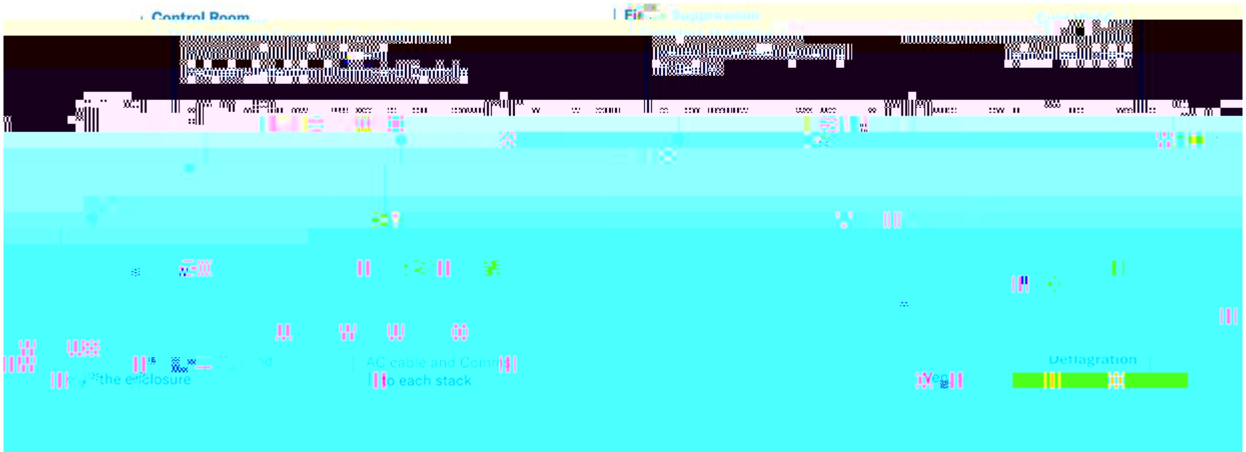
Energy storage fundamentally improves the way we generate, deliver, and consume electricity. Battery energy storage systems can perform, among others, the following

Image Source: Fluence

Battery energy storage systems operate by converting electricity from the grid or a power generation source (such as from solar or wind) into stored chemical energy. When the chemical energy is discharged, it is converted back into electrical energy. This is the same process used with phones, laptops, and other electronic devices. However, while batteries in consumer electronics have a single function, those connected to the electrical grid -- which are much larger -- serve more complex functions. For instance, electrical grid batteries must be combined with power conversion devices to produce AC (alternating current) power. Batteries connected to the electrical grid can also have a different composition than those found in consumer electronics.



Battery energy storage system operators develop robust emergency response plans based on a standard template of national best practices that are customized for each facility. These best practices include extensive collaboration with first responders and address emergency situations that might be encountered at an energy storage site, including extreme weather, fires, security incidents and more. They also address emergency response roles and highlight the importance of coordinating with first responders—particularly during planning—to ensure there is a complete and detailed shared understanding of potential emergencies and the proper safety responses. Emergency response plans also include contact details for subject-matter experts who can advise first responders on appropriate actions for each situation.

To learn more, read ACP's Energy Storage Emergency Response Plan Template.

In the rare case where fires do occur, they may be managed without endangering broader communities. A study for the New York State Energy Research & Development Authority states that, while battery fires emit toxic fumes, the average level of toxicity is similar to that of plastics fires involving materials such as sofas, mattresses, or office furniture. Depending on the size of the facility, authorities may close nearby roads and issue shelter-in-place advisories to local residents. The diverse system components that comprise the energy storage facility have chemical and fire smoke data that can be utilized to determine the risks for each facility. The code-required Hazard Mitigation Analysis will summarize how risks beyond the site boundary will be prevented.

A September 2022 fire in California presents a case study where a thermal event was resolved with minimal effect to the local community. Fire broke out in one battery enclosure (out of 256). The fire did not spread to adjacent units, and firefighters had been trained to allow the fire to burn while protecting nearby exposures. After some hours, shifting winds caused a nearby highway to be closed and residents were advised to shelter in place with their windows closed. The fire burned itself out in five hours, leaving no possibility of reignition. Approximately 18 hours after the fire broke out, the highway was reopened and the advisory lifted when air-quality sampling around the facility showed no detectable traces of airborne contaminants.

Battery energy storage systems are currently deployed and operational in all environments and settings across the United States, from the freezing temperatures of Alaska to the deserts of Arizona. These systems are designed with associated heating and cooling systems to ensure optimal battery operations and life based on the environmental conditions at the installation location. Not only are battery energy storage facilities built to withstand disruptive weather events, but they can also help increase resiliency to extreme weather events, prevent power outages, and provide back-up power.

