

INSURING THE ENERGY TRANSITION: Packaging Design Reduces Risk in Lithium-ion and Critical Infrastructure Claims

White Paper



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EXECUTIVE SUMMARY

As lithium-ion batteries and electrified infrastructure are deployed at unprecedented scale, insurers face a shifting risk landscape. Losses increasingly originate outside of fixed operational environments, in storage, staging, or transport, where assets rely on packaging rather than engineered facility controls.

This white paper examines packaging as a quantifiable insurance control that materially affects loss frequency, severity, and claims outcomes. It explores how containment design can reduce exposure to thermal events, improve claim defensibility through documentation, and support underwriting for high-risk assets. Drawing on insurer risk reports, battery hazard analyses, and material sustainability data, the paper concludes with actionable guidance for integrating packaging data into underwriting, claims, and sustainability reporting frameworks.

INTRODUCTION: PACKAGING AT THE INTERSECTION OF RISK AND COVERAGE

The global energy transition is reshaping not only how power is generated and stored, but also how risk is distributed across supply chains, facilities, and insurance portfolios. Lithium-ion batteries now underpin critical infrastructure across transportation, data centers, grid storage, and industrial operations. As these assets scale in size, energy density, and deployment frequency, insurers are encountering loss patterns that differ markedly from those associated with traditional equipment.

A key challenge for insurers is that many controls used to evaluate risk—site fire protection, monitoring, trained staff, and operating procedures—do not travel with the asset. During handoffs between parties, packaging becomes one of the few controls that is both consistent and observable. That makes it unusually useful from an insurance standpoint: it can be specified, tested, audited, and documented in a way that supports underwriting decisions and claims defensibility.

RISK EVALUATION CRITERIA EXAMPLES



This disconnect presents a challenge for insurers. Underwriting models may account for chemistry, system design, and site protections, while overlooking the role packaging plays in loss prevention and claims outcomes. Similarly, claims investigations frequently hinge on questions of handling, containment, and documentation, areas where packaging design and lifecycle management are decisive.

This white paper reframes packaging as an insurance-relevant control: one that can be evaluated, specified, tested, and documented. By examining packaging through the lenses of underwriting, claims prevention, and sustainability-aligned risk reporting, the paper demonstrates how engineered containment can reduce loss severity, improve claim clarity, and support insurability for high-risk energy assets. In doing so, it offers insurers and insureds a more complete framework for managing risk in the energy transition.

UNDERSTANDING THE RISK ENVIRONMENT

Before packaging can be evaluated as a loss-mitigation tool, it's essential to understand the broader risk environment in which lithium-ion batteries and critical energy infrastructure operate. These assets do not exist in isolation; they move through complex networks of manufacturers, logistics providers, storage facilities, integrators, and end users. Each transition introduces new variables that influence exposure, many of which fall outside the scope of traditional facility-based risk controls.

From an insurance perspective, this environment is defined by variability and fragmentation. Assets may pass through multiple custodians, encounter diverse environmental conditions, and be handled by personnel with differing levels of training and oversight. Unlike fixed installations, where fire suppression, monitoring, and access controls are engineered into the site, transport and interim storage environments rely heavily on procedural discipline and physical containment to manage risk.

Lithium-ion batteries further complicate this landscape due to their sensitivity to mechanical damage, thermal stress, and improper spacing. Events such as drops, compression, or exposure to elevated temperatures, can compromise internal cell integrity and create latent hazards that may manifest later. These characteristics make the upstream phases of the asset lifecycle especially relevant to insurers assessing both probability and severity of loss.

The sections below translate these conditions into insurance-relevant terms: the failure pathways that matter most (mechanical damage, heat stress, propagation), the packaging features that interrupt them, and the documentation that makes those controls legible to underwriters and claims teams.

The Nature of Lithium-Ion Hazards

Lithium-ion batteries pose particular challenges due to their potential for thermal runaway, a rapid, self-sustaining reaction in which internal heat generation exceeds heat dissipation, raising temperatures and pressures that can lead to venting, fire, explosion, and the release of flammable and toxic gases during failure events. Thermal runaway can produce combustible off-gas, heat, and pressure that create fire-spread risks and toxic byproducts that are difficult to suppress with conventional firefighting measures.

Risk experts emphasize that these hazards extend well beyond manufacturing and use phases into transport and storage environments, where protective systems are largely mobile rather than fixed, and packaging often represents the principal containment barrier during interim custody, handling, and transitional exposure.

Transport and Storage as High-Exposure Phases

The insurance sector has increasingly identified transport and storage as concentration points for lithium-ion battery loss events, especially when packaging does not provide adequate mechanical protection, spacing, or

containment. Lithium-ion cells are classified as dangerous goods precisely because they can overheat, short circuit, or ignite as a result of physical damage or environmental stress during transit if not properly packaged and protected. Inadequate packaging has been linked to increased risks of fire and explosion, particularly when batteries are stacked, vibrated, or exposed to temperature fluctuations in storage and transport environments.

