

RESEARCH BRIEF

# Why Battery Energy Storage Must Be Mobile

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Environmental Resilience, True Mobility, and the Case for IP65+ BESS

An Independent Market Analysis by KhahanA Insights

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## 1. The Storage Paradox

The global battery energy storage system (BESS) market is experiencing unprecedented growth. Valued at USD 10.16 billion in 2025, the market is projected to reach USD 86.87 billion by 2034, growing at a CAGR of 26.9% (Straits Research, 2025). Latin America alone is targeting 20 GWh of installed BESS capacity by end of 2026 (Sungrow/Strategic Energy Europe, 2025).

Yet a fundamental paradox exists at the heart of this growth: the vast majority of BESS products are designed as permanent, fixed installations — bolted to concrete foundations, wired into substations, and commissioned for a single location for their entire operational life.

This design philosophy serves utility-scale grid applications well. But it ignores an expanding category of use cases where energy storage must be temporary, transportable, and resilient to harsh environmental conditions.

This research brief examines why true mobility and environmental protection (IP65 and above) are becoming critical requirements for the next generation of BESS, and identifies the application fields where these requirements are most acute.

## 2. The Mobility Gap

### 2.1 Deployment Speed

A typical fixed BESS installation requires 6–18 months from order to operation. This timeline includes site selection, environmental permitting, civil works (concrete foundations, fencing, access roads), grid connection engineering, equipment delivery, installation, commissioning, and testing.

For many applications, this timeline is simply unacceptable:

- A mining operation transitioning between phases cannot wait 12 months for power at the new site.
- A disaster relief operation needs power within days, not months.
- A construction project lasting 18 months cannot justify permanent infrastructure that outlives the project.
- A renewable energy farm experiencing curtailment today loses revenue every day it waits for permanent storage.

### 2.2 Asset Utilisation

Fixed BESS represents a single-use asset tied to one location. If the demand profile changes, the facility closes, or the project moves, the asset remains — stranded. Mobile BESS, by contrast, can be redeployed across multiple projects and locations throughout its lifecycle, fundamentally changing the asset economics from a single-project cost to a multi-project investment.

### 2.3 Civil Works Dependency

Fixed installations require concrete pads, earthworks, and permanent civil infrastructure. In remote locations (mining sites, off-grid communities, construction zones), the cost and time associated with civil works can exceed the cost of the storage system itself. A truly mobile BESS — one designed

for crane-lifting, truck transport, and drop-and-use deployment — eliminates this dependency entirely.

### 3. The Environmental Protection Gap

#### 3.1 Understanding IP Ratings

The Ingress Protection (IP) rating system, defined by IEC 60529, classifies equipment based on its resistance to solid particles (first digit, 0–6) and water (second digit, 0–9). For BESS deployed outdoors in demanding environments, the IP rating is a critical specification that directly impacts reliability, safety, and operational lifespan.

IP Rating	Dust Protection	Water Protection	Suitability for Outdoor BESS
IP54	Limited dust ingress	Splash-proof	Indoor or sheltered outdoor only
IP55	Limited dust ingress	Low-pressure water jets	Light outdoor use
IP65	Completely dust-tight	Water jets from any direction	Full outdoor deployment
IP66	Completely dust-tight	Powerful water jets	Harsh outdoor / coastal
IP67	Completely dust-tight	Temporary immersion (1m/30min)	Marine / flood-prone areas
IP68	Completely dust-tight	Continuous submersion	Subsea / extreme flooding

Source: IEC 60529, compiled by KhahanA Insights

#### 3.2 The Industry Reality

The majority of commercially available containerised BESS products are rated IP54 or IP55. This level of protection is adequate for controlled environments — substations, warehouse facilities, or sheltered outdoor installations with secondary enclosures.

However, for the growing category of applications that require true outdoor deployment in uncontrolled environments, IP54/55 is insufficient:

- Port environments: Salt spray, humidity, and direct water exposure demand IP65 minimum. Quayside installations face constant salt-laden air that corrodes IP54 enclosures within months.
- Mining sites: Fine mineral dust (copper, lithium, iron ore) penetrates IP54 enclosures, blocking cooling channels and causing thermal failures. IP65+ dust-tight construction is essential.
- Tropical regions: Humidity levels of 80–95% RH (Amazon basin, Southeast Asia, West Africa) cause condensation and corrosion inside IP54 enclosures. IP65+ sealed construction prevents moisture ingress.
- Disaster/flood zones: IP54 provides zero protection against flooding. IP67-rated battery modules can survive temporary immersion (1 metre, 30 minutes), maintaining functionality in flood conditions.
- Coastal and marine environments: Salt spray accelerates corrosion of standard steel enclosures. Marine-grade construction with IP65+ rating and corrosion-resistant materials extends operational life by 3–5x.

