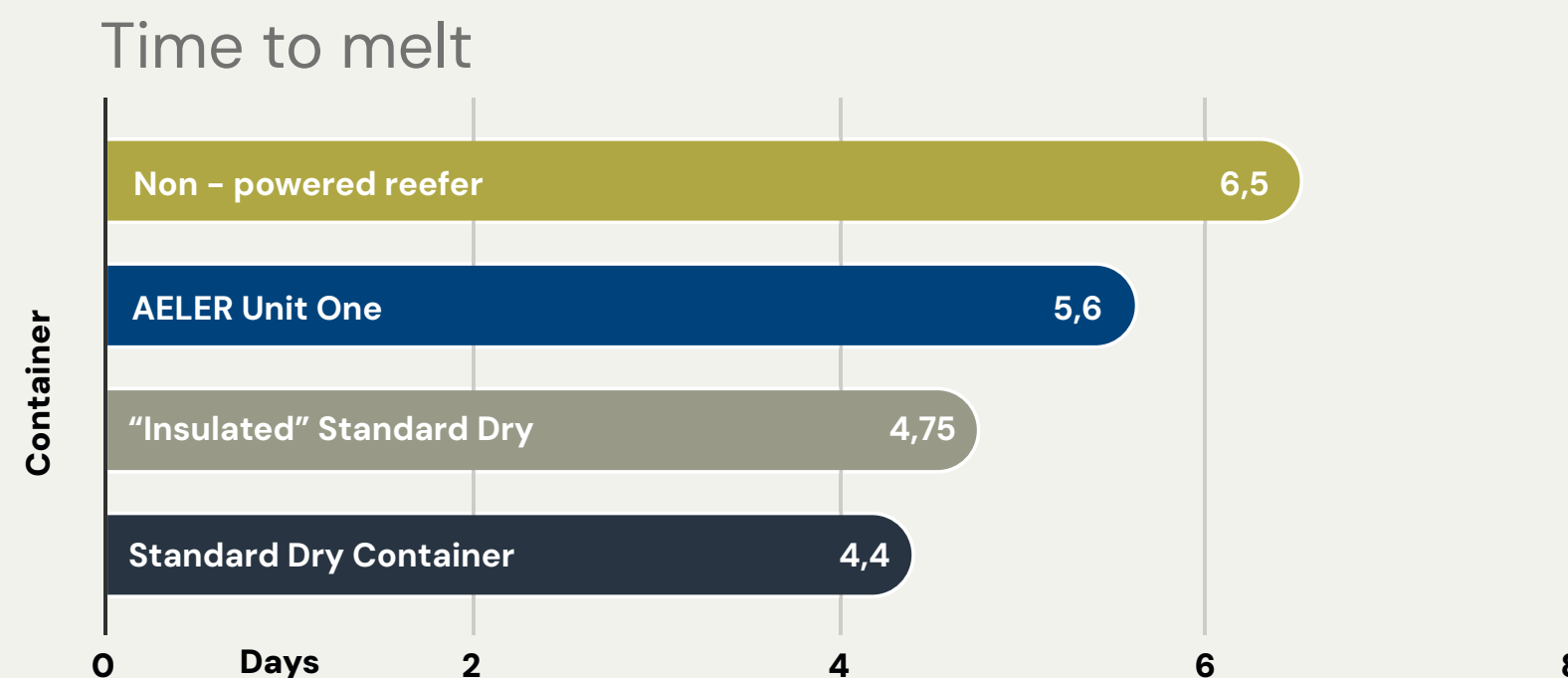
In contrast, smart containers are equipped with native insulation, thanks to a foam layer integrated directly into their composite walls. This innovative design eliminates the need for additional cooling engines and single-use insulation, offering a streamlined solution. By advancing the transportation of temperature-sensitive goods that don't require active cooling, these containers provide a more cost-effective, environmentally friendly, and efficient option.

Similar thermal performance to an non-operating reefer: a field test

To compare the thermal performance of the different solutions for shipping temperature-sensitive goods, AELER conducted a field test, filling four different containers with 500 litres of ice.

The results of the test revealed that the ice took the longest to melt in the NOR (6.5 days), followed by Unit One (5.6 days), the insulated dry container (4.75 days), and the standard dry container (4.4 days).

Time to melt

Container	Days
Non – powered reefer	6,5
AELER Unit One	5,6
"Insulated" Standard Dry	4,75
Standard Dry Container	4,4

AELER Unit One   Standard Dry Container   "Insulated" Standard Dry   Non – powered reefer


Case study: transforming pharmaceutical logistics with smart containers

These findings are significant for several reasons. First, they show that Unit One's thermal performance surpasses that of insulated steel containers without relying on harmful and time-consuming single-use plastic insulation.