Regulatory frameworks such as the U.S. Hazardous Materials Regulations (HMR) require specific packaging standards for lithium batteries in transit to help prevent incidents, underscoring the recognized link between packaging performance and safety outcomes. Storage hazards also extend beyond shipment to warehousing and staging, where insufficient physical protection can increase the potential for thermal events or spread to adjacent inventory. These patterns have implications across Property, Cargo, Construction, and Energy lines, signaling to insurers the need for controls that reduce both the probability of damage during these high-exposure phases and the impact should an event occur.

PACKAGING AS A RISK-CONTROL SYSTEM

For insurers, a risk-control system is any measure that can be evaluated and shown to reduce frequency or severity. Packaging fits that definition when it is engineered to do more than “protect”: it should manage impact energy, reduce thermal transfer, and prevent a localized failure from becoming a multi-unit event. When those functions are designed and verified, packaging becomes a performance-based control that can be incorporated into both underwriting and claims expectations.

Viewed through this lens, packaging is not simply a means of protection, but a functional extension of risk engineering. Its design determines how mechanical forces are absorbed, how thermal energy is managed, how units are isolated from one another, and how failures are contained. These factors directly influence whether an incident remains localized or escalates into a broader loss event.

For insurers, this reframing is critical. Packaging performance affects not only safety outcomes, but also underwriting confidence, claims clarity, and portfolio volatility. A system that is engineered, tested, standardized, and maintained introduces predictability into otherwise variable phases of the asset lifecycle. Conversely, ad hoc or disposable packaging introduces uncertainty that complicates both risk assessment and post-loss evaluation.

This section examines packaging as a deliberate, engineered control, one that can be evaluated alongside other loss-prevention measures. By understanding how containment design constrains exposure and limits escalation, insurers and insureds alike can better align packaging decisions with risk management and insurance objectives.

How Packaging Influences Loss Frequency and Severity

Packaging serves not merely to hold an asset in place, but to actively manage exposures throughout transport, storage, and handling. Well-engineered containment systems cushion against impact and vibration, reducing mechanical stress that can compromise internal cell structures. Mechanical shocks, such as drops, compression, and vibration, are known contributors to battery failure modes because they can initiate internal damage that accelerates heat generation and destabilizes cell chemistry without adequate structural buffering. Engineered packaging with impact-resistant materials and structural isolation helps absorb and dissipate this energy before it reaches sensitive battery internals, mitigating a known trigger for thermal incidents.

Beyond mechanical protection, packaging also plays a significant role in thermal management. Lithium-ion batteries are highly sensitive to heat accumulation and distribution; uneven temperatures within a pack can accelerate degradation, increase reaction rates, and heighten the risk of thermal runaway. Strategies such as thermal barriers, insulating materials, and compartmentalization within packaging are used to slow heat transfer and isolate cell-to-cell propagation during abnormal heating events, helping to limit the acceleration and spread of hazardous reactions.

When packaging performs effectively in both mechanical and thermal dimensions, the likelihood of a localized failure transitioning into a cascading loss event is significantly reduced. Containment systems that physically isolate components and regulate heat distribution help prevent one cell's failure from triggering adjacent cells, a critical factor in limiting both the frequency and severity of multi-unit loss scenarios in lithium-ion systems.



AmeriCase container for lithium-ion backup power, engineered for Data Center environments.

Standardization Enables Underwriting Predictability

Disposable or improvised containment adds significant variability to risk evaluations because it lacks standardized performance criteria and often isn't validated against the specific hazards posed by lithium-ion batteries and other high-energy assets. Packaging that is improvised, ad hoc, or selected solely for convenience may not account for impact resistance, lateral loading, vibration profiles, thermal gradients, or regulatory containment requirements, all of which have been linked to loss events in transport and storage. For example, informal packaging solutions can fail to mitigate mechanical shock during handling, a known contributor to internal cell damage and subsequent thermal runaway initiation in lithium-ion systems.

By contrast, engineered packaging that has been tested for specific hazards introduces structured performance data into risk evaluation. Validated designs are subjected to defined test protocols, such as mechanical shock, drop, compression, and thermal cycling, that simulate real-world stresses and demonstrate containment limits under predicted use conditions. Industry standards and regulatory frameworks (e.g., UN Model Regulations and/or 49 CFR Parts 100 - 180) outline criteria for packaging of hazardous materials, including energy-storage batteries, to ensure repeatable performance across transport and interim storage.

Because engineered packaging is developed and evaluated with respect to these recognized hazard profiles, it introduces predictability into both performance and loss outcomes. Standardization reduces variability across use cycles, supports documented inspection and maintenance, and enables insurers to assess packaging as a control rather than an uncertainty. This predictability, in turn, enables more confident underwriting across diverse risk portfolios, as carriers can incorporate packaging performance into loss models and pricing strategies with clearer boundaries around expected behavior under stress.