### 3.3 The Cost of Getting It Wrong

Deploying an under-rated BESS in a harsh environment does not simply reduce performance — it creates cascading failures:

- Dust ingress blocks cooling pathways, leading to thermal runaway risk
- Moisture causes corrosion of electrical connections, leading to short circuits
- Salt spray degrades battery management system (BMS) electronics
- Warranty claims are typically denied when damage results from environmental conditions exceeding the rated IP protection

The additional cost of specifying IP65 or IP67 enclosures at the point of purchase is a fraction of the cost of a single environmental failure event, which can include equipment replacement, project downtime, and safety incidents.

## 4. Application Analysis: Where Mobile + IP65+ BESS Is Critical

The following analysis identifies ten application fields where the combination of true mobility (transportable, redeployable, zero civil works) and high environmental protection (IP65 or above) is either essential or provides significant operational advantage.

Application	Mobility Need	Environmental Challenge	Minimum IP Rating	Market Readiness
Ports & Shore Power (OPS)	HIGH — different berths, seasonal demand	Salt spray, humidity, water exposure	IP65 (enclosure) / IP67 (modules)	Accelerating — IMO regulations driving adoption
Mining & Resource Extraction	HIGH — phase transitions, remote sites	Fine dust, extreme heat/cold, corrosion	IP65 minimum, IP67 preferred	Strong — diesel replacement economics compelling
Construction & Infrastructure	VERY HIGH — temporary by nature	Dust, rain, vibration	IP65	Growing — emissions regulations tightening
Disaster Relief & Emergency	CRITICAL — rapid deploy to unknown conditions	Flooding, debris, extreme weather	IP67 essential for flood resilience	Underserved — limited purpose-built solutions
EV Fleet Charging Depots	MEDIUM — depot scaling, seasonal	Outdoor exposure, rain	IP65	Emerging — grid upgrade bottleneck driving demand
Renewable Energy Integration	MEDIUM-HIGH — bridge to permanent	Outdoor, often remote	IP65	Strong — curtailment losses driving urgency
Defence & Military	CRITICAL — field operations	Sand, dust, extreme temperature, water	IP67 minimum	Active procurement in multiple countries
Remote & Off-Grid Communities	HIGH — access challenges	Tropical humidity, extreme cold, flooding	IP65, IP67 for flood-prone	Growing — diesel replacement + rural electrification
Events & Festivals	VERY HIGH — temporary by nature	Outdoor, rain, mud	IP65	Niche but growing — sustainability mandates
Oil & Gas Remote Operations	HIGH — site transitions	Corrosive atmospheres, sand, humidity	IP65, ATEX zones may require higher	Emerging — ESG + flare reduction driving interest

Source: KhahanA Insights analysis based on industry standards (IEC 60529, IEC 62619, UL 9540A) and market intelligence

## 5. Key Findings

**Finding 1:** The fixed-installation paradigm that dominates the BESS market today is inadequate for a growing category of use cases where energy storage must be temporary, transportable, and environmentally resilient.

**Finding 2:** Most commercially available containerised BESS products are rated IP54 or IP55 — insufficient for uncontrolled outdoor environments including ports, mining sites, tropical regions, and disaster zones.

**Finding 3:** IP65 should be considered the minimum acceptable standard for any BESS deployed in an uncontrolled outdoor environment. IP67 is recommended for marine, coastal, flood-prone, and military applications.

**Finding 4:** The combination of true mobility (crane-liftable, zero civil works, redeployable) and high environmental protection (IP65+) represents a distinct product category that is currently underserved by the market.

**Finding 5:** At least 10 major application fields require mobile, environmentally resilient BESS — representing a significant market opportunity as BESS deployment accelerates globally.

## 6. Sources & Methodology

- Straits Research — Global BESS Market Size, Trends & Regional Analysis 2034
- MarketsandMarkets — Global BESS Market 2024–2029
- Strategic Energy Europe / Sungrow — Latin America BESS capacity forecast 2026
- IEC 60529 — Degrees of protection provided by enclosures (IP Code)
- IEC 62619/62620 — Safety requirements for secondary lithium cells in industrial applications
- UL 9540A — Test method for evaluating thermal runaway fire propagation in BESS
- IEC 62933-5-2 — Electrical energy storage systems — Safety requirements
- ACE Battery / FFD Power / BSLBATT / Large Power — Industry guides on IP ratings for BESS
- IMARC Group — Brazil Energy Storage Market 2026–2034
- ACERA (Chile) — BESS operational data and curtailment analysis 2025

*Methodology: All data points are sourced from published research reports, international standards, and official industry publications. No AI-generated statistics. Source credibility tiered as T1 (official/standards bodies) or T2 (market research firms/trade publications).*

## 7. Disclaimer

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