Building Safer Energy Systems: A Deep Dive Into the EASE Battery Energy Storage System Safety Guidelines

27 May 2025

Carolina Cruz
Junior Policy Officer

Agenda

Time Slot	Item	Speaker
10:00 – 10:05	Welcome and House Keeping	Carolina Cruz EASE Secretariat
10:05–10:15	Introduction: Key Facts and Figures on BESS Safety	Harshal Upadhye Technical Executive at the Electric Power Research Institute (EPRI)
10:15 – 10:20	Overview of the BESS Safety Best Practices Guidelines	Carolina Cruz EASE Secretariat
10:20 – 10:30	Product Safety chapter	Ralf Schimanek Global Compliance Specialist at Fluence
10:30 – 10:40	Site Safety chapter	Tiago Sousa Product Safety Manager at SAFT
10:40 – 10:50	Personnel Safety chapter	Coralie Lecoq DNV Principal Consultant and Team leader of DNV Safety advisory team in Southern Europe
10:50 – 10:55	Q&A session	Carolina Cruz EASE Secretariat

Welcome & Housekeeping

1. If not done already: **set your badge to Name, Organisation**
2. **Camera and mics are off,** but you are more than welcome to use the chat!
3. You can **ask the questions throughout the webinar in the Q&A section and/or send your comments**
4. This webinar will be **recorded and will accessible in the EASE website**

EASE Battery Energy Storage System Safety Guidelines

Harshal Upadhye
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EPRI Gulf
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May 27, 2025

EPRI ENERGY STORAGE

COLLABORATION

EPRI has worked with utilities, government agencies, and technology developers to design, deploy and test energy storage on seven continents.

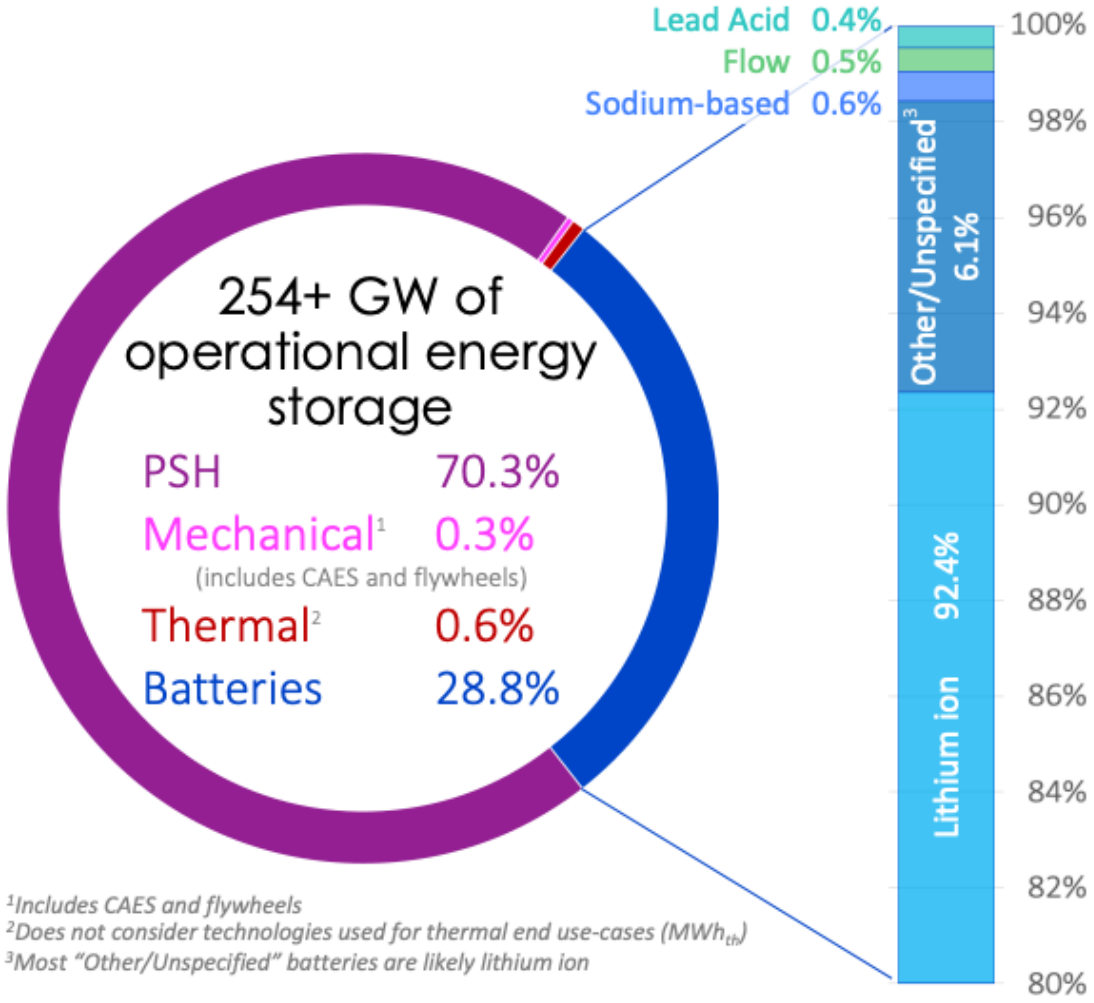
CREDIBILITY

EPRI's work is guided by our commitment to science and facts to address the challenges and opportunities of the future

EXPERIENCE AND EXPERTISE

EPRI staff come from backgrounds in technology development, lab testing, field deployment, and commercial operation, and have first-hand experience with hundreds of proposed storage technologies and products

Global Operational Energy Storage Capacity



[1]Includes CAES and flywheels
[2]Does not consider technologies used for thermal end use-cases (MWh_{th})
[3]Most "Other/Unspecified" batteries are likely lithium ion

The foregoing chart was obtained using data from 1) the Energy Storage Projects Database, a product of Wood Mackenzie, 2) the U.S. DOE Global Energy Storage Database, and 3) the 2024 World Hydropower Outlook from the International Hydropower Association.

- As of October 21, 2024, global operational energy storage capacity is estimated to exceed 254 GW.
  - Pumped storage hydropower (PSH) accounts for 70.3% of global operational energy storage capacity. PSH grew by 6.5 GW from 2022 to 2023, totaling 179 GW in 2023.
  - Batteries make up 28.8% of global operational energy storage capacity. This suggests a 76% year-over-year growth in operational BESS.
  - Lithium ion batteries account for more than 90% of installed BESS capacity.
  - Operational capacity for flow and sodium-based battery chemistries grew by 25% and 20%, respectively.

Europe: Key Energy Storage Markets

United Kingdom

- 2.5 GW of ESS deployments planned in 2024
- Largest ancillary service market in Europe, quickly saturating
- 176 GW of solar, wind and storage in the interconnection queue
- De-rating factor reform lowering capacity value of short duration storage

Germany

- 450,000 residential energy storage systems installed in H1 2023 equivalent to 2.77 GW and a 444% increase over H1 2022
- "Grid Booster / Netzbooster" 450 MW of transmission connected ESS by 2026
- Ancillary services market dominated by traditional plants, ESS targeting secondary frequency regulation market (aFRR).