UNDERWRITING IMPLICATIONS

Underwriting for lithium-ion batteries and critical energy infrastructure increasingly hinges on exposures that are difficult to validate through traditional site-based assumptions. Transport routes, interim storage, and multi-party custody introduce variability that standard risk submissions do not always capture.

Packaging helps close that gap because it is one of the few controls that can be assessed consistently across those phases. When packaging is engineered, tested, and maintained, it provides evidence that exposures are being managed rather than absorbed. When it is improvised or undocumented, uncertainty increases, often translating into more restrictive terms around transit and storage.

This section outlines how packaging can be incorporated into underwriting evaluation across Property, Cargo, Construction, and Energy lines, and how packaging data can support clearer pricing and capacity decisions.

Packaging as an Underwriting Variable

Packaging can be treated as an underwriting variable when it is evaluated through a small set of repeatable criteria that connect design intent to verifiable performance. Effective packaging offers observable evidence that risk is being actively managed during transport and storage, phases that industry loss-prevention guidance identifies as concentration points for battery incidents and where containment failures can significantly amplify severity.

One key consideration is hazard alignment: whether the packaging design is specifically tailored to the risk profile of the asset being protected. Lithium-ion batteries are classified as hazardous materials under U.S. and international transport regulations, and improper packaging, handling, or storage is explicitly called out as a risk factor in regulatory safety guidance. Packaging that fails to match design to hazard class increases the likelihood of mechanical compromise, short circuits, or thermal propagation during transport and storage.



Testing history is another critical underwriting input. Engineered packaging that has been subjected to defined mechanical and environmental stress tests demonstrates performance boundaries under real-world conditions and supports more confident underwriting. Industry testing efforts such as those outlined by standards development committees emphasize repeatable, validated methodologies to assess containment integrity and hazard mitigation.

Underwriters also benefit from reviewing lifecycle documentation, including inspection, maintenance, and refurbishment records. These show whether containment performance is maintained over time or degrades through repeated use—an important factor in evaluating long-term exposure and pricing.

Finally, traceability and chain-of-custody support play a growing role in underwriting confidence. Packaging systems that enable tracking and usage histories reduce ambiguity around handling and responsibility, aligning with cargo insurance practices that require adequate packaging to validate claims.

Taken together, these factors allow packaging to be evaluated as an active risk control rather than a logistics afterthought. Incorporating packaging considerations into underwriting aligns with established risk engineering principles and provides a tangible basis for differentiated terms, pricing, and capacity decisions across Property, Cargo, Construction, and Energy portfolios.

Expanding Insurability for Complex Exposures

Certain assets, such as damaged or off-spec battery units, high-capacity battery packs, and mobile energy systems, present underwriting challenges due to elevated uncertainty and loss severity potential. These complex exposures often fall outside the comfort zone of standard underwriting models because they combine elevated energy density, variable handling histories, and non-stationary exposure periods (e.g., during transport or staging), all of which can amplify the severity of loss events. Lithium-ion batteries, for example, are classified as dangerous goods under both U.S. and international regulations due to their propensity for thermal runaway and difficulty of suppression once initiated.

Damaged or previously compromised units are particularly problematic. Batteries that have been dropped, overheated, or subjected to physical shock may have latent internal damage that is not visually detectable, yet can significantly increase the probability of failure during subsequent handling or use. Underwriters often view such latent damage as a hidden risk, because the absence of visible defects does not correlate reliably with internal integrity. This phenomenon is cited in hazard mitigation guidance from fire protection and battery safety organizations, which recommend enhanced controls for compromised units precisely because their failure dynamics are more unpredictable.

High-capacity battery packs and mobile energy systems (including grid-connected storage units and portable microgrids) heighten underwriting complexity due to their energy concentration and diverse operating environments. Insurance loss data and industry risk reports identify transport, temporary storage, and rapid redeployment as stages where containment failures are most likely to occur and most consequential when they do.

Engineered packaging that is purpose-designed, tested, and documented provides measurable controls in these scenarios. For example, packaging that demonstrates impact resistance, thermal isolation, and structural integrity under documented test standards (such as UN Model Regulations and/or 49 CFR Parts 100 - 180) gives underwriters concrete performance evidence rather than assumptions.

By introducing demonstrated containment performance into the underwriting equation, insurers can extend coverage into areas that might otherwise be restricted, rated at prohibitive levels, or excluded entirely. This enables:

- Conditional acceptance of high-risk assets with specific containment protocols required.
- Differentiated pricing based on the existence of verifiable containment controls.
- Expanded capacity where packaging performance reduces uncertainty sufficiently for carriers to pool risk.

In essence, engineered packaging turns an otherwise unquantified exposure into a manageable and measurable control, enhancing the insurability of complex lithium-ion and energy infrastructure assets without compromising underwriting integrity.

