Safetytech Accelerator

WHITEPAPER · 2025

Navigating the Fire Risk

Electric vehicles, lithium-ion batteries, and maritime safety

SAFETYTECH ACCELERATOR 2026

Navigating the Fire Risk

Electric vehicles, lithium-ion batteries, and maritime safety

Safetytech Accelerator White Paper | April 2026

The global shift to electric vehicles (EV) is rapidly changing what ships carry. As millions of lithium-ion batteries move through maritime supply chains, a familiar maritime hazard - fire - is re-emerging in a new and more complex form. This paper pulls together evidence from published reports and recent incidents to describe how the system is changing, where controls are lagging, and what practical steps could reduce the risk to ships, crews, and cargo while regulation catches up. Drawing on recent incidents, industry reports, and Safetytech Accelerator's work supporting fire detection and loss prevention in cargo environments, this paper explores how the risk is evolving and what practical steps could reduce exposure while regulation catches up.

Key takeaways

250	**30%**	**2027**
Fire incidents reported in 2024 (highest in a decade)	Of incidents occurred in container, cargo, or roll-on/roll-off vessels	The year we are expecting mandatory regulations for transportation of new energy vehicles from the IMO

- EV transport is rapidly increasing the number of lithium-ion batteries at sea.
- Lithium battery fires behave differently from conventional vehicle fires and can overwhelm existing shipboard controls.
- Recent vessel incidents illustrate how quickly thermal runaway events can escalate.
- While regulation is evolving toward 2027, early detection, operational readiness, and practical retrofit pathways can materially reduce risk today.

Sources: Allianz Commercial, 2025 and BIMCO & Maritime Technologies Forum, 2025

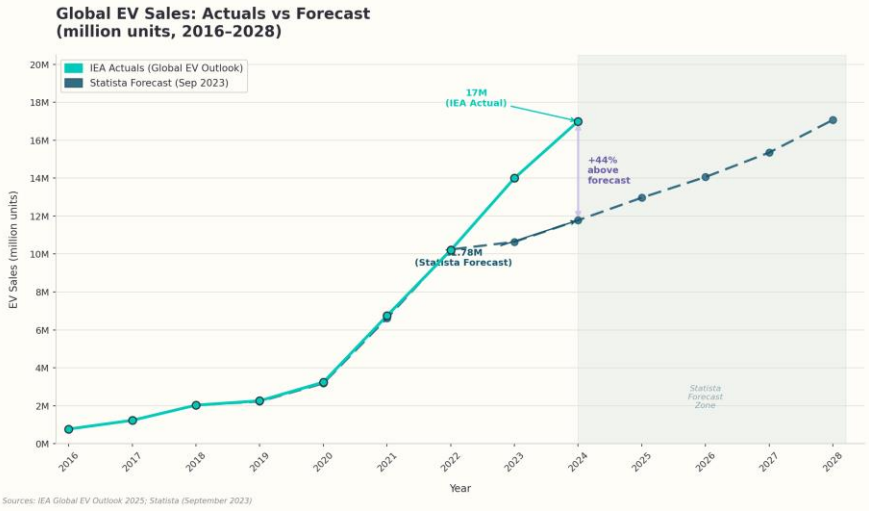
"Decades of experience exist for managing fuel-powered vehicle fires, whereas the marine industry currently lacks similar protocols for EVs" (Klopott & Urbanyi-Popiolek, 2024, p.922).

How we see the system

The world is moving to more sustainable alternatives in transport. According to the International Energy Agency (IEA), reaching Net Zero Emissions by 2050 requires a wide portfolio of low-emission technologies, and EVs provide nearly one fifth of the projected emission reduction by 2030 (International Energy Agency, 2023).

EV demand is now translating into material changes in global logistics. Statista forecasted that EV sales would reach 12.97 million units in 2025 and 17.1 million units by 2028 (Statista, 2023). Meanwhile, the IEA reported that EV sales reached 17 million in 2024 alone (International Energy Agency, 2025).

Table 1



As shown in Table 1, actual EV sales have significantly outpaced earlier forecasts, exceeding projected trajectories by approximately 44%. This divergence between forecast and reality highlights the speed at which EV adoption is accelerating and the extent to which supply chains are having to adjust in real time.