Italy

- Transmission system operator (TSO) Terna calls for 94 GWh of ESS for RE integration
- 1.95 GW of operational of capacity planned to be installed in 2024
- Second largest residential ESS market
- 700 MW of fast reserve ESS projects coming online in 2024-2025
- 8+ hour duration storage tender organized by Terna

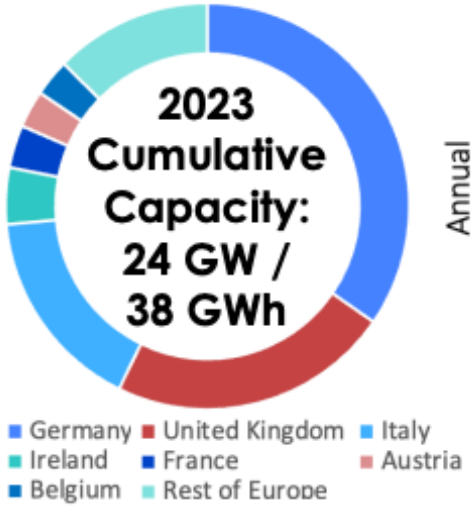
Europe: Annual Additions in BESS Capacity

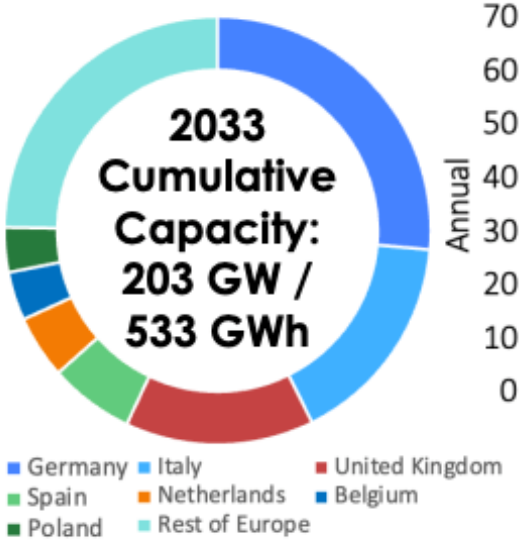
GROWING MARKET

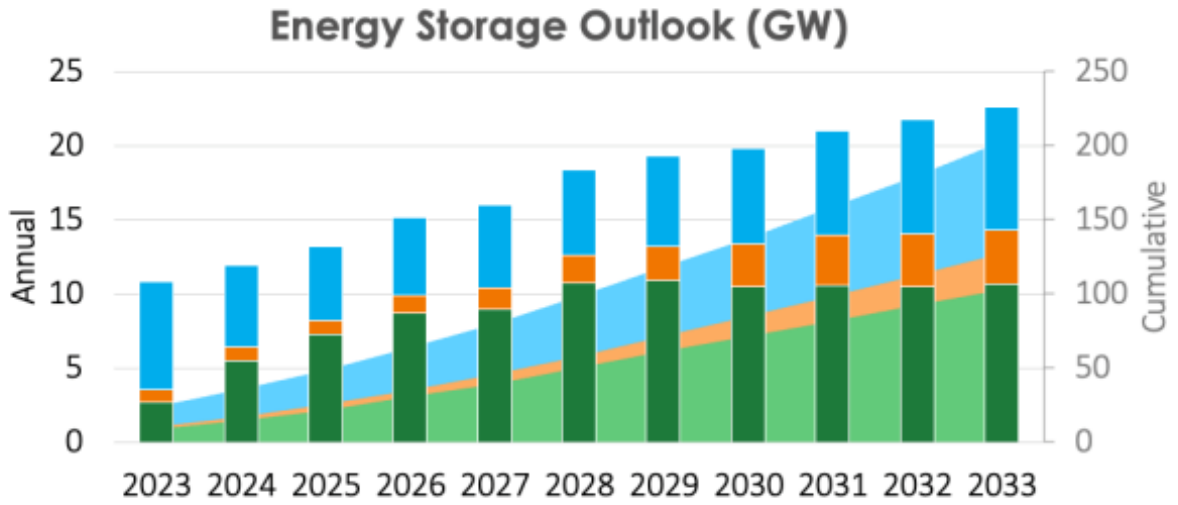
- 4.7 GW of new ESS capacity planned in 2024, projected to reach 6 GW in 2026.
- Cumulative energy storage capacity to reach 203 GW / 533 GWh by 2033 (versus 212 GW / 792 GWh in the US) according to Wood Mackenzie Global Market Outlook.

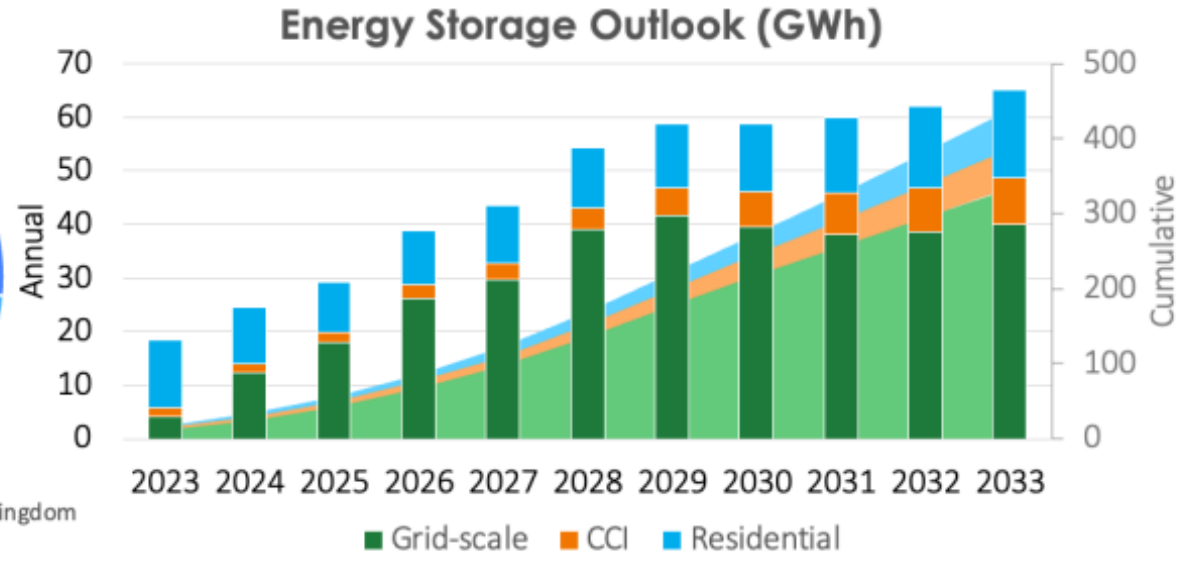
DRIVERS

- Energy storage targets in Spain (22 GW), UK (21 GW), Italy (9 GW), Netherlands (9 GW).
- New capacity markets in Italy and attractive merchant revenues in Germany and Sweden.
- Price volatility creates new arbitrage opportunity.
- Saturating ancillary service markets have prompted investors to target energy trading, firming and ramp control as the primary application









