

BESS PLANT PROTECTION

Battery energy storage systems (BESS) are now an essential technology for the energy transition, as they allow the electrical grid to be stabilised by efficiently integrating renewable sources. However, the very nature of lithium batteries introduces specific risks that require a multi-level approach to safety.

The main danger is represented by thermal runaway, a chemical chain reaction that generates extreme heat and releases gas, with the consequent risk of fire or explosion. To prevent these scenarios, system design must comply with national provisions, guidelines, and risk assessment methodologies. The fire safety measures to be implemented in the design, installation, and operation of BESS must distinguish three installation categories: residential use, solutions not intended for mass production (such as those serving apartment blocks or commercial centres), and utility-scale mass production installations. In any case, the presence of a BESS installation entails an increased fire risk in the facility where it is installed and therefore requires the adoption of technical measures consistent with such increase.

The core of the protection system, regardless of the scale of the facility, consists of an active fire detection and extinguishing system, certified according to standards EN 54 and EN 12094-1. The deployed technologies are not limited to detection alone, but intervene promptly through the control of fixed extinguishing devices, such as aerosols, designed to flood the protected space and suppress the propagation of uncontrolled chemical phenomena right from their first onset.

In this context, Tecnofire offers a range of solutions based on the TSA1 system, designed to adapt to installations of any size: from single units to be protected (SINGLE BESS), to configurations with multiple units managed by a single control panel (MULTI BESS, up to 10 units), up to installations for large-scale facilities composed of a network of control panels (LARGE BESS, up to 150 units), and GIGA BESS solutions capable of coordinating up to 1,000 units via centralized supervision.

In the EXTENDED configuration, the TSA1 control panel manages a detection loop that can control up to 199 detectors, 99 modules, and 9 TSM1 modules (peripheral extinguishing EDU channels), for a total of 150 detection zones associated with 100 alarm plans. The integrated extinguishing device unit (EDU) features inputs and outputs dedicated to controlling extinguishing valves and optical-acoustic alarm devices; the extinguishing cycle can be managed in five different execution modes, both centrally and locally. The system is certified in accordance with standards EN 54-2, EN 54-4, and EN 12094-1.

In distributed installations, TSM1 modules allow the decentralisation of each extinguishing channel's management, operating autonomously or following the extinguishing logic dictated by the TSA1 control panel. Typical devices of a BESS system include: the fire detection and extinguishing control panel, optical-acoustic alarm devices, manual alarm call points, input/output interface modules, optical detectors, rate-of-rise heat detectors, and ATEX-certified gas detectors for off-gas monitoring.

System effectiveness is ensured by constant and intelligent monitoring. The protected space is analysed in real time to detect sudden temperature variations or the presence of smoke or gas. In the event of an anomaly, the control panel coordinates an automatic response that includes activating alarms, tripping emergency electrical disconnectors, and activating ventilation systems. For more complex installations, the safety architecture provides centralized supervision via SCADA or EMS which, in a single interface, integrates data from the different BMS (Battery Management Systems), ensuring redundancy and operational continuity even in the event of failure of a single unit.

Operating logic

Pre-Alarm (Early Warning phase)

- Activation: tripping of a gas sensor (off-gas), or a smoke or temperature detector.
- Action: local acoustic warning, notification via SCADA/BMS, activation of forced ventilation for purge/inert gas extraction, if integrated.

Confirmed Alarm (Extinguishing discharge phase)

- Activation: coincidence confirmation (double knock) between two detectors (gas, smoke, or temperature).
- Action:
 - Transmission of the BESS Trip signal (electrical disconnection of the storage system and inverters).

- Closure of HVAC dampers / ventilation fire dampers, to isolate the enclosure and avoid dispersing the extinguishing gas.
- Activation of the discharge delay (typically 30s, for evacuation and safety).
- Discharge of the extinguishing agent (FK-5-1-12 for total flooding, or aerosol).

For larger facilities, the Supervisor Plus software enables centralized supervision of up to 1,000 TSA1 control panels, manageable from up to 40 client workstations divided into 40 independent business units. The software features operator profiling, interactive graphical maps, and integrated video management. The TFNET communication interface manages data traffic and, thanks to MODBUS protocol support, ensures integration with third-party systems such as SCADA and EMS. This allows monitoring and managing fire safety and energy storage processes in a unified manner.

In addition to the technological component, regulatory compliance requires rigorous management of documentation and emergency procedures. Each system must be accompanied by detailed operating manuals, updated diagrams, and safety signage compliant with the provisions in force in the country where it is installed.

Safety over time is ultimately guaranteed by mandatory periodic maintenance, carried out according to local regulatory criteria, and by the transmission of alarms to Alarm Receiving Centres (CMS/ARC). Through the integration of these measures, Tecnofire guarantees a complete protection ecosystem that safeguards both the technological investment and the safety of people and facilities.