This rapid growth is also increasing exposure to risks associated with the transport of electric vehicles, particularly fire incidents during maritime shipping. Although up to 20 per cent of global electric car sales are traded internationally, sea freight remains essential to intercontinental EV distribution (International Energy Agency, 2025; Climate Action Tracker, 2024). As a result, the movement of EVs by sea introduces a renewed focus on fire risk within a long-established category of maritime hazards (Klopott & Urbanyi Popiolek, 2024).

Electric vehicles are usually fitted with lithium-ion batteries, including safety systems such as battery management systems (BMS) that can isolate battery packs in case of hazards. However, when a vehicle enters thermal runaway, the chemical reactions can be difficult to control (International Union of Marine Insurance [IUMI], 2025). EV fires can be self-sustaining as cathode material generates its own oxygen, increasing the risk of prolonged burning and re-ignition (International Union of Marine Insurance [IUMI], 2025).

Where the risk is concentrating

Fire incidents across shipping are rising. In 2024, a total of 250 fire incidents were reported, the highest number in the past decade; seven were declared total losses. Around 30% of incidents occurred on container, cargo, or roll-on/roll-off vessels, and over the past decade fires have caused more than 100 total vessel losses (Allianz Commercial, 2025).

Current evidence suggests EVs are not necessarily more likely to ignite than internal combustion engine (ICE) vehicles, but the consequences of an EV fire can be significantly harder to manage (Gard AS, 2023). This becomes more consequential on vehicle carriers, where vehicles are loaded with minimal

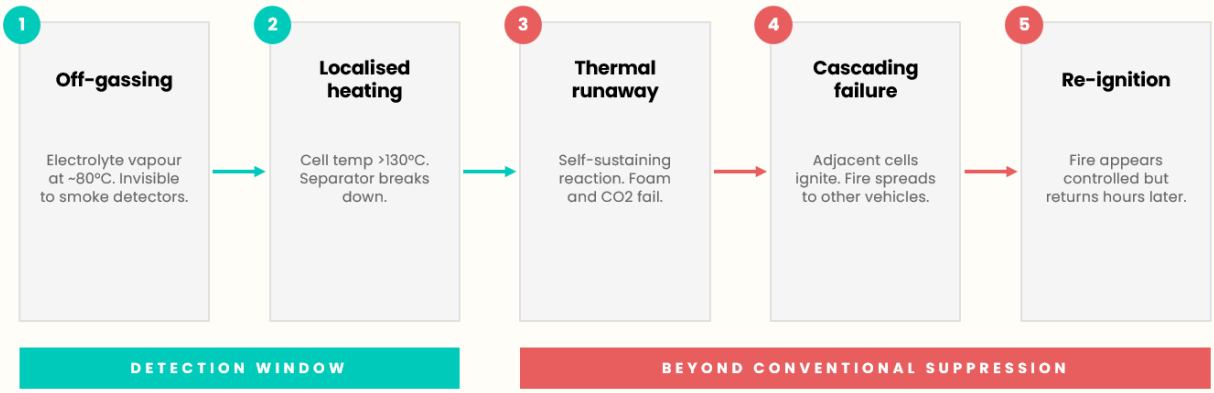
distance between them, increasing the difficulty of approaching a burning vehicle and the likelihood of adjacent cars catching fire (BIMCO & Maritime Technologies Forum, 2025).

What makes lithium-ion fires hard at sea

Lithium battery fires pose serious hazards due to their unpredictable and persistent nature. They can burn for extended periods, produce toxic gases, and re-ignite multiple times (TT Club, 2025). Suppression is particularly challenging: conventional agents such as foam or CO2 are largely ineffective, and while water can be effective, large quantities are required and its use introduces electrocution risk (TT Club, 2025).

Onboard response is constrained by visibility (smoke), heat, access, crew safety, and the presence of nearby hazardous materials, passengers, and lifesaving appliances - meaning crews must assess multiple factors under pressure, not just the fire itself (TT Club, 2025).

Thermal runaway follows a five-stage sequence with a narrow detection window



Source: TT Club (2025), Lee et al. (2024), SafetyTech Accelerator analysis.