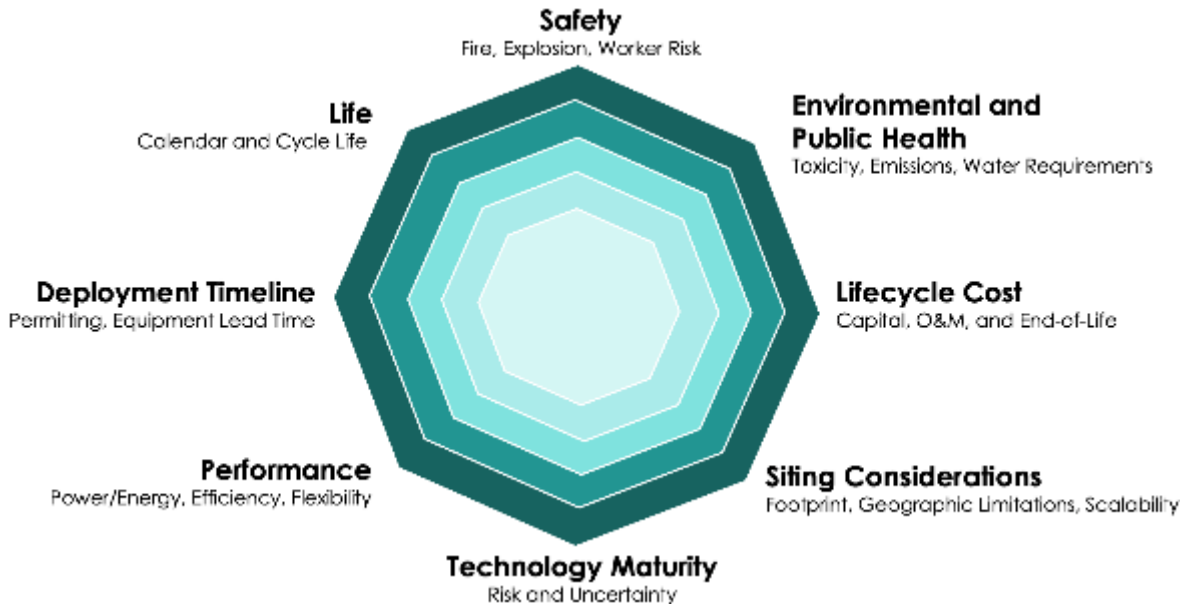
The foregoing chart was obtained using data from the Global Energy Storage Market Outlook Update: Q2 2024, a product of Wood Mackenzie.

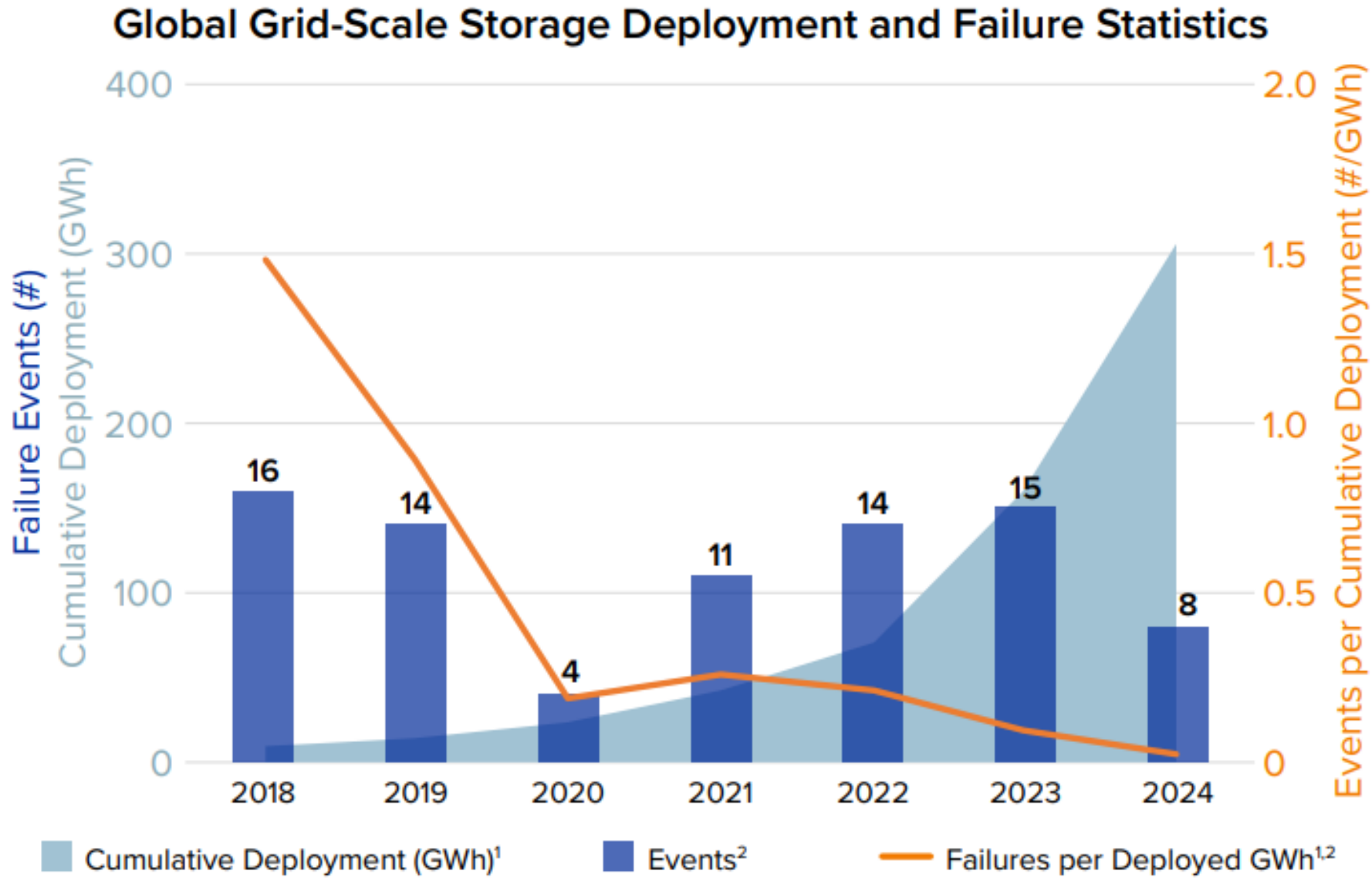
Lithium Ion Battery Energy Storage System (BESS) Technology Attributes

Reported Attributes

Safety	- Requires thermal runaway, fire, and explosion protection/prevention/mitigation
Environmental and Public Health	- Potential safety risks · More research required
Life Cycle Cost	+ Falling costs due to growing demand · Community engagement and outreach impacts · Reliable estimates of end-of-life costs and value needed
Siting Considerations	+ Flexible configurations · Health and safety impacts could limit site location
Technology Maturity	+ Widely deployed in multiple markets
Performance	+ High power and energy densities + High AC to AC efficiencies (80% - 90%+) + Small daily self-discharge rates
Deployment Timeline	+ Fast deployment possible · Dependent on applicable codes, project requirements, and equipment procurement
Life	- Affected by ambient conditions, # of cycles, depth of discharge, and shelf life (~3.5k - 10k cycle; 20 yr w/ augmentation)

Key Storage Technology Attributes for Project Evaluation





Between 2018-2024, 98% reduction in global failure rate

Source (1) Wood Mackenzie, Global Energy Storage Outlook, Data as of 12/31/24, (2) EPRI Failure Incident Database