In normal operation, energy storage facilities do not release pollutants to the air or waterways. Like all energy technologies, batteries can present chemistry-specific hazards under fault conditions. Batteries with free-flowing electrolytes could leak or spill chemicals, so these systems are normally equipped with spill containment. Batteries with aqueous electrolytes may emit small quantities of hydrogen gas in normal operation and larger amounts under fault conditions, but these emissions are handled by ventilation systems and are not considered polluti Tf1 0 a7iy-6(il)5(bo un)3(0.0000516.9 BT/F1 11 Tf1 0 0 1 72.025 487.9 T

402T1 g(,)]TJETQF1 11 Tf1 0 0 612 79aslat-5(heg0.00000912 0 612 792 reW*nBT/F1 11 Tf1 0 0 1 165.08 545.92 Tm3(ai)402T1 g(,)]TJETQ(i)-

Battery energy storage systems may or may not be visible from a facility’s property line. Grid batteries can be housed in a variety of enclosures or buildings, none of which are taller than a house. Energy storage facilities are often unmanned and do not need light to function. Som-5(y)u7enot need light to funsEe ligqQ0 612

Battery energy storage systems are equipped with sensors that track battery temperatures and enable storage facilities to turn off batteries if they get too hot or too cold. Battery management systems also monitor the performance of each individual cell voltage and other key parameters then aggregate that data in real time to assess the entire system's operation, detect anomalies, and adjust the system to maintain safety. Battery management systems often contain state of the art software designed to safely operate and monitor energy storage systems.

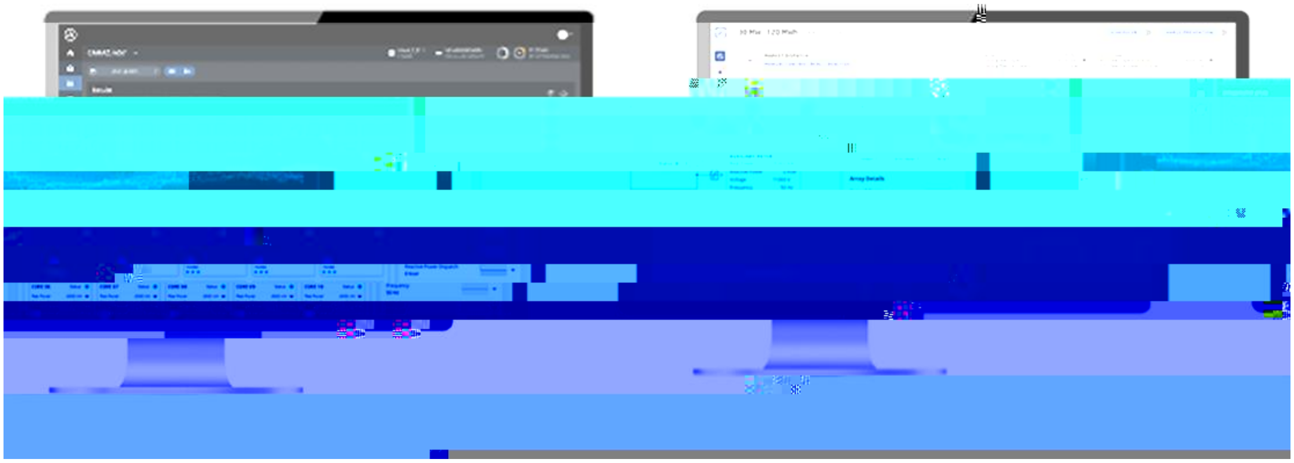


Image Source: Fluence

Battery energy storage systems must comply with electrical and fire codes adopted at the state and local level. Facility owners must submit documentation on system certification, fire safety test results, hazard mitigation, and emergency response to the local Authority Having Jurisdiction (AHJ) for approval. Before operation, facility staff and emergency responders must be trained in safety procedures and are required to be given annual refresher training.

To learn more, refer to ACP's ESS Codes and Standards Overview. The U.S. storage industry has continuously supported the development of codes, standards, and best practices to promote safety.

The fire codes require battery energy storage systems to be certified to UL 9540, *Energy Storage Systems and Equipment*. Each major component – battery, power conversion system, and energy storage management system – must be certified to its own UL standard, and UL 9540 validates the proper integration of the complete system. Additionally, non-residential battery systems exceeding 50 kWh must be tested in accordance with UL 9540A, *Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*. This test evaluates the amount of flammable gas produced by a battery cell in thermal runaway and the extent to which thermal runaway propagates within the battery system.

Rated power is the total possible instantaneous discharge capability, usually in kilowatts (kW) or megawatts (MW), of the system. Energy is the maximum amount of stored energy (rate of power over a given time), usually described in kilowatt-hours (kWh) or megawatt-hours MWh. Cycles are the number of times the battery goes from fully (or nearly fully) charged to discharged (or fully discharged). The amount of time or cycles a battery storage system can provide regular charging and discharging before failure or significant degradation is typically the cycle lifetime. State of Charge (SoC617.2 T40 G[f)10(ul)5(ly)]TJETQm(F1 1