Signals from real incidents

Recent incidents show how quickly these fires can exceed shipboard controls - and how the presence of EVs can change firefighting and salvage decisions even when the ignition source is uncertain.

Felicity Ace (2022) burned for more than 13 days and destroyed nearly 4,000 vehicles, including several electric models (CTIF, 2022). Heavy smoke reduced visibility, and the vessel's foam-based fire suppression systems did not operate as intended when the crew attempted to activate them; conditions ultimately required the crew to abandon the vessel (Maritime Safety Innovation Lab, 2025). The persistence of the fire, combined with numerous high-value vehicles and combustible materials, made containment extremely difficult and ultimately led to the vessel sinking.

A similar pattern was observed during the Morning Midas incident in June 2025, which involved hundreds of electric and hybrid vehicles. Although the fire suppression systems were deployed correctly, the crew was unable to control the fire, forcing them to abandon ship and resulting in the vessel sinking weeks later (The Maritime Executive, 2025).

Even where EVs were not conclusively the ignition source, the Fremantle Highway fire in 2023 underscores the operational complexity of managing large vehicle cargoes at sea. Despite preliminary investigations indicating the fire likely originated from an internal combustion engine vehicle, the potential involvement of nearly 500 EVs complicated firefighting and salvage operations (The Maritime Executive, 2025).

Gaps in today's controls

Guidelines and recommendations exist - including EMSA guidance, the International Union of Marine Insurance (IUMI), the UK Government's Marine Guidance Note (MGN 653 amendment 1), the Polish Registry of Shipping, and U.S. National Safety Board guidance - but the landscape is often fragmented, incomplete, or lacks legal enforceability (Klopott & Urbanyi-Popiolek, 2024). The International Maritime Organisation (IMO) is developing mandatory regulations for transportation of new energy vehicles, expected in 2027 (BIMCO & Maritime Technologies Forum, 2025).

Early detection is central to preventing catastrophic loss, yet existing shipboard detection and monitoring systems are often blind during the earliest stages of lithium battery failure (BIMCO & Maritime Technologies Forum, 2025). Retrofitting or upgrading vessels is slow and expensive, constrained by regulatory approvals, capital costs, and operational disruption.

To address these gaps, different technologies are being tested, including CCTV, infrared, gas, heat, and flame detectors, as well as explosion-proof electric devices, ventilation control, thermal imaging, and AI-enhanced systems (BIMCO & Maritime Technologies Forum, 2025; Klopott & Urbanyi-Popiolek, 2024). Despite availability, adoption can be slow due to retrofit costs, approvals, and disruption. In suppression planning, methods that help extinguish the fire can still carry risks around electrical conductivity and the potential to exacerbate thermal runaway (Lee et al., 2024).

Impact across operations, environment, and people

People: These incidents are people-intensive and high-stakes: crews face toxic gases and poor visibility, alongside uncertain and fast-changing failure dynamics that make early judgement calls hard. That raises the bar on training, clear decision triggers, and decision support that helps crews act early without overreacting or delaying escalation (TT Club, 2025).

Environment: Beyond asset loss, ship fires can create environmental harm through smoke and airborne deposition, and through contaminated fire-water and debris entering the marine environment. Evidence from lithium-ion incidents suggests impacts can extend beyond the immediate burn site, with

pollutant pathways that depend heavily on fire dynamics and how extinguishant and runoff are captured and treated (Wan et al., 2022; NFPA Fire Protection Research Foundation, 2025).

Operations: EV-related incidents can turn a single failure into a system disruption: downtime and route deviation, complex salvage and port coordination, insurance pressure, and knock-on changes to how cargo is stowed, monitored, and declared. The operational impact often comes less from the initial event than from the duration and uncertainty of managing it safely at sea (Allianz Commercial, 2025; Klopott & Urbanyi-Popiolek, 2024).

What could unlock change

No single intervention removes the risk. The most credible improvements combine faster, earlier detection, suppression and post-fire management that is designed for lithium-ion behaviour, and learning loops that help standards and operating practice catch up.