Second, Unit One's thermal performance is comparable to that of an NOR, making it a viable alternative for transporting goods usually shipped in this type of container. Moreover, since Unit One does not contain a refrigeration unit, operators can ship up to 11% more cargo, which directly translates into reduced per-unit transportation costs.

A leading pharmaceutical company adopted smart containers, achieving enhanced temperature stability, a significant reduction in CO_2 emissions, and a 21% decrease in logistics costs while ensuring complete end-to-end visibility and improved container availability.

Read the full article

Protection layer

Native insulation layer
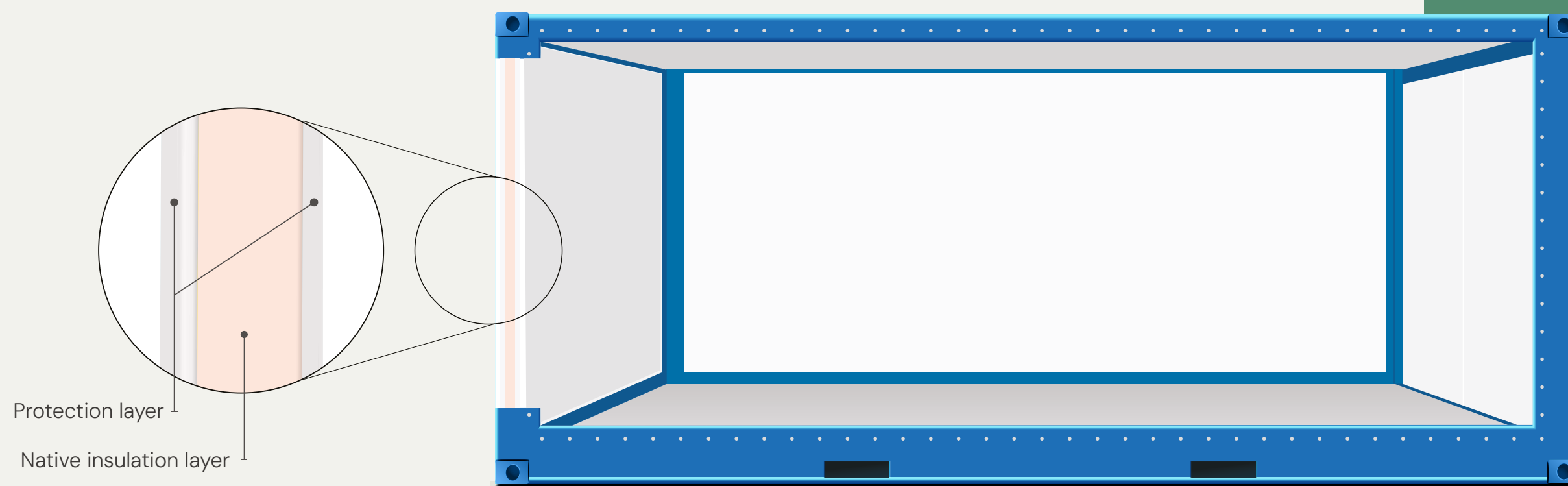
Smart containers with built-in insulation offer superior temperature and humidity control for cargo protection

Designed for efficiency: **native insulation**

04

Designed for sustainability: a decarbonisation enabler

As the world increasingly prioritises environmental responsibility, smart containers are crafted with sustainability at their core, engineered to actively support a circular economy. This is achieved throughout the conatiner's life cycle with three main strategies:

- **Design:** utilising environmentally friendly, recycled materials in manufacturing

- **Cradle to cradle:** enabling the repurposing of the entire container

- **Cradle to grave:** ensuring the recyclability of components at the end of their life cycle

Sustainable manufacturing with recycled materials

Smart container panels are crafted from recycled materials that offer a more sustainable alternative to traditional steel containers. Though steel is recyclable, its production process is energy-intensive and has a significant environmental impact.

The floor of smart containers represents a significant innovation, transitioning from traditional, heavy, non-renewable materials to those sourced from renewable resources. These floors are also chemically treated for durability and coated with highly resistant, food-grade paint. This process not only prevents pest infestations but also extends the container's lifespan, reducing the need for frequent replacements and minimising environmental impact.

AELER

Container repurposing and end-of-life recycling

Sustainability in smart containers goes beyond their operational lifespan. These containers can be repurposed for various applications, enhancing their contribution to the circular economy and reducing waste.

