560 kWh lithium-ion battery energy storage safety

560 kWh lithium-ion battery energy storage safety

Lithium-ion batteries (LIBs) are widely regarded as established energy storage devices owing to their high energy density, extended cycling life, and rapid charging capabilities. Nevertheless, the stark contrast between the frequent incidence of safety incidents in battery energy storage systems (BESS) and the substantial demand within the ...

Lithium-ion batteries (LIBs) have raised increasing interest due to their high potential for providing efficient energy storage and environmental sustainability [1]. LIBs are currently used not only in portable electronics, such as computers and cell phones [2], but also for electric or hybrid vehicles [3].

This work describes an improved risk assessment approach for analyzing safety designs in the battery energy storage system incorporated in large-scale solar to improve accident prevention and mitigation, via incorporating probabilistic event tree and systems theoretic analysis. The causal factors and mitigation measures are presented.

Even in lithium-ion batteries with integrated safety features, an unanticipated breach in the battery separator material can result in high current that overheats the battery''s electrolyte, quickly leading to thermal runaway and fire or even explosion.

Sources of wind and solar electrical power need large energy storage, most often provided by Lithium-Ion batteries of unprecedented capacity. Incidents of serious fire and explosion suggest that ...

Battery energy storage systems (BESS) use an arrangement of batteries and other electrical equipment to store electrical energy. Increasingly used in residential, commercial, industrial, and utility applications for peak shaving or grid support these installations vary from large-scale outdoor and indoor sites (e.g., warehouse-type buildings) to modular systems. Containerized systems, a form of modular design, have become a popular means of efficiently integrating BESS projects.

Due to the fast response time, lithium-ion BESS can be used to stabilize the power grid, modulate grid frequency, and provide emergency power or industrial-scale peak shaving services, reducing the cost of electricity for the end user. However, high-powered and rapid charge cycles can put stress on the batteries resulting in degradation over time, which is not beneficial to safety.

In the past four years, more than thirty large-scale BESS around the world experienced failures that resulted in fires and, in some cases, explosions. Given these concerns, professionals and authorities need to develop and implement strategies to prevent and mitigate BESS fire and explosion hazards. The guidelines provided in NFPA 855 (Standard for the Installation of Energy Storage Systems) and Chapter 1207 (Electrical Energy

Storage Systems) of the International Fire Code are the first steps.

Prevention and mitigation measures should be directed at thermal runaway, which is by far the most severe BESS failure mode. If thermal runaway cannot be stopped, fire and explosion are the most severe consequences.

Thermal runaway of lithium-ion battery cells is essentially the primary cause of lithium-ion BESS fires or explosions. Under a variety of scenarios that cause a short circuit, batteries can undergo thermal runaway where the stored chemical energy is converted to thermal energy. If the process cannot be adequately cooled, an escalation in temperature will occur fueling the reaction, which can result in cell rupture and release of flammable and toxic gases. The most common initiating events for thermal runaway include:

In battery energy storage systems, one of the most important barriers is the battery management system (BMS), which provides primary thermal runaway protection by assuring that the battery system operates within a safe range of parameters (e.g., state of charge, temperature). In a UL 9540 listed BESS, the BMS monitors, controls and optimizes the performance of battery modules and disconnects them from the system in the event of abnormal conditions. The BMS also provides charge and discharge management of the batteries.

In case of undervoltage or overvoltage, over-temperature, or overcurrent conditions, the BMS will alarm and then limit the charge and discharge current or power. Under emergency conditions, the BMS will cease operations and electrically disconnect each battery enclosure. This is assuming that the BMS is not damaged and operational. However, if an internal cell breakdown has occurred, the BMS will not stop the thermal runaway.