CLAIMS DEEP-DIVE: PERILS, PATTERNS, AND PACKAGING'S ROLE

To fully understand packaging's impact on insurance outcomes, it is necessary to look beyond prevention and underwriting intent and examine how lithium-ion losses are actually investigated, documented, and resolved once an incident occurs. Claims provide the clearest lens into where controls succeed, where they fail, and how seemingly upstream decisions, such as packaging selection and handling protocols, shape loss severity, causation analysis, and coverage determination.

Lithium-ion battery claims present unique challenges for insurers and adjusters. Events often involve complex failure mechanisms, delayed ignition, or partial damage that evolves over time. Establishing the sequence of events can be difficult, particularly when assets have passed through multiple custodians or environments prior to the incident. In many cases, the most consequential questions are not about the battery's chemistry or design, but about how it was protected, moved, stored, and documented leading up to the loss.

Packaging influences these determinations in two ways: it shapes the physical outcome of an incident (whether damage is localized or escalates), and it affects what evidence is available after the fact. Claims outcomes improve when both the physical control and the supporting records are designed into the system from the start.

This section examines common loss perils, recurring claim patterns, and the ways in which packaging design and lifecycle management affect both the substance and efficiency of claims resolution. By understanding packaging's role at the point of loss, insurers and insureds can better align prevention strategies with real-world claims experience.

Typical Loss Scenarios Involving Lithium-Ion Batteries

Loss events involving lithium-ion batteries often originate outside of permanent facility protections, where assets are most vulnerable to mechanical damage, environmental stress, and containment failures. During loading, transport, and interim storage, batteries rely heavily on packaging to manage risk. When that protection is insufficient, relatively minor events can escalate into significant insurance losses.

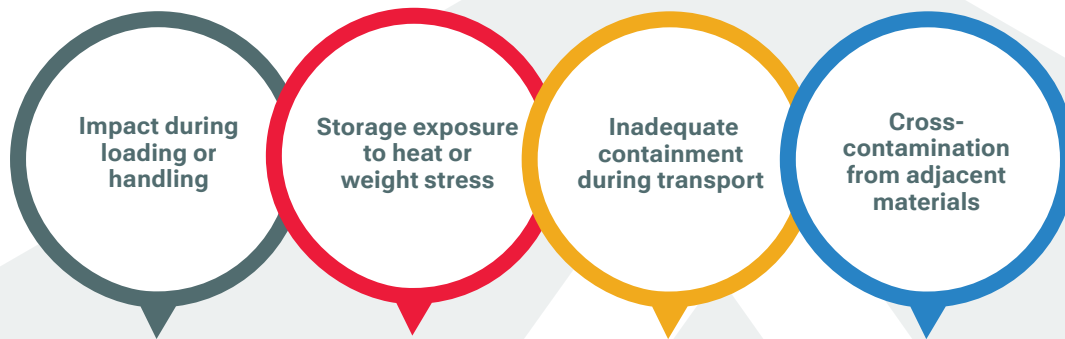
Impact during loading or handling is one of the most common initiating factors. Drops, collisions, or crushing forces from forklifts and pallet jacks can deform battery cells or damage internal separators. Research into lithium-ion failure mechanisms shows that mechanical shock can initiate latent internal short circuits, which may not manifest immediately but later trigger thermal runaway during storage or transport.

Storage exposure to heat or weight stress represents another frequent loss driver. Batteries staged in warm environments, exposed to direct sunlight, or subjected to excessive stacking loads can experience accelerated degradation or uneven heating. Fire safety authorities note that elevated temperatures and improper storage conditions significantly increase the likelihood of battery fires, particularly when spacing and ventilation are inadequate.

Inadequate containment during transport further compounds these risks. Vibration, repeated handling, and temperature fluctuations during shipment can cumulatively stress battery systems if packaging lacks sufficient shock absorption or structural support. International transport standards such as UN 38.3 exist specifically

because batteries exposed to vibration, shock, and thermal cycling without appropriate packaging have demonstrated increased failure rates in transit.

TYPICAL LOSS SCENARIOS INVOLVING LITHIUM-ION BATTERIES



Finally, cross-contamination from adjacent materials can contribute to loss events. Lithium-ion batteries transported or stored alongside conductive metals, incompatible hazardous materials, or liquids face higher risk of electrical shorting or chemical interaction. U.S. hazardous materials guidance emphasizes segregation and dedicated containment for batteries to reduce these risks, yet improper co-location remains a documented contributor to transport and storage incidents.

Across all of these scenarios, it is critical to note that thermal runaway, smoke generation, and fire do not occur solely due to intrinsic cell defects. Mechanical compromise or environmental insult frequently acts as the trigger, underscoring why packaging performance plays a central role in both loss prevention and claims outcomes, not just battery design itself.