Temporary structures: smart containers can be transformed into booths, housing units, temporary office spaces, or mobile kiosks. Their durability and insulation make them ideal for these applications, offering a second life beyond their original use.

Trailers and mobile units: with minimal modification, smart containers can serve as the foundation for mobile trailers or units, providing a sustainable solution for industries ranging from construction to retail.
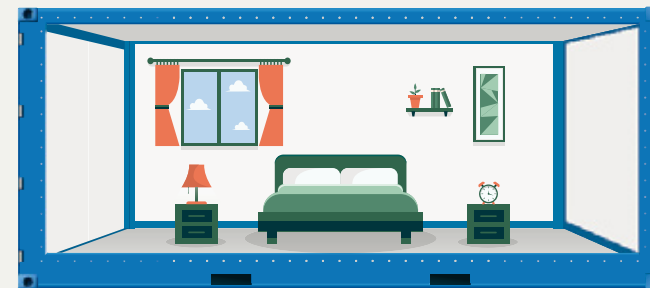
Alternatively, at the end of their service life, the metal joints and reinforcements can be melted down and reused, conserving resources and reducing waste.

Designed for sustainability: **a decarbonisation enabler**
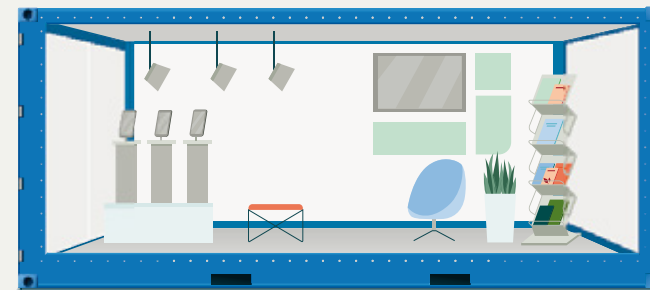
Booth

Temporary workspace

Housing

Mobile kiosk

Trailer

Mobile storage

05
Designed for visibility:
## connected every step of the way

The logistics and shipping industry faces significant challenges due to the lack of real-time visibility into shipping containers. Traditional steel containers provide no insights into critical factors like location, temperature, humidity, and door status. This leaves shippers and cargo owners unable to respond promptly to extreme conditions or unauthorised container access, increasing the risk of damaged goods, shipment delays, and higher costs.

As discussed, traditional smart containers address many of these issues by incorporating Internet of Things (IoT) technology, transforming ordinary containers into connected, intelligent assets that provide real-time visibility into cargo conditions. These containers give operators and shippers enhanced control, security, and efficiency throughout shipping, offering insights that improve customer satisfaction and operational outcomes.

Empowering shippers with IoT sensors and real-time monitoring

Smart containers by design take it one step further by incorporating **pre-installed IoT sensors** directly into the container's construction. This eliminates the need for separate installations, additional procurement, or additional subscriptions typically required for containers using add-on IoT devices. As a result, smart containers by design offer a seamless, ready-to-use solution with superior integration into data systems.

