Swiss Re
Corporate Solutions

Risk Engineering Services

# Sustainability Series: Energy Storage Systems Using Lithium-Ion Technologies

**Energy storage systems (ESS)** using lithium-ion technologies enable on-site storage of electrical power for future sale or consumption and reduce or eliminate the need for fossil fuels. Battery ESS using lithium-ion technologies such as lithium-iron phosphate (LFP) and nickel manganese cobalt (NMC) represent the majority of systems being installed today. Economic advantages include a stored supply of power that can be used on demand to reduce time-of-use rates and demand charges or during power outages. However, ESS using these technologies introduce fire and explosion hazards that building owners and occupiers should be aware of when considering this sustainable power source.

Energy storage systems using lithium-ion technologies generally comprise individual battery cells that are housed in protective metal or plastic casings and grouped together in larger cabinets to form modules. Typically, modules are stacked in racks that are connected in series and arranged to deliver voltage to an inverter or charger. Larger ESS may include a multitude of racks. Auxiliary equipment such as a Battery Management System (BMS), Power Control System (PCS), and overall Energy Storage Management System (ESMS) are typically included, especially for larger installations. Ideally, equipment will be installed in standalone enclosures dedicated solely to the ESS. However, ESS may be found in rooms within a building housing other operations.

## Property Risk Considerations

If a building has an ESS using a lithium-ion technology, or if such a system is proposed, consider how a fire or explosion might impact the overall property or enterprise, including business interruption. The following features and considerations will likely be of interest to commercial property insurers when evaluating the building's overall risk profile.

**Potential for fire and explosion:**
The most significant hazard associated with ESS using lithium-ion technologies is thermal runaway. This occurs when heat develops quicker than can be dissipated, either as a result of design failure or equipment malfunction, resulting in elevated temperatures and subsequent ignition. Cell malfunction can also result in an explosion if there is an off-gassing and buildup of flammable vapors and ignition is delayed. The most common causes of cell malfunction are physical impacts/damage, exposure to external heat sources, and electrical malfunctions such as improper charging or discharging conditions.

**Considerations:** Fires of electrical origin are one of the most common causes of property loss. As with any electrical installation, a comprehensive approach that considers all aspects of design, installation, commissioning, operation and maintenance should be undertaken to minimize both the potential for loss and its extent, should one occur. This includes installing ESS with only certified subsystems and components.

Fires involving lithium-ion batteries have a high heat release and are difficult to extinguish. Currently, surface and area cooling using water-based fire suppression is preferred along with minimum one-hour fire-rated construction and separation measures that reduce the potential for fire spread to other cells or combustibles. Consider the following:

**Location** — Dedicated energy storage enclosures and buildings physically separating the hazard from other assets offer the best protection against fire or explosion damage to critical operations. When space separation is not possible, the location of dedicated ESS rooms relative to other occupancies and design features aimed at limiting fire spread such as limitations on maximum allowable stored energy become paramount. Other considerations include locating the room along an outside wall and providing exterior access for manual firefighting. Minimum separation distances between individual racks and between ESS and surrounding occupancies are also recommended for all installations. Combustible materials should not be stored in ESS rooms.

**Construction** — For facilities where ESS must be within the building footprint, minimum one-hour fire-rated construction with additional safeguards such as damaging limiting construction and fire barriers between multiple racks should be provided.

**Protection** — Provide automatic sprinkler protection based on design criteria from an internationally recognized testing laboratory. Alternative sources of protection such as non-water-based fire suppression should undergo proven or credible large-scale testing to demonstrate effectiveness before being relied upon to limit loss. Smoke detection, explosion prevention systems and deflagration venting should be considered based on the size and scope of ESS installations.

**Battery Management Systems (BMS)** — A battery management system with a full array of safety controls should be provided where the potential for significant loss exists. This system will serve to oversee safe operational parameters (e.g., temperature and off-gassing) and may be part of a larger energy storage management system (ESMS).

**Ventilation** — Provide combustible gas detection and adequately designed emergency ventilation to exhaust heat and flammable vapors created by thermal runaway. These systems can be standalone or provided as part of the BMS.

**Electrical Protection** — Electrical testing programs and physical protection measures such as DC ground fault and over/under voltage protection should be provided for both individual racks and the overall system. The power conversion equipment connected to the energy storage system should have complete and comprehensive protection and controls, as well.

**Operation and Maintenance** — Activities should be in accordance with manufacturer specifications. Systems should undergo formal and appropriate commissioning and decommissioning operations. The latter is especially important, as batteries nearing the end of their useable life are more likely to malfunction, resulting in loss.

**Training** — Emergency planning and training for facility staff and emergency responders should be conducted. A pre-incident plan and guidelines for steps to be taken after an incident that damages equipment, including addressing the potential for re-ignition, will provide thorough preparedness before an incident occurs.

Swiss Re Corporate Solutions Risk Engineering Services recognizes society's ever-increasing dependence on battery power and energy storage. However, careful consideration should be given to all aspects of the design, installation and maintenance to reduce the likelihood of loss.

Contact your Swiss Re Corporate Solutions risk engineer for additional information or assistance.

**References:**

NFPA 855, "Standard for the Installation of Stationary Energy Storage Systems," 2020

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