How Packaging Performance Affects Claim Investigation

When an incident involving lithium-ion batteries or energy infrastructure occurs, claims investigations quickly move beyond the question of what failed to focus on how the asset was protected and handled leading up to the loss. For claims adjusters, packaging often becomes one of the most consequential pieces of physical evidence available, particularly when losses occur outside fixed installations.

At the outset of an investigation, adjusters typically seek to establish:

- How the asset was being protected during transport, storage, or staging.
- Whether handling and storage protocols were followed consistently across custodians.
- Whether the packaging was appropriate for the asset's hazard class, condition, and lifecycle stage.

These questions are central to determining causation, responsibility, and coverage applicability. Industry guidance on hazardous materials claims emphasizes that inadequate or non-compliant packaging can materially influence both loss outcomes and coverage determinations, particularly in cargo and property claims involving dangerous goods.

Engineered packaging systems that integrate inspection logs, unique identifiers, and documented compliance histories significantly improve the quality of evidence available to claims teams. Inspection records can demonstrate whether packaging integrity was verified prior to shipment or storage. Unique identifiers (such as serial numbers, RFID tags, or QR codes) allow adjusters to link the specific container involved in an incident to its maintenance history and prior usage. Documented compliance histories help establish whether packaging met applicable regulatory and safety expectations at the time of the loss.

This level of documentation reduces reliance on post-incident reconstruction and inference. Instead of speculating about how an asset might have been handled or protected, adjusters can reference documented performance expectations and compare them against observed damage patterns. Claims and cargo insurance guidance consistently note that clear evidence of adequate packaging and handling is a key factor in accelerating claim resolution and reducing disputes over causation or negligence.

From a severity standpoint, packaging performance can also influence how broadly damage is attributed. When engineered containment demonstrably limits propagation or isolates failure, claims are more likely to remain confined to the original asset rather than extending to adjacent property or inventory. This distinction is critical in multi-line losses, where packaging performance may determine whether a claim is treated as a contained cargo loss or escalates into a broader property or liability event.

In this way, packaging does not merely affect loss prevention, it directly shapes the efficiency, clarity, and outcome of the claims process itself, reinforcing its role as an insurance-relevant control rather than a logistical afterthought.

Loss Severity and Secondary Damage

In lithium-ion battery incidents, loss severity is rarely determined solely by the initial failure. Instead, it is driven by whether that failure is contained or allowed to propagate beyond the original asset. Without engineered containment, localized events can escalate rapidly, transforming a single damaged battery or module into a multi-line insurance loss.

One of the most significant escalation mechanisms is thermal runaway propagation. When a cell enters thermal runaway, it can release intense heat, flammable gases, and burning debris. If adjacent cells or battery units are not adequately isolated, this heat transfer can trigger secondary failures, resulting in cascading ignition across multiple units. Fire protection authorities note that lithium-ion battery fires are particularly prone to propagation when spacing, barriers, or containment measures are insufficient.

Beyond direct ignition, gas release and smoke migration contribute to secondary damage. Venting gases can spread heat and toxic byproducts into surrounding storage areas, vehicles, or buildings, damaging nearby equipment and increasing cleanup complexity. Insurers have identified smoke contamination and corrosive residue as frequent drivers of property damage and business interruption claims following lithium-ion incidents, even when flames are limited to a small area.

When escalation occurs, claims often extend beyond the original asset to involve:

- Property damage, including structural impact, smoke infiltration, and equipment contamination.
- Business interruption, driven by facility shutdowns, evacuation, or regulatory intervention.

- Environmental cleanup and disposal, particularly when hazardous residues or fire-suppression runoff must be managed.

These secondary impacts can far exceed the value of the initiating asset, significantly increasing claim severity and complicating coverage allocation across policies.

Engineered packaging plays a critical role in limiting this escalation. Containment systems designed to isolate units, manage heat transfer, and control venting can prevent a single failure from spreading to adjacent assets. By constraining propagation pathways, packaging helps keep losses localized and more predictable, often the difference between a contained cargo or equipment claim and a complex, multi-coverage loss scenario.

From a claims perspective, packaging that demonstrably limits propagation supports more favorable severity outcomes, clearer attribution of damage, and more efficient resolution. In this way, containment design directly influences not just whether a loss occurs, but how far it spreads and how costly it ultimately becomes.

Documentation and Traceability as Mitigation Tools

In lithium-ion battery and critical infrastructure claims, documentation is often as important as physical evidence. When incidents occur during transport, staging, or storage, claims teams must reconstruct how an asset was handled across multiple custodians, environments, and timeframes. In the absence of reliable records, investigations rely heavily on inference, increasing uncertainty around causation, responsibility, and coverage applicability.

Packaging systems that incorporate tracking technologies, such as RFID tags, QR codes, or serialized identifiers, play a critical role in addressing this challenge. These technologies enable containers to be uniquely identified and linked to inspection records, maintenance histories, and usage cycles. Supply-chain standards organizations note that RFID and digital identification tools significantly improve traceability by creating persistent, verifiable records of asset movement and handling events across complex logistics chains.