Data from integrated IoT sensors is also fed into a **unified dashboard**, accessible from the moment the smart container is acquired, giving shippers and operators a comprehensive view of the cargo's condition and position at any moment.
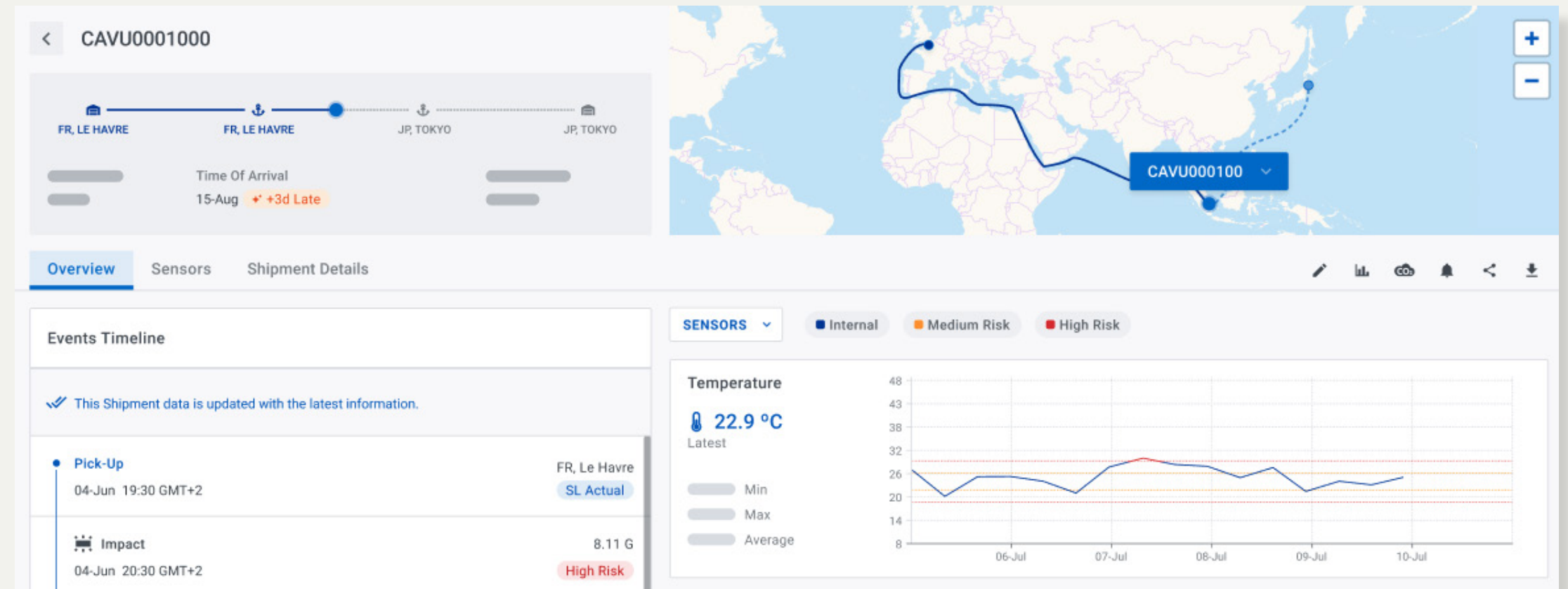
Control Tower: the platform for real-time cargo updates, tracking every change and movement

These smart monitoring platforms go beyond basic tracking. They aggregate up-to-date information from various shipping lines, including detailed updates on vessel and port events like Estimated Time of Arrival (ETA), loading, discharging, and departures. With this system, operators can receive **advanced warnings of potential delays**—sometimes even before the shipping line reports them. This predictive capability allows for proactive disruption management, helping to keep the supply chain smooth and efficient.

With the data and insights these smart containers provide, operators can monitor their cargo's safety every step of the way. **Proactive alerts** signal when a shipment is at risk, allowing immediate action to protect the products and ensure their arrival at the final destination. Moreover, the convenience of receiving notifications on various devices enables quick reactions to disruptions through a single, integrated platform without needing to log onto different systems.
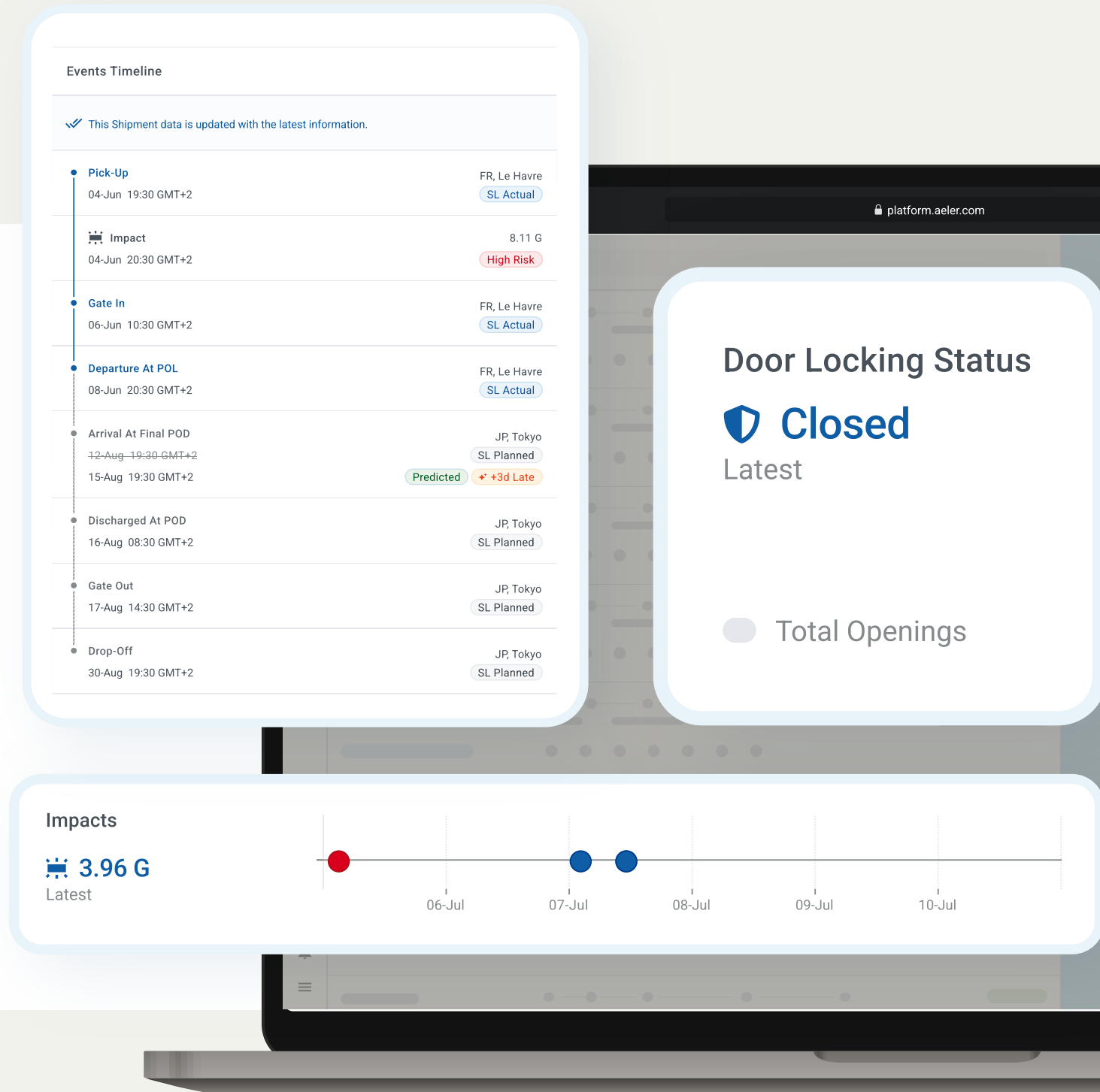
The importance of a smart fleet management: maximising efficiency and reducing costs