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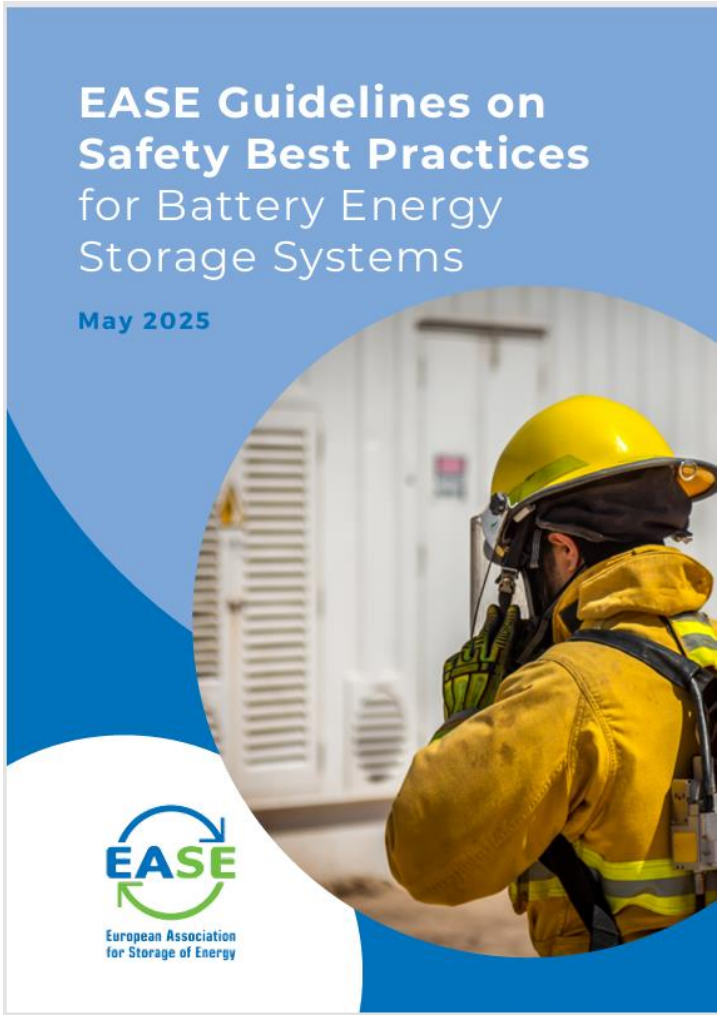
The Guidelines

Developed in collaboration with **EASE Members**, **national energy storage associations**, and **certification bodies**, the Guidelines address best practices for improving safety in outdoor, utility-scale lithium-ion Battery Energy Storage System (BESS) installations.

Covers key safety considerations across the BESS lifecycle:

- **Product Safety** – cell and system design, thermal runaway, fire protection
- **Site Safety** – system integration, site layout, ventilation, emergency access
- **Personnel Safety** – training, emergency response plans, personal protective equipment (PPE)



The Guidelines

Chapter rundown

Product

- Battery design
- Battery Management System
- Thermal Management System
- Enclosure design
- Fire detection and alarm
- Fire alarm, fire panel
- F-STOP mechanism
- Explosion protection
- Venting
- Fire suppression battery
- Draining and wastewater
- FSS electrical/chiller
- Large scale fire testing

Site

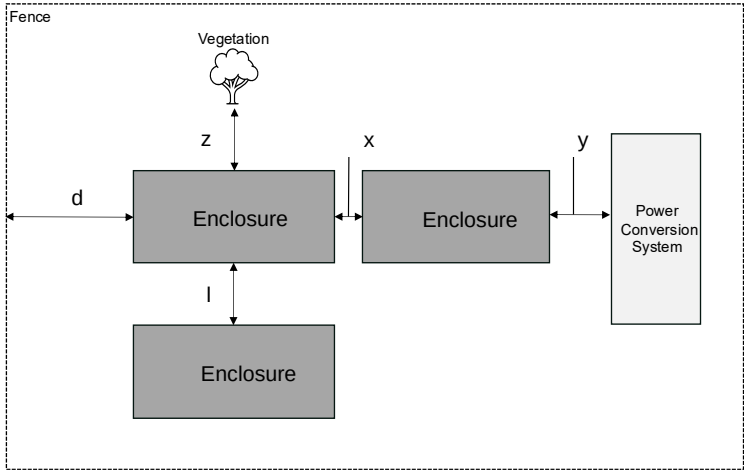
- Location requirements
- Fencing
- Water availability
- Wastewater containment
- Container spacing
- Spacing towards PCS
- Spacing towards environment
- Gas/smoke/noise emissions
- Site condition assessment

Personnel

- Personal Protective Equipment (PPE)
- Public access
- Training
- Firefighters' collaboration
- Emergency response plan
- Hazard mitigation analysis
- Control and maintenance

The Guidelines

Main recommendations



Large scale fire testing

no harmonisation at EU level, most projects refer to UL9540A testing. Battery Regulation requires a fire and propagation/protection test since 18 August 2024, but it is unclear how to demonstrate compliance to this.

Container spacing requirements

to guarantee safety, based on large scale fire test instead of different prescriptive requirements within EU.

Gas and smoke emissions

no existing standard, hard for first responders to take the right decision (security area, evacuation procedure, …).

Firefighters' collaboration

close cooperation is key to avoid injuries and fatalities. Recent incidents in Europe support this (e.g. no door opening during a fire).

Source: Northvolt presentation at ESGC 2024

The Guidelines

Link to endorse!

EASE Guidelines on Safety Best Practices for Battery Energy Storage Systems

Call for Endorsement!

European Association for Storage of Energy

Already endorsed by over 40 stakeholders:

PIME STOWARZYSZENIE
HARMONY ENERGY POLAND
Honeywell
Ukrhydroenergo
atee ASSOCIATION TECHNIQUE ENERGIE ENVIRONNEMENT
EDF
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SBaA SLOVENSKÁ BATÉRIOVÁ ALIANCIA
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ECGA European Advanced Carbon and Graphite Materials Association
POLSKIE STOWARZYSZENIE MAGAZYNOWANIA ENERGII
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Metlen Energy & Metals
VfM consultanta si servicii
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BEPA Batteries European Partnership Association
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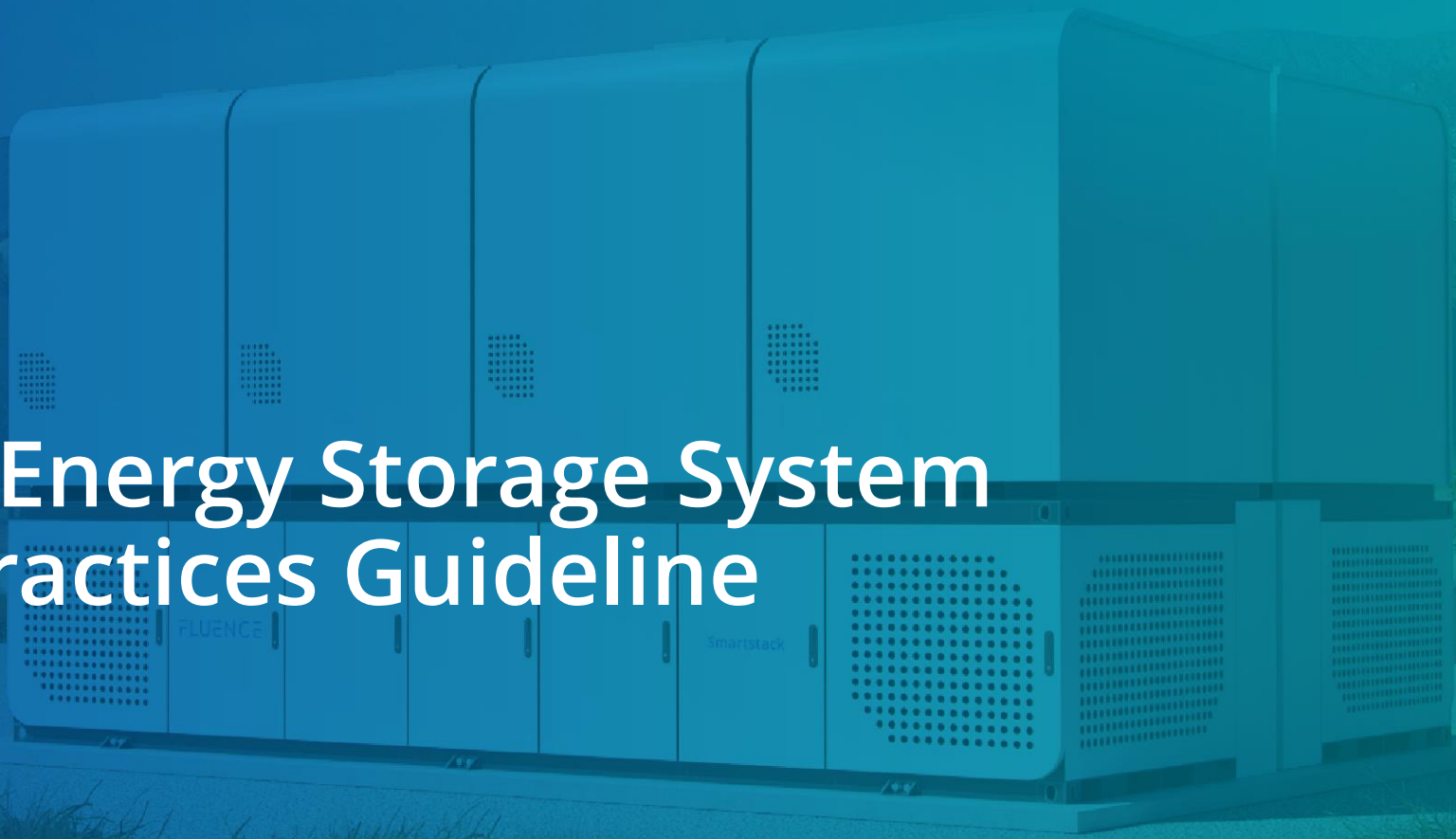


EASE WEBINAR

EASE Battery Energy Storage System Safety Best Practices Guideline Webinar

Ralf Schimanek

Compliance Specialist & Fire Safety Expert

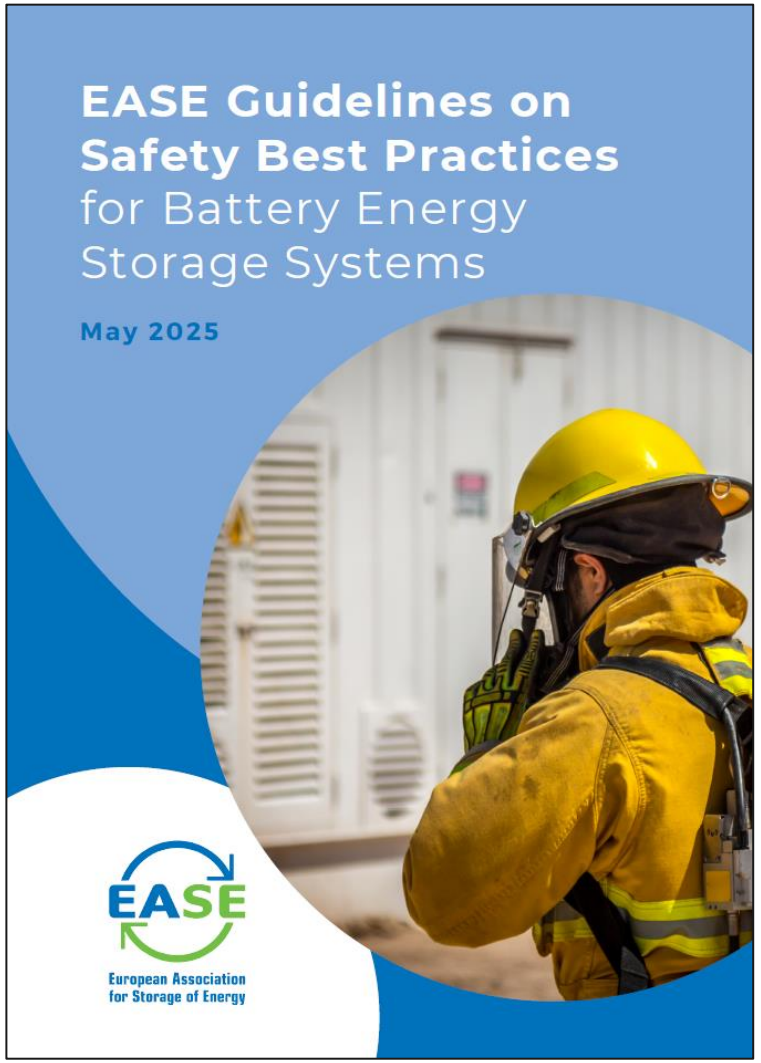
FLUENCE®
A Siemens and AES Company

FACTS/BACKGROUND

- Working on BESS Product Safety & Certification since 2018
- Experience within UL / IEC standard for BESS
- Panel member of UL9540/A / EASE and BVES
- Passionate about Product Compliance Requirements & Product Safety

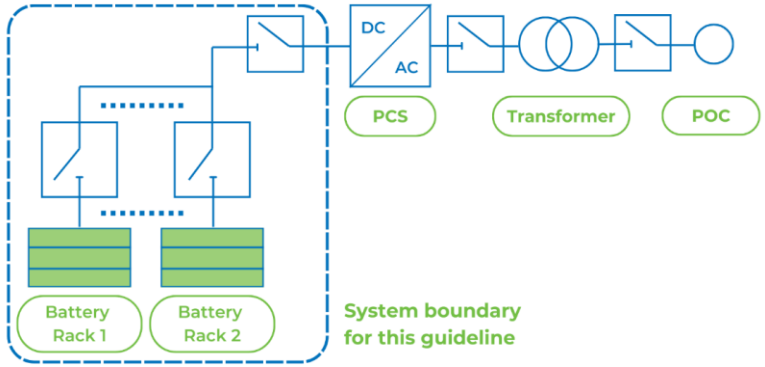
Why is the EASE guideline so good?