Structured inspection and maintenance histories further strengthen this evidentiary trail. Documented pre-use inspections, periodic condition checks, and refurbishment records help establish whether packaging integrity was verified prior to shipment or storage. From a claims perspective, these records provide objective evidence that protective measures were in place and functioning as intended, rather than relying on post-loss testimony or assumptions. Regulatory guidance on hazardous materials transport emphasizes documentation and recordkeeping as essential components of safe handling and compliance, particularly for lithium-ion batteries.

Traceability also supports chain-of-custody clarity, which is especially important in cargo and multi-party logistics claims. Cargo insurance guidance consistently highlights adequate packaging and documented handling as key factors in determining liability and coverage, noting that unclear custody or undocumented handling can complicate or delay claims resolution.

By linking physical containment with digital records, traceable packaging systems help bridge the gap between how risk is managed in practice and how it is evaluated by insurers. For underwriters, this transparency supports confidence in risk controls. For claims teams, it accelerates investigation, reduces disputes, and improves the consistency of outcomes. In this way, documentation and traceability are not administrative afterthoughts, they are active mitigation tools that directly influence insurance performance.

PACKAGING DATA IN SUSTAINABILITY AND RISK REPORTING

As organizations expand their focus on sustainability, resilience, and governance, data transparency has become a central expectation, not only for regulators and investors, but also for insurers evaluating long-term risk. Sustainability and enterprise risk reporting increasingly require organizations to demonstrate how risks are identified, controlled, and monitored across the full lifecycle of high-impact assets. For lithium-ion batteries and critical energy infrastructure, this expectation extends beyond fixed installations into transport, storage, and transitional phases that have historically been underreported.

Packaging data offers a practical and often underutilized input into this reporting landscape. Engineered containment systems generate measurable information: inspection records, reuse cycles, maintenance histories, incident data, and chain-of-custody documentation. When captured and structured, this data provides tangible evidence of how organizations manage safety, environmental exposure, and operational discipline in high-risk contexts.

From a sustainability perspective, packaging data supports multiple dimensions. It can demonstrate reductions in waste through reuse, improved safety outcomes through engineered controls, and stronger governance through documented compliance and accountability. From a risk management standpoint, it aligns operational practices with insurance expectations, helping organizations substantiate claims of loss prevention and resilience rather than relying on qualitative assurances.

This section explores how packaging-related data can be integrated into ESG disclosures and enterprise risk frameworks, transforming containment from a logistical detail into a reportable, auditable control that strengthens both sustainability narratives and financial risk positioning.

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Packaging Performance as a Governance Signal

Within ESG frameworks, the governance aspect increasingly extends beyond board composition and policies to include how organizations identify, monitor, and control operational risk. Regulators, investors, and insurers are placing greater emphasis on whether companies can demonstrate active oversight of physical risks, particularly those associated with high-impact assets such as lithium-ion batteries and critical energy infrastructure. Governance is no longer assessed solely on stated intent or policy commitments, but on the presence of measurable controls and documented performance.

Packaging performance metrics provide a tangible governance signal in this context. Data such as inspection outcomes, reuse cycles, maintenance and refurbishment records, and compliance verifications offer quantifiable evidence that risk controls are not only designed but actively managed over time. Risk governance frameworks emphasize that effective oversight depends on continuous monitoring and feedback loops, particularly for risks that evolve across the asset lifecycle rather than remaining confined to fixed operations.

From a governance standpoint, packaging data demonstrates several key attributes:

- Accountability, by clearly assigning responsibility for inspection, maintenance, and handling.
- Consistency, by showing that controls are applied systematically rather than ad hoc.
- Oversight, by enabling management and risk committees to review performance trends and exceptions.

International guidance on responsible business conduct and supply-chain governance highlights the importance of traceability and documentation in demonstrating that risk controls are implemented in practice, not merely articulated in policy.

For insurers and stakeholders evaluating ESG disclosures, this level of operational transparency strengthens confidence in governance quality. Packaging performance metrics move governance discussions from intent to execution, providing auditable evidence that organizations are actively managing exposure in high-risk environments. In doing so, they position packaging not as a logistical detail, but as a visible indicator of risk governance maturity.

Sustainability and Material Efficiency

Reusable packaging constructed from durable, recyclable materials supports sustainability objectives while simultaneously reinforcing risk control. Unlike disposable or short-life packaging, reusable systems are designed for extended service, allowing their environmental footprint to be amortized across many use cycles. This combination of longevity and material recoverability aligns closely with both sustainability expectations and circular economy principles.