Finally, smart containers, equipped with IoT devices that provide real-time data, significantly enhance the capability of container fleet management tools, which use data analysis and optimisation algorithms to make containers available when and where needed.

This continuous data stream from IoT devices allows container fleet management tools to perform more effectively. Advanced analysis and optimisation algorithms ensure containers are available precisely when and where they are needed. The result is precise container positioning, reducing inefficiencies associated with empty container movements and ensuring continuous utilisation across the fleet.

Container fleet management

The use of data data analysis and optimisation algorithms to position containers so that they are available when and where needed.

Events Timeline

✔ This Shipment data is updated with the latest information.

● **Pick-Up**
04-Jun 19:30 GMT+2 — FR, Le Havre — SL Actual

🚆 **Impact**
04-Jun 20:30 GMT+2 — 8.11 G — High Risk

Gate In
06-Jun 10:30 GMT+2 — FR, Le Havre — SL Actual

Departure At POL
08-Jun 20:30 GMT+2 — FR, Le Havre — SL Actual

Arrival At Final POD
12-Aug 19:30 GMT+2 — JP, Tokyo — SL Planned
15-Aug 19:30 GMT+2 — Predicted — +3d Late

Discharged At POD
16-Aug 08:30 GMT+2 — JP, Tokyo — SL Planned

Gate Out
17-Aug 14:30 GMT+2 — JP, Tokyo — SL Planned

Drop-Off
30-Aug 19:30 GMT+2 — JP, Tokyo — SL Planned

platform.aeler.com

Door Locking Status
🛡 **Closed**
Latest

Total Openings

Impacts
🚆 **3.96 G**
Latest

06-Jul   07-Jul   08-Jul   09-Jul   10-Jul

05

Conclusion: designed for high-performance modern logistics

Smart containers by design reflect a deep understanding of the challenges faced by modern logistics, addressing issues from payload capacity and cargo protection to sustainability, visibility and cost-effectiveness.

These containers are built to last, enhance operational efficiency, and reduce environmental impact. Moreover, the digital connectivity through IoT sensors and advanced monitoring platform offers unprecedented visibility and control over the shipping process.

This technological integration enables more informed decision-making, proactive management of potential disruptions, and significantly reduced operational inefficiencies.

Smart containers are more than just containers; they are a comprehensive solution designed to meet the demands of a rapidly evolving logistics industry. By embracing these innovations, it can achieve greater efficiency, sustainability, and resilience, paving the way for a more connected and environmentally conscious shipping future.

AΞLER

Offices in Switzerland (HQ), Portugal, Germany
Distributed in 35 countries, +90 depots

business@aeler.com