- “The” Guideline for the target audience - developers, manufacturers, service providers, and wider stakeholder groups
- In-depth walkthrough of safety requirements for outdoor utility scale lithium-ion BESS, which is a differentiator to other Guidelines and white papers
- Combines the consensus of the EASE Council contributors
- Peer reviewed by CEN-CENELEC



What is the scope of the Product Safety part

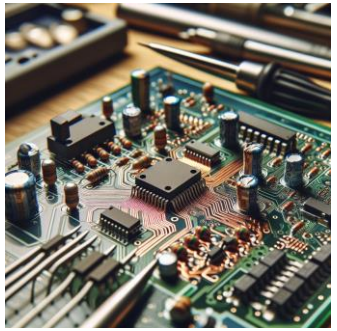
- Battery Design
- Battery Management System
- Thermal Management System
- BESS Enclosure Design
- Hazard Mitigation Analysis
- Fire Detection and Alarm
- F-Stop Mechanism and Other Shut-Down Mechanisms
- Explosion Control
- Fire Safety Strategy
- Large Scale Fire Testing



Details of the Product Safety parts

- Battery Design
  - BESS to comply with Battery Regulation (EU) 2023/1542)
  - Relevant Standards: IEC 62933-5-1/2; 62485-5; IEC 62619; 63056; UL 9540/A; 1973
  - EASE Recommendation:
    - International harmonization of standards

- Battery Management System
  - Functional safety and real-time monitoring
  - EASE Recommendation:
    - Compatibility with other system components
    - Advanced diagnostic and predictive maintenance tools



What is the scope of the Product Safety part

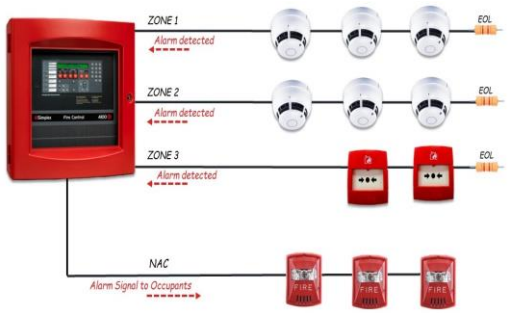
- Thermal Management System
  - Cooling methods: Liquid cooling and air cooling
  - EASE recommendation:
    - Leakage alarms/warnings of the thermal management system
    - Thorough Risk assessment and certification

- BESS Enclosure Design
  - Protection against environmental factors
  - Compliance with IEC 60529 and other relevant standard
  - EASE recommendation:
    - IP54 or higher; Evaluate site-specific risk analysis for environmental and operation factors

What is the scope of the Product Safety part

- Hazard Mitigation Analysis
  - BESS specific Risk identification, analysis, and mitigation
  - EASE recommendation:
    - HMA according to IEC 62933-5 or NFPA 855

- Fire Detection and Alarm
  - Essential for early warning of failures
  - EASE recommendation:
    - Automatic fire detection system
    - Integrate fire detection with the BMS



What is the scope of the Product Safety part

- F-Stop Mechanism and Other Shut-Down Mechanisms
  - Isolate the system in case of failure
  - EASE recommendation:
    - F-Stop shall not interfere the operational functionality of the BMS
    - F-Stop as part of the functional safety assessment

- Explosion Control
  - Explosion protection and Explosion prevention
  - EASE recommendation:
    - Compliance with NFPA 68 and NFPA 69
    - Prioritise real-world testing and risk assessment

What is the scope of the Product Safety part

- Fire Safety Strategy – Battery fires
  - Strategy for Battery fires:
    - Controlled burning (evidenced by UL9540A and NFPA855 LSFT report)
    - Water injection (evidenced by report)
  - EASE recommendation:
    - Compliance with UL 9540A and NFPA 855 (Large Scale Fire Testing)
    - Provide evidence of effectiveness and reliability of the method

- Fire Safety Strategy – non-Battery fires
  - Strategy for non-Battery fires:
    - Suppression systems such as Clean agents, Aerosols
  - EASE recommendation:
    - Methods mentioned in NFPA 855

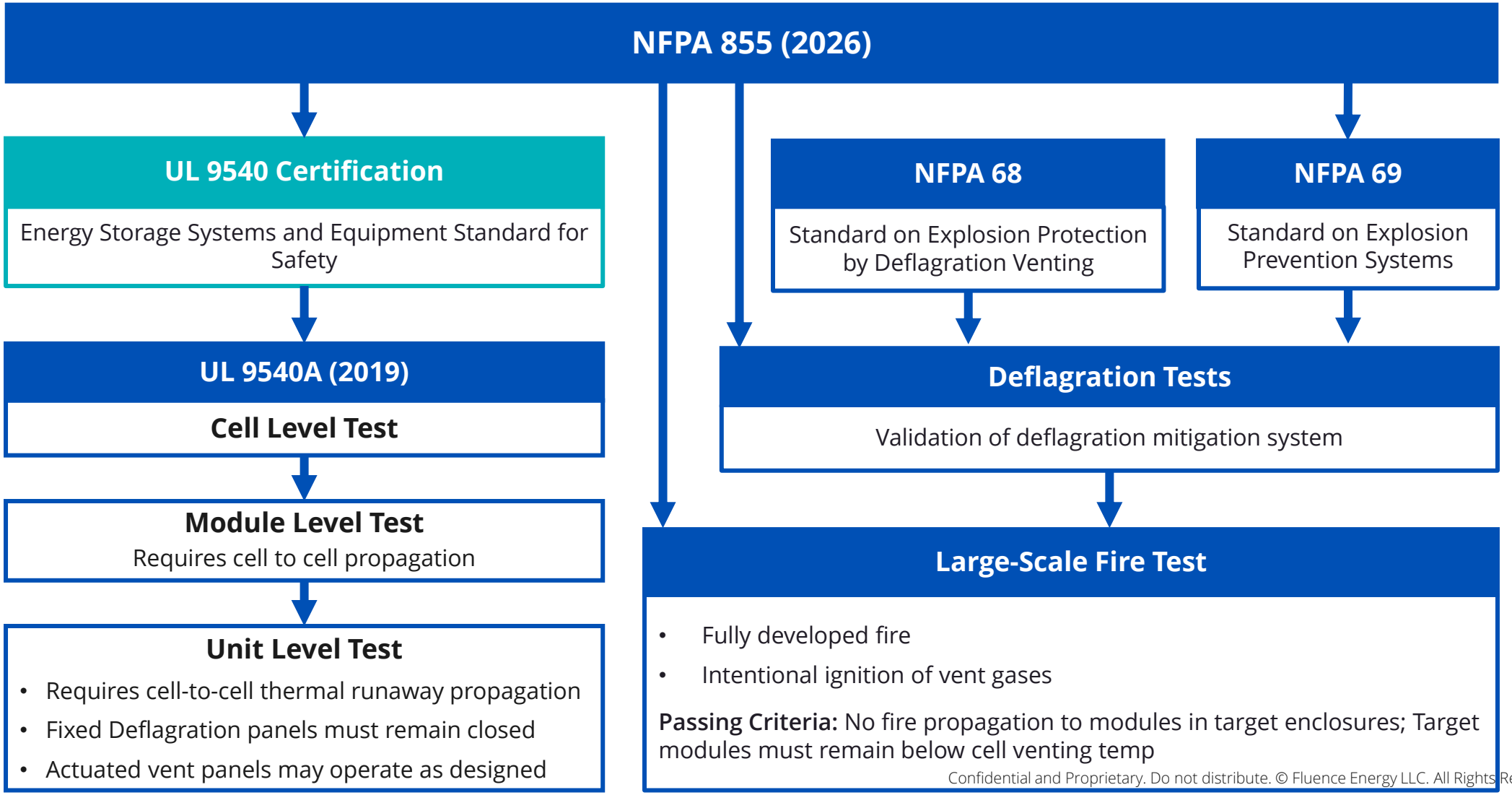
What is the scope of the Product Safety part

- Large Scale Fire Testing
  - Large scale fire test
    - Evidences no-BESS-to-BESS propagation
    - Validates required spacing
  - EASE recommendation:
    - Provide evidence of adherence to NFPA 855 Large Scale Fire Testing
    - Confirm no-BESS-to-BESS propagation

Leaders in the Industry

NFPA 855 is the only comprehensive safety standard globally

as of April 2025



Top of the industry guideline – here is why

1. **Comprehensive Coverage:**
   Guideline covers all critical aspects of BESS safety

2. **Regulatory Alignment:**
   Aligns with the latest EU regulations and international standards

3. **Risk-Based Approach:**
   Emphasizes a risk-based approach to safety

4. **Flexibility and Adaptability:**
   Allows for flexible safety strategies that can be adapted to different BESS designs and architectures

5. **Collaboration and Expertise:**
   Developed by the EASE Task Force, with contributions from leading experts and organizations

6. **Focus on Continuous Improvement:**
   Intended to be a living resource, subject to updates as new developments emerge

These factors make the EASE guidelines a **benchmark for safety** in the rapidly growing field of battery energy storage systems, supporting the safe and reliable deployment of BESS across Europe and beyond.

