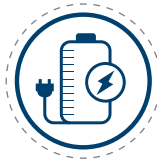


Understanding Battery Energy Storage Safety



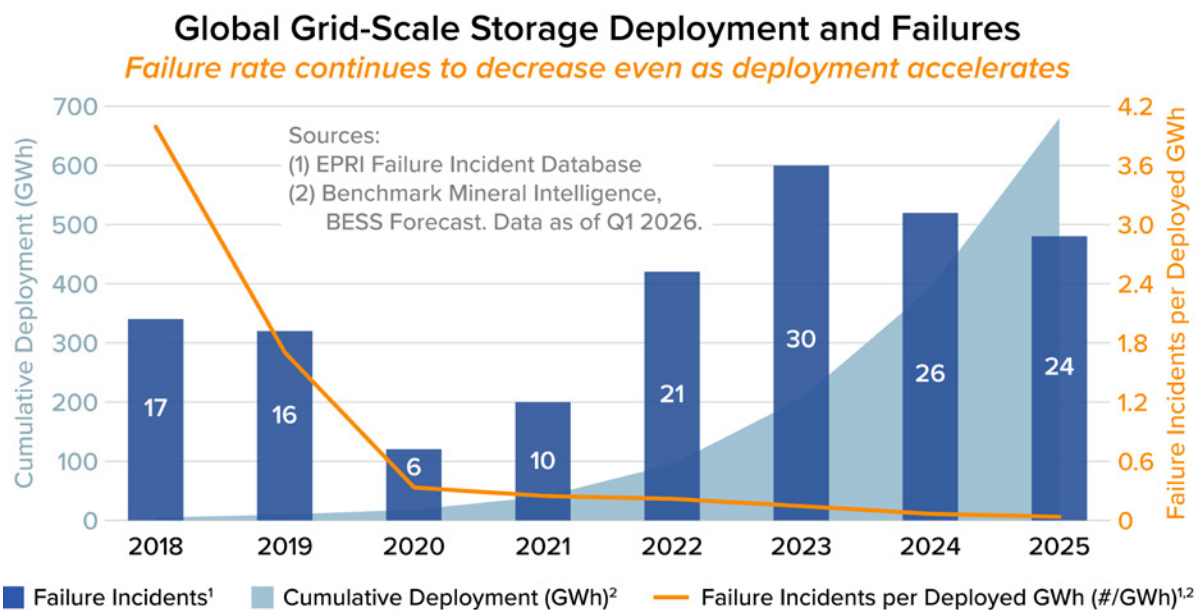
FACT SHEET

Public safety is a top priority for the state. Like all technology development and infrastructure projects, utility-scale battery energy storage facilities have potential hazards that must be identified, and addressed through careful design, siting, construction, operation, and emergency planning.

Accordingly, as the battery storage industry has grown and technology has advanced, California's safety requirements have evolved. Modern battery storage facilities incorporate multiple layers of protection intended to prevent thermal runaway or fire incidents, detect problems early and protect workers, emergency responders, and surrounding communities.

How Has Battery Storage Safety Improved?

California and the rest of the world have added large amounts of battery storage in recent years. At the same time, the rate of reported system failures has declined substantially. According to the Electric Power Research Institute (EPRI), the failure rate for utility-scale battery storage systems declined by approximately 99 percent between 2018 and 2025 as lessons learned from earlier incidents have been incorporated into newer designs and safety practices.



Source: [Battery Energy Storage System Failure Incident Database](#) | [Energy Storage Hub](#)

A failure is defined as an event that increases the safety risk in a battery storage facility. This can range from a malfunction in the battery management system to thermal runaway in a cell or module that may lead to a fire. Failures resulting in large-scale, consequential fires, such as Moss Landing or Otay Mesa, have been rare.

What Is Thermal Runaway?

A primary concern associated with lithium-ion batteries is thermal runaway. Thermal runaway occurs when a battery cell enters a self-heating reaction that causes its temperature to rapidly increase. If not contained, thermal runaway can result in fire and the release of flammable and

potentially hazardous gases. Under some circumstances, it can also spread from one battery cell or module to another.

Preventing thermal runaway and limiting its spread are priorities for battery storage facility design, testing, and safety standards.

How Are Battery Storage Risks Addressed?

Modern battery storage facilities use multiple layers of protection to prevent, detect, contain, and respond.

PREVENT: Battery storage facilities can use battery management systems, temperature controls, and other equipment to maintain batteries within appropriate operating conditions. Modern battery chemistries and system designs can also reduce the potential for thermal runaway. Equipment is tested and evaluated against established safety standards before being installed.

DETECT: Detection systems inside a battery storage compartment can continuously monitor conditions, such as temperature, voltage, and electrical current, to identify abnormal conditions. Additional measures developers can take may include thermal infrared cameras, smoke or gas detection, and other monitoring equipment intended to identify potential problems before they escalate.

CONTAIN: Newer utility-scale battery storage projects place batteries in separate outdoor containers rather than housing large quantities of batteries together inside a building. Containerization, separation between units, ventilation or pressure release systems, and other design features help reduce the potential for an incident in one battery unit to spread to others.

RESPOND: Emergency response planning is an important part of battery storage safety. Planning entails coordination and training with local fire departments, emergency response plans, remote monitoring and command centers, environmental monitoring, and systems that provide first responders with information about conditions inside battery units.

- UL 1973: Establishes safety requirements and testing for batteries used in stationary applications.
- California Fire Code: Includes state requirements governing the installation and fire safety of battery storage facilities.
- California Public Utilities Commission (CPUC) General Order 167-C: Established requirements related to the operation and maintenance of battery energy storage systems and emergency response planning.

How Does the California Energy Commission Evaluate Battery Energy Storage?

Under the California Energy Commission's (CEC's) Opt-In Certification Program, each proposed battery storage facility is evaluated individually based on the technology, design, location, and potential environmental and safety impacts of the project. The CEC may require changes to a project's design, construction, operation, or emergency response plans as conditions of project certification.

CEC staff evaluate issues that can include:

- Fire and life safety
- Battery technology and facility design
- Prevention and detection of thermal runaway
- Potential fire propagation
- Hazardous materials
- Emergency response
- Site layout and access for emergency responders
- Potential emissions and impacts to air quality and public health
- Environmental monitoring
- Site-specific hazards
- Proximity to homes, schools, and businesses
- Compliance with applicable codes and safety standards

CEC staff also work with local fire departments and other agencies to evaluate proposed fire protection and emergency response measures. Depending on the project and site, safety requirements may include measures such as thermal infrared monitoring, ventilation or deflagration systems, construction and operations fire-protection programs, command-and-control capabilities, environmental monitoring, and training and coordination with local emergency responders.

What Safety Standards Apply to Battery Storage Facilities?

Battery storage projects are subject to numerous fire, electrical, building, and safety requirements. Several standards are particularly important:

- National Fire Protection Association (NFPA) 855: Addresses the design, construction, installation, commissioning, operation, maintenance, and decommissioning of stationary energy storage systems.
- Underwriters Laboratories (UL) 9540: Provides safety requirements and certification for energy storage systems and equipment.
- UL 9540A: Provides a testing method for evaluating thermal runaway and fire propagation in battery energy storage systems.



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