What follows is Safetytech Accelerator's point of view, informed by the evidence and incidents discussed above, and by what we have learned supporting fire detection and loss prevention in cargo fire contexts through the Cargo Fire & Loss Innovation Initiative (CFLII). It is a set of low-regret moves that improve outcomes even as guidance evolves

- **Bridge-to-2027:** With formal guidance expected in 2027, the priority now is to strengthen the human side of readiness. That means capturing what experienced responders are learning in real incidents, building shared language for decision making and escalation, and making sure crews and shore teams are prepared to act early, under uncertainty, when the signals are still ambiguous.
- **Faster, earlier detection:** The goal is not to replace ship systems wholesale. It is to enhance existing capability to address blind spots in the earliest stages of battery failure, and to buy time for isolation, cooling, and escalation before conditions deteriorate. That means aligning new sensors and monitoring approaches with real ship conditions and maintenance constraints, so earlier warning is usable in practice, not just possible in theory.
- **De-risking suppression and post-fire management:** Training and drills matter, but they do not change the operational constraints at sea. In parallel, the industry needs testing and evaluation of suppression and support technologies that can de-risk firefighting and improve the chances of containment. The aim is not to discard existing protocols, but to strengthen them with additional tools that are better suited to lithium-ion behaviour, including the risk of re-ignition and the long duration of cooling and monitoring after an initial event.
- **Tech adoption that matches ship realities:** The most elegant solution on paper will fail if it cannot survive the environment it operates in. Any retrofit or new capability needs to be designed for ship realities, including harsh conditions, constrained spaces, limited crew time, maintenance windows, training burden, and integration with existing systems. Adoptable technology is not the same as available technology.
- **The power of collaboration:** These incidents sit across a system. Manufacturers, shippers, carriers, ports, class, insurers, regulators, and technology providers all hold part of the risk. Collaboration can

de-risk innovation through shared trials and evaluation, accelerate learning through shared near-miss and incident insights, and improve safety faster than fragmented approaches.

- **Standards and regulation:** Longer-term, consistent standards and clearer regulatory expectations are needed to reduce variation in preparedness, detection capability, response planning, and reporting. Getting to that future safely depends on near-term readiness and shared learning, so that new guidance is shaped by what actually happens on ships, not just what looks good in a procedure.

Open questions and trade-offs

This is a fast-moving risk area, and some of the evidence base is uneven across vessel types, routes, and reporting practices. The goal is not to claim certainty, but to make better decisions under uncertainty.

- **Probability vs consequence:** Even if EV fire probability is comparable to ICE, consequence management demands different capabilities and training.
- **Water is the best tool - and a new hazard:** Water reduces heat, but creates electrocution risk and can challenge stability, drainage, and pollution management.
- **Standardisation vs innovation:** New detection and suppression technologies are emerging, but may outpace classification and regulatory frameworks, widening the gap between what is possible and what is deployable.

References

Allianz Commercial. (2025). *Safety and shipping review 2025* (Report). Allianz Commercial. https://commercial.allianz.com/content/dam/onemarketing/commercial/commercial/reports/commercial-safety-shipping-review-2025.pdf

BIMCO & Maritime Technologies Forum. (2025). *Safe carriage of electric vehicles at sea 2025* (Report). BIMCO. https://www.bimco.org/media/vwdp4o5f/2025-mtf-safe-carriage-of-evs-1.pdf

Climate Action Tracker. (2024). *Decarbonising light-duty vehicle road transport: Paris benchmarks for the transport sector* (Briefing). Climate Action Tracker. https://climateactiontracker.org/documents/1275/CAT_2024-10-29_Briefing_ParisBenchmarks_TransportSector.pdf

CTIF. (2022). *Burning ship carrying lithium EV cars sank outside of Azores*. CTIF. https://ctif.org/news/burning-ship-carrying-lithium-ev-cars-sank-outside-azores

Djoumessi, A., Tei, A., & Ferrari, C. (2025). The Adoption of Technological Innovations in the Maritime Industry: A Bibliometric Review. Journal of Marine Science and Engineering, 13(8), 1484. https://doi.org/10.3390/jmse13081484