Questions

Site Safety

27/05/2025

EASE Battery Energy Storage System
Safety Guidelines

Tiago Sousa
ESS Product Safety Manager
Saft

EASE BESS Safety Guidelines – Site Safety

Challenges and Objectives

Objectives

- Provide clear guidelines and recommendations for ESS site installation. It focuses on mitigation measures to reduce risks and ensure rapid emergency response
- Example of international standards are given, and **recommendations are proposed**

Challenges

Site safety rules are highly dependent on:

- Location of the installation.
- Local standards and safety practices.
- First responders' strategy, proximity and training.

This Guide highlights the following points:

EASE BESS Safety Guidelines – Site Safety

Main International Standards

IEC62933-5: This series focuses on safety considerations for electrical energy storage (EES) systems, particularly those integrated with the electrical grid.

Hazard Identification & Risk Assessment

1. Site-specific analysis of potential hazards (e.g., fire, explosion, toxic gas).
2. Must consider local environmental and operational conditions

Risk Mitigation Measures

1. Tailored to the specific EES technology and site layout.

Installation Environment

1. Requirements vary for indoor vs. outdoor installations.
2. Must account for temperature, humidity, seismic activity, and accessibility

EASE BESS Safety Guidelines – Site Safety

Main International Standards

NFPA 855 Standard for the Installation of Stationary Energy Storage Systems

Hazard Mitigation Analysis (HMA)

1. Required for systems exceeding certain thresholds (e.g., 600 kWh for Li-ion).
2. Must evaluate potential hazards like thermal runaway, fire, explosion, and toxic gas release.
3. Results guide the design of mitigation strategies and emergency response plans

System Spacing and Separation

1. Minimum separation distances between ESS units and from buildings or property lines.

Maximum Allowable Capacity

1. Limits on the total energy capacity allowed per fire area or building.
2. Exceeding limits may trigger additional requirements like fire barriers, suppression system

EASE BESS Safety Guidelines – Site Safety

EASE Recommendations

Location Requirements	• Conduct site assessments for environmental and safety risks. • Address proximity to communities, water runoff, and scaled regulation
Fencing	• Tailor fencing to local regulations, site characteristics, and security needs. • Integrate surveillance systems to enhance security.
Water Availability	• Ensure water resources align with fire suppression strategies. • Consult local fire authorities to determine water supply requirements.
Wastewater Containment	• Install systems to manage firefighting runoff and prevent contamination, only if water based extinguishing systems are present. Otherwise, procedures must be included in the emergency plan. • Include sealed containers for floods or fire operations.

The on-site water requirement shall be determined by the local jurisdiction. This guide provides a list of advantages and disadvantages to consider when water is used.

Please note that the fire protection strategy of "letting it burn" is widely adopted, and water management constraints are not present in such cases.

EASE BESS Safety Guidelines – Site Safety

EASE Recommendations

Enclosure Spacing	• Use risk-based analysis to determine spacing. • Address fire suppression access and system-specific characteristics
Spacing Towards the PCS	• Maintain safe distances to mitigate electrical and fire risks. • Incorporate fire barriers where necessary
Spacing Towards Environment	• Clear vegetative barriers and establish fire safety perimeters. • Engage stakeholders to ensure urban and rural safety compliance

As part of the risk assessment or hazard mitigation analysis, appropriate safety distances must be demonstrated.

- Noise analysis
- Flammable gas dispersion (toxicity , fireball, jet fire)
- Fire risk assessment (simulations, large-scale fire test)

WHEN TRUST MATTERS

Personnel Safety

Protecting personnel working with BESS

In collaboration with European Association for Storage of Energy

27th May 2025

Types of Hazards for a BESS

Electrical hazards	• Exposure to live conductor (with high voltages causing electric shock) • Exposure to arc flash
Mechanical hazards	• Exposure to sharp edges or heavy weights • Tripping or falling
Chemical hazards	• Exposure to spilling of liquid electrolyte • Exposure to emission of poisonous gas inside or outside container
Explosive hazards	• Exposure to explosive gas in combination with ignition source
Temperature hazards	• Exposure to heat • Exposure to cold
Fire hazards	• Exposure to internal fire (and potential propagation) • Exposure to external fire
Digital hazards	• Exposure to cyber attacks

Personnel safety key item n°1

Emergency response plan (ERP) / firefighting considerations

Every installation must have a site-specific ERP shared with local fire services and relevant authorities typically including items such as:

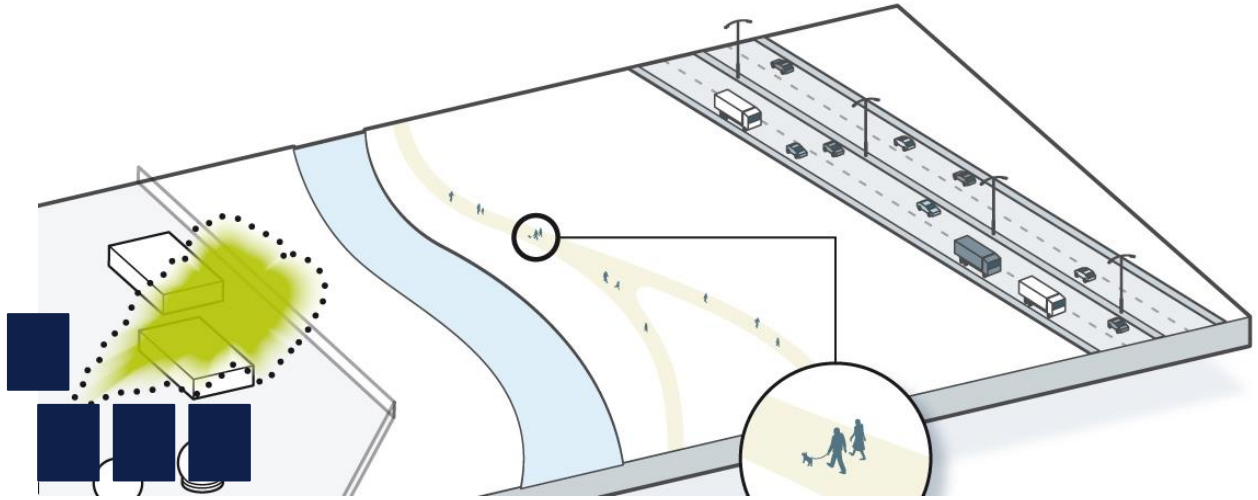
- Roles and responsibilities
- Notification and communication
- Description of the systems
- Detailed contingency measures for fire or chemical leaks

Anticipate:

Expected extent of major hazard consequences

Water contamination – Samples can be taken to test the contamination levels

Removal of equipment following a fire event – Establish specific procedures



Firefighting method

- The method of firefighting will be determined by the local fire department,
  a range of techniques was observed:
  - Water cooling of batteries on fire
  - Water cooling of adjacent batteries
  - Let it burn
  - Temperature monitoring of adjacent batteries

EASE Recommendations:

1- When a large-scale fire testing shows that the fire is confined to a single BESS unit, firefighters should adopt a defensive approach. Allowing the fire to self-extinguish reduces risks to responders.