Aluminum is a frequently used material in engineered reusable packaging because of its strength-to-weight ratio, corrosion resistance, and recyclability. From a sustainability perspective, aluminum offers a distinct advantage: it is infinitely recyclable without degradation of material properties. Industry data shows that recycling aluminum saves up to 95% of the energy required for primary aluminum production, largely because it avoids the energy-intensive processes of bauxite mining, alumina refining, and electrolytic smelting.

This energy efficiency translates directly into lower greenhouse gas emissions over the material lifecycle, making recycled aluminum a strong contributor to emissions reduction goals. The International Aluminum Institute notes that more than 75% of all aluminum ever produced is still in use today, underscoring its suitability for long-term, circular applications.

From a packaging performance standpoint, material durability also supports consistent containment over long reuse cycles. Reusable aluminum enclosures maintain structural integrity through repeated handling, inspection, refurbishment, and redeployment, reducing the need for replacement and minimizing waste generation. This durability reinforces safety outcomes by ensuring that protective performance does not degrade prematurely, a factor that is particularly important for high-risk assets such as lithium-ion batteries.

In sustainability initiatives reporting, these attributes allow organizations to demonstrate tangible progress across multiple dimensions: reduced material consumption, lower lifecycle emissions, waste avoidance, and sustained risk control. By integrating recyclable materials into reusable packaging systems, organizations can align environmental stewardship with operational resilience, strengthening both sustainability narratives and insurance-relevant risk management.

APPLICATIONS ACROSS ENERGY AND INFRASTRUCTURE

Across the energy and infrastructure landscape, engineered packaging is increasingly being specified not merely as a protective measure, but as a formal component of risk management frameworks. In sectors where assets

are mobile, high-value, and energy-dense, packaging has become a practical mechanism for managing exposure during the most loss-prone phases of the asset lifecycle: transport, staging, storage, and redeployment.

In grid-scale energy storage, lithium-ion battery systems are often transported as large modules or containerized units before installation. Industry risk assessments have identified transport and pre-commissioning stages as periods of heightened vulnerability, particularly when systems are staged outdoors or moved between project sites. Insurers and risk engineers increasingly recognize containment, spacing, and thermal isolation during these phases as critical controls for preventing escalation and limiting loss severity.

In electric vehicle (EV) logistics, packaging plays a similarly critical role. Batteries may be shipped new, recalled, damaged, or destined for recycling: each condition presenting a different hazard profile. Regulatory guidance and insurer loss experience emphasize that damaged or end-of-life batteries require enhanced containment and documentation due to the increased likelihood of latent defects and delayed thermal events.

For industrial backup power systems and critical infrastructure, such as data centers, hospitals, and telecom networks, packaging is increasingly tied to continuity planning. Backup energy assets are often stored for extended periods, rotated between sites, or redeployed during emergencies, conditions that expose them to mechanical stress and environmental variation. Risk guidance for critical infrastructure highlights the importance of documented controls during non-operational phases to prevent losses that could compromise resilience objectives.

Treating packaging as a controlled engineering variable makes loss outcomes more legible to insurers. Performance specifications, inspection routines, and traceability reduce ambiguity about handling conditions and limit disputes over whether protections were adequate. In practice, that can mean cleaner attribution of loss drivers, more predictable severity, and faster alignment between underwriting expectations and claims investigation.

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BEST PRACTICES FOR INSUREDS AND INSURERS

As lithium-ion batteries and energy infrastructure become more central to modern economies, the question is no longer whether these assets can be insured, but how risk can be structured, managed, and documented to support sustainable coverage over time. The preceding sections have shown that packaging design, performance, and data play a meaningful role in loss prevention, claims outcomes, and insurability. Translating those insights into consistent practice, however, requires alignment between insureds and insurers.

For insured organizations, best practices focus on treating packaging as an engineered system rather than a transactional purchase, one that is specified, maintained, and documented with the same rigor applied to other critical risk controls. This includes aligning containment design with hazard profiles, integrating inspection and traceability into operations, and ensuring that packaging data feeds into broader risk and sustainability reporting processes.

For insurers, best practices center on incorporating packaging considerations into underwriting, risk engineering, and claims workflows in a structured and repeatable way. Doing so enables clearer differentiation between risks, more confident pricing and capacity decisions, and more efficient claims resolution when incidents occur.

This section outlines practical, actionable best practices for both sides of the insurance relationship. By adopting a shared framework for evaluating and managing packaging performance, insureds and insurers can reduce uncertainty, limit loss severity, and build more resilient, insurable energy and infrastructure portfolios in an evolving risk landscape.

For Insured Organizations

For organizations that own, operate, or transport lithium-ion batteries and critical energy assets, best practices begin with treating packaging as a deliberate risk-control decision, not a downstream logistics detail. This requires aligning containment strategy with both hazard exposure and insurance expectations.

Specify packaging to match hazard class and operational context.

Packaging should be selected based on the asset's energy density, condition (new, damaged, end-of-life), and lifecycle stage (transport, storage, redeployment). Regulatory guidance for lithium batteries emphasizes that inappropriate or non-compliant packaging materially increases incident risk during handling and transit, particularly for damaged or recalled units.