Fire Protection Research Foundation. (2025, October 1). Environmental impact of lithium-ion battery incidents compared to other common incidents. National Fire Protection Association. https://www.nfpa.org/education-and-research/research/fire-protection-research-foundation/projects-and-reports/environmental-impact-of-li-ion-incidents-compared-to-other-types-of-fires

Gard AS. (2023, 8 November). *The risk of EV battery fires should not be downplayed*. Gard AS. https://gard.no/insights/the-risk-of-ev-battery-fires-should-not-be-downplayed/

International Energy Agency. (2023). *Net zero roadmap: A global pathway to keep the 1.5 °C goal in reach – 2023 update* (Report). International Energy Agency. https://iea.blob.core.windows.net/assets/9a698da4-4002-4e53-8ef3-631d8971bf84/NetZeroRoadmap_AGlobalPathwaytoKeepthe1.5CGoalinReach-2023Update.pdf

International Energy Agency. (2025). *Global EV outlook 2025* (Report). International Energy Agency. https://iea.blob.core.windows.net/assets/7ea38b60-3033-42a6-9589-71134f4229f4/GlobalEVOutlook2025.pdf

International Union of Marine Insurance (IUMI). (2025). *Safe carriage of EVs: Best practice recommendations* (Position paper). IUMI. https://iumi.com/wp-content/uploads/2025/09/250903-Safe-carriage-of-EVs-IUMI-Best-Practice-Recommendations-Review-2025-final.pdf

Klopott, M., & Urbanyi-Popiolek, I. (2024). The insurance business perspective on the risk of transporting electric vehicles by sea. *European Research Studies Journal, 27*(2), 910–928.

Lee, S., Choi, D., Jeong, Y., Moon, M., Kwon, H., Han, K., Kim, H., Im, H., Park, Y., Shin, D., & Gwak, G. (2024). Assessing fire dynamics and suppression techniques in electric vehicles at different states of charge: Implications for maritime safety. *Case Studies in Thermal Engineering, 64,* Article 105474.

Maritime Safety Innovation Lab. (2025). *Panama: Felicity Ace cargo fire and sinking, March 2022* (Report). Maritime Safety Innovation Lab. https://maritimesafetyinnovationlab.org/wp-content/uploads/2025/03/Panama-Felicity-Ace-Cargo-Fire-Sinking-March-2022.pdf

Statista. (2023). *Global EV market volume forecast*. Statista. https://www.statista.com/statistics/1359574/global-ev-market-volume-forecast/

The Maritime Executive. (2025). *Car carrier with 800 EVs is burning and abandoned mid-Pacific*. The Maritime Executive. https://maritime-executive.com/article/car-carrier-with-800-evs-is-burning-and-abandoned-mid-pacific

The Maritime Executive. (2025). *Report details confused and chaotic rescue for North Sea car carrier fire*. The Maritime Executive. https://maritime-executive.com/article/report-details-confused-and-chaotic-rescue-for-north-sea-car-carrier-fire

TT Club. (2025). *Lithium batteries whitepaper: Risks, regulations and handling practices to reduce fires and incidents across shipping and logistics* (White paper). TT Club. https://www.ttclub.com/fileadmin/uploads/tt-club/Documents/files/tt-club/corporate-literature/lithium-batteries-whitepaper.pdf

Wan, S., Yang, X., Chen, X., Qu, Z., An, C., Zhang, B., Lee, K., & Bi, H. (2022). Emerging marine pollution from container ship accidents: Risk characteristics, response strategies, and regulation advancements. Journal of Cleaner Production, 376, 134266. https://doi.org/10.1016/j.jclepro.2022.134266

Safetytech Accelerator

ABOUT US

Safetytech Accelerator is the bridge between industry and the global technology ecosystem. We help safety-critical organisations identify, test, and implement emerging technologies - from AI and industrial IoT to robotics and clean energy - that improve people's safety at work, operational performance, and environmental outcomes. Founded in 2018 as a joint initiative of Lloyd's Register and Lloyd's Register Foundation, we work where innovation matters most.

WEBSITE

safetytechaccelerator.org

ADDRESS

71 Fenchurch Street London, EC3M 4BS, UK

CONNECT

LinkedIn: Safetytech Accelerator

PUBLISHED

2026

Turning innovation into impact.

@SafetytechAccelerator