What are the environmental and health risks?

Environmental and health impacts are carefully managed. During normal operation, BESS produce no emissions, and systems are designed with spill containment and ventilation to handle fault conditions. In the rare event of a fire, the toxicity of emissions is comparable to that of common household fires. In the rare event of a fire, emissions may include toxic gases such as hydrogen fluoride, but studies have shown that the toxicity is comparable to that of common household fires.

Systems are engineered to operate safely in extreme weather conditions, from sub-zero temperatures to desert heat, with enclosures rated for ingress protection and thermal stability. Noise levels are typically low, comparable to commercial HVAC systems, making BESS suitable for deployment in both urban and rural settings.

Are there rules in place to ensure safe battery projects are built?

Regulatory compliance is essential to ensuring BESS safety. Systems must meet local and national electrical and fire codes, including the National Electrical Code (NEC) Article 706, NFPA 855 for energy storage system installation, and International Fire Code (IFC) Chapter 12. Certification standards such as UL 9540 (system safety), UL 9540A (thermal runaway testing), and UL 1973 (battery safety) provide a framework for evaluating and validating system safety. These standards guide manufacturers, integrators, and inspectors in designing, testing, and approving BESS installations. Compliance with these codes is often a prerequisite for permitting and insurance.

How are BESS tested for fire safety?

In addition to UL 9540A thermal runaway testing, new requirements for large-scale fire testing of BESS are being adopted in many jurisdictions. These complex tests involve creating a worst-case fire scenario with a series of energy storage system enclosures spaced and their minimum recommended separation. Multiple battery cells are deliberately and simultaneously sent into thermal runaway to ensure all the battery cells are burned. With no fire suppression or outside intervention, the fire is left to burn until it self-extinguishes. The temperature of the battery cells inside adjacent test enclosures are monitored to verify that the fire will not spread.

What happens when the battery needs to be replaced?

End-of-life management is an emerging focus area for BESS safety and sustainability. As systems reach the end of their operational life, proper decommissioning, recycling, and repurposing become critical. A growing industry is focused on recovering valuable materials such as lithium, cobalt, and nickel from used batteries. Additionally, second-life applications are being explored, where electric vehicle batteries are repurposed for stationary storage. These practices not only reduce environmental impact but also enhance the economic viability and circularity of energy storage technologies.

DNV

Battery Energy Storage System (BESS) Safety

Frequently Asked Questions

Battery Energy Storage Systems (BESS) are becoming increasingly vital to the modern energy grid, offering flexibility, reliability, and support for renewable energy integration. However, as their deployment grows, so does the importance of understanding and managing the safety risks associated with these systems. This document provides a brief overview of the most critical safety considerations for BESS.

What are the safety risks of BESS?

One of the primary safety concerns with BESS is the risk of thermal runaway, a condition where a battery cell overheats and triggers a chain reaction that can lead to fire or explosion. Although such events are rare, they are taken very seriously by manufacturers, operators, and emergency responders. Modern BESS are equipped with advanced Battery Management Systems (BMS) that continuously monitor temperature, voltage, and current to detect anomalies early. These systems are designed to detect early signs of failure and automatically isolate or shut down affected components to prevent escalation. The use of such as smoke, heat, gas detector, and thermal imaging are increasingly common, or required by code. The integration of predictive analytics and machine learning into BMS platforms also allows for proactive maintenance and anomaly detection before faults occur.

Do battery storage sites plan for emergencies?

Emergency response planning is a cornerstone of BESS safety. Site-specific emergency response plans are developed in collaboration with local fire departments, emergency medical services, and utility operators. These plans include detailed procedures for system shutdown, fire suppression, ventilation, and hazardous material containment. Community protection measures such as road closures, shelter-in-place advisories, and public notification systems are also incorporated. Regular drills and training sessions ensure that all stakeholders are prepared to respond effectively to incidents involving BESS installations. Collaboration between the local fire department and the project developer at an early stage of project development is essential to developing and coordinating robust safety and responses frameworks.

How is a fire incident approached?

In the rare case of a fire event, the preferred strategy is to allow a controlled burn rather than immediate extinguishment. First responders will take action to cool the surrounding battery containers with water to prevent any fire spread, and let the affected container burn completely. This approach minimizes the risk of reignition and explosion, especially in lithium-ion battery systems. Fire suppression systems within BESS enclosures may include clean agents, inert gases, or water mist systems, each selected based on the specific battery chemistry and enclosure design. Fire departments often receive specialized training to recognize the unique hazards of BESS fires and to coordinate with facility operators for safe incident management.