2- When necessary, cool adjacent units or exposed assets using fog nozzles with a wide-angle cone. This approach is advisable when large-scale fire testing has not been performed or when additional cooling is required.

Personnel safety key item n°2
Training (personnel & firefighters)

EASE Recommendation
Training programmes must be based on the established emergency response strategy, which is specifically designed for people at **BESS locations**. Key features include:

1- Develop **tailored training programmes** for emergency responders and site personnel, aligned with national and regional standards (including the specific hazards on BESS sites e.g. high-voltage systems, thermal events and battery chemical hazards)

2- Ensure **firefighters and first responders receive comprehensive, role-specific instruction** for effective emergency response.

3- **Update training regularly** to reflect new battery technologies and evolving safety practices.

4- **Conduct annual refresher sessions**, including on-site exercises and tabletop drills.

Personnel safety key item n°3

Restrict public access

EASE Recommendations:

1- Perimeter security: Use 24-hour surveillance, secure fencing, and controlled entry gates, especially for BESS locations in urban areas, to effectively exclude the public and limit unauthorised access.

2- Community engagement: Local governments should conduct risk communication campaigns as part of their Seveso III compliance. These efforts should educate the public about restricted zones, safety practices, and emergency plans, raising awareness of potential hazards and access restrictions.

Personnel safety key item n°4
Control and Maintenance

- The current set of standards provide a solid foundation for maintenance practices and high-voltage safety. However, they do not address predictive maintenance or advanced monitoring systems commonly used in modern BESS installations.
- Maintenance activities should be guided by alarms or performance indicators, along with regularly scheduled tasks, **minimizing unnecessary exposure to risks**

EASE Recommendations:
1-**Implement a permit system** to ensure maintenance tasks are performed safely.

2- **Monitor BESS facilities** 24/7 using remote systems and Closed-Circuit Television (CCTV), especially in remote locations.

3- **Prohibit lone working during high-voltage maintenance** and ensure **strict adherence to safety protocols.**

Personnel safety key item n°5
Personnel Protective Equipment (PPE)

- All personnel need to be equipped to manage routine and emergency situations effectively

EASE Recommendations:
1- Establish a comprehensive PPE programme for both routine maintenance and emergency scenarios.

2- Required PPE includes helmets, gloves, arc-resistant clothing, boots, and lifting aids for handling heavy modules.

3- Tailor PPE requirements for specific risks, such as high-voltage exposure or thermal runaway events.

4- Integrate PPE systems into emergency response plans to ensure readiness.

Main takeaways

01 **Emergency Response Plan**

An essential piece to ensure personnel safety and mitigate risks during incidents

02 **Training (personnel & firefighters)**

Priority to emergency response preparedness for all staff / coordination with firefighters

03 **Public access restriction**

Unauthorised entry and reduce risks of injury or interference

04 **Control and Maintenance**

Safe operation and maintenance are vital for preventing accidents and ensuring the longevity of BESS.

05 **Personal Protection Equipment**

proper use of personal protective equipment (PPE) is crucial for safety during both maintenance and emergency situations.

Call for endorsement!

Endorse them today!

EASE Guidelines on Safety Best Practices for Battery Energy Storage Systems

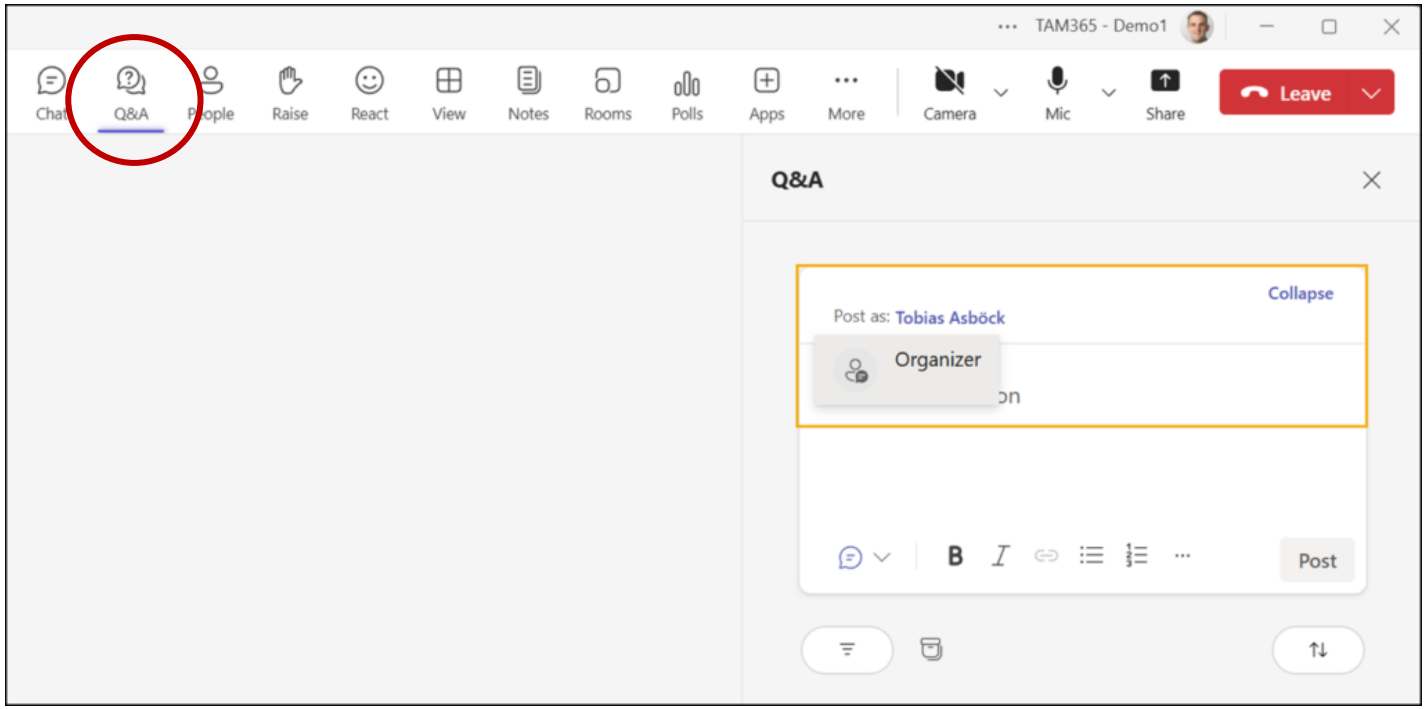
Call for Endorsement!

European Association for Storage of Energy

Already endorsed by over 40 stakeholders:

Q&A Session

Use the Teams Q&A functionality!



Talk to us.

We're ready to answer your questions.

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