Require testing and documentation of performance history.

Insureds should favor packaging systems that have been tested against relevant mechanical and environmental stressors and can provide documentation of those results. Transport safety frameworks such as UN 38.3 exist precisely to validate performance under vibration, shock, and thermal conditions representative of real-world exposure.

Track usage cycles and maintenance outcomes.

Reusable packaging introduces lifecycle risk that must be actively managed. Tracking reuse counts, inspection outcomes, and refurbishment events helps ensure that containment performance remains consistent over time. Risk governance frameworks emphasize continuous monitoring of controls, particularly for risks that evolve through repeated use rather than remaining static.

Integrate packaging data into enterprise risk records.

Packaging inspection and traceability data should feed into broader enterprise risk management (ERM) and ESG systems. Supply-chain standards bodies note that structured traceability data improves accountability, auditability, and governance across complex logistics networks.

By institutionalizing these practices, insured organizations reduce loss frequency, limit severity, and present a more transparent, insurable risk profile to carriers.

For Insurers

For insurers, best practices involve incorporating packaging considerations into existing underwriting, risk engineering, and claims frameworks, rather than treating them as exceptions or informal judgment calls.

Include packaging evaluation in underwriting guidelines.

Underwriting for lithium-ion batteries and energy infrastructure should explicitly address how assets are packaged during transport and storage. Insurer risk reports consistently identify these phases as concentration points for losses, making packaging a relevant variable in risk selection and pricing decisions.

Encourage documented inspection and chain-of-custody protocols.

Insurers can reduce uncertainty by encouraging insureds to maintain inspection logs, serialized packaging identifiers, and documented custody transfers. Cargo insurance guidance highlights adequate packaging and documentation as key determinants in both coverage applicability and claims resolution.

Align packaging expectations with claims investigation criteria.

Claims teams benefit when underwriting expectations around packaging mirror the evidence adjusters will later seek. Aligning these criteria reduces disputes over causation and negligence and accelerates resolution, particularly in multi-party logistics losses.

Use packaging performance data to refine risk scores and pricing.

Where packaging performance data is available, such as test results, reuse histories, and incident records, insurers can incorporate it into risk scoring models. This supports differentiated pricing and capacity decisions by reducing reliance on assumptions and improving predictability of loss outcomes, a core objective of modern risk engineering practice.

By formalizing these best practices, insurers move toward a more data-driven, defensible approach to underwriting and claims in high-growth energy sectors, one that rewards disciplined risk management while preserving underwriting integrity.

CONCLUSION: PACKAGING AS A STRATEGIC INSURANCE LEVER

The global energy transition is accelerating the deployment of lithium-ion batteries and critical energy infrastructure across increasingly diverse and dynamic environments. As these assets move beyond fixed facilities into transport corridors, staging areas, and temporary storage, the nature of risk changes, and so must the tools used to manage it. In this evolving landscape, packaging can no longer be viewed as a peripheral logistical concern. It has emerged as a strategic insurance lever with direct influence over loss frequency, loss severity, and insurability.

This white paper has demonstrated that many of the most consequential lithium-ion losses do not originate from intrinsic cell defects alone, but from mechanical, thermal, and handling exposures encountered outside permanent protections. In these scenarios, packaging often serves as the primary, or only, risk control in place. When containment is improvised or undocumented, uncertainty increases across underwriting, claims, and governance functions. When packaging is engineered, tested, and traceable, that uncertainty is reduced.

For insurers, incorporating packaging design and performance into risk frameworks enables more nuanced underwriting, clearer differentiation between risks, and more defensible pricing and capacity decisions. For claims teams, packaging documentation and traceability accelerate investigations, improve causation clarity, and help contain losses before they escalate into multi-line events. For insured organizations, reusable, recyclable, and well-documented packaging supports safer operations while strengthening sustainability disclosures and enterprise risk reporting.

Most importantly, engineered containment creates alignment. It bridges the gap between physical hazard management and insurance expectations by translating real-world controls into measurable, auditable data. This alignment supports safer deployment of energy technologies, clearer claim outcomes when incidents occur, and more resilient insurance portfolios over time.

As lithium-ion batteries and energy infrastructure continue to scale in both volume and importance, insurers and insureds alike must rethink where risk truly resides and how it is controlled. Treating packaging as a strategic, data-driven component of risk management is not merely an operational improvement. It is a necessary step toward insuring the energy transition with confidence, clarity, and resilience.

About Americase

Americase is a leading provider of custom-engineered protective packaging solutions for hazmat and high-value goods. With a focus on safety, compliance, and sustainability, Americase helps organizations protect their most valuable assets throughout the supply chain lifecycle.

For inquiries about custom packaging solutions or to learn more about our capabilities, contact us at www.AmericaseInternational.com.

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