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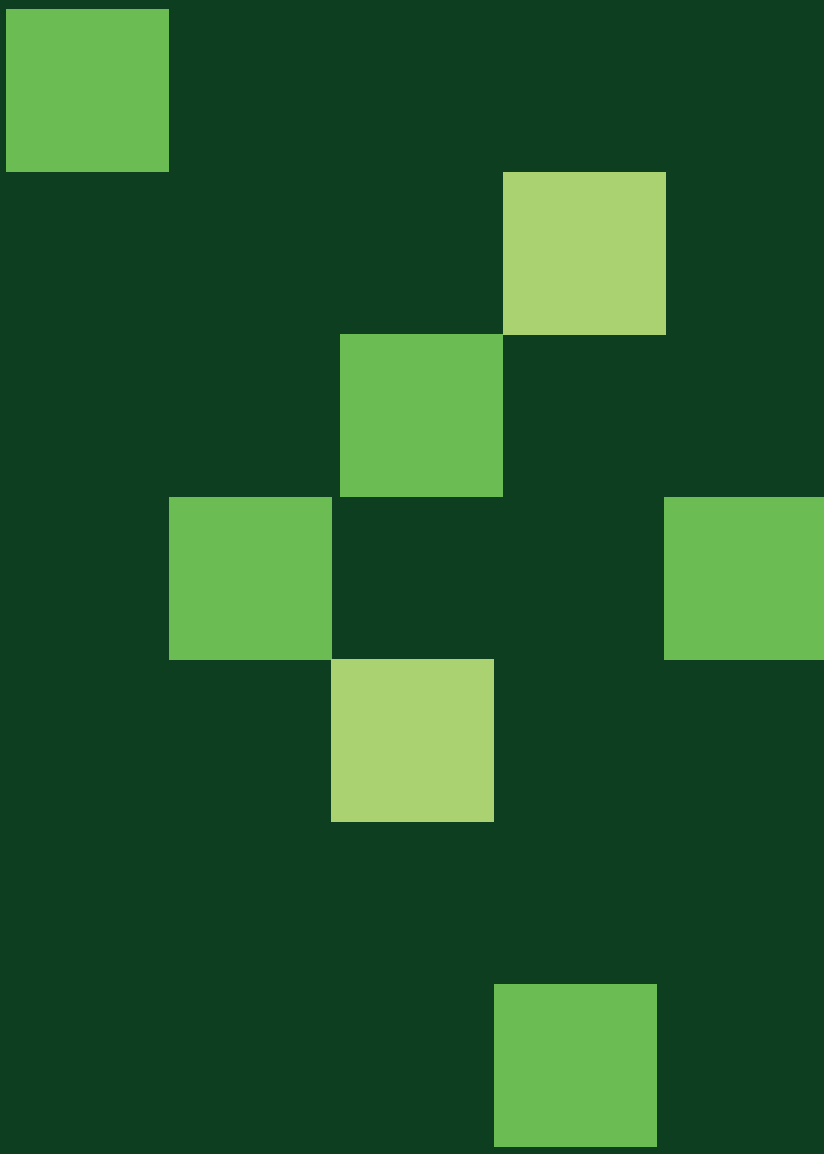


Autronica BESS Safety System

BESS is booming

Battery energy storage systems (BESS) are at the heart of the transition to clean energy. In just ten years, the BESS industry has grown from under 1 GW to more than 55 GW of installed capacity, a 60% annual growth rate. This boom is fueled by the need for grid stability, better integration of renewables, and energy cost savings. Supportive policies and new technologies have helped accelerate this progress.

Safety challenges

As BESS adoption grows, so do concerns about safety, especially fire risks. Although complete public data is limited, more than 85 fire incidents in stationary BESS systems have been reported in the past decade. A recent tragedy in East Asia highlighted the risks: a BESS fire caused significant harm and loss of life. Incidents like this show why we need stronger, integrated safety systems for the entire BESS facility not just at individual component levels.

Comprehensive safety

Most current BESS safety solutions focus on individual parts with safety features existing at the cell, pack, rack, and container levels. What the industry truly needs is a complete and unified safety solution for the entire BESS plant.

Autronica offers a comprehensive safety approach from prevention and detection to suppression. Our advanced system monitors the entire plant in real time, spotting issues both inside and outside the system and ensuring quick, accurate responses.

1. PREVENTION PHASE

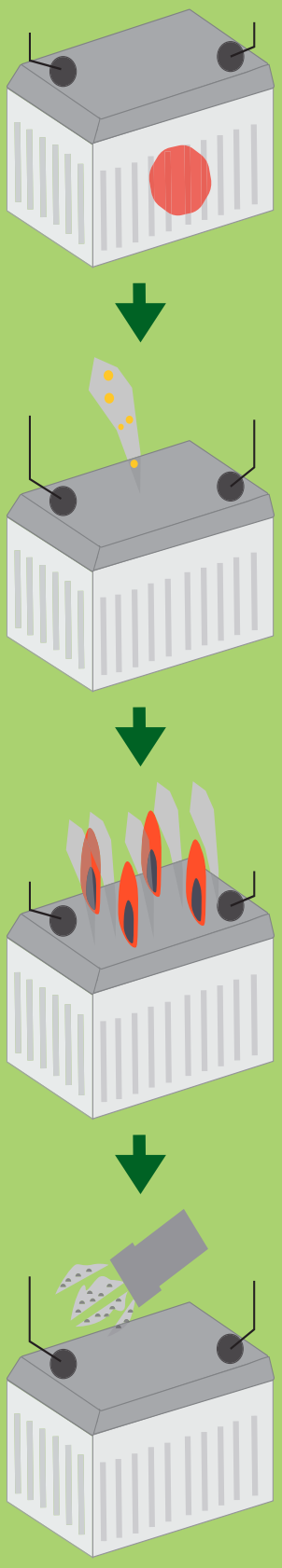
Keeping battery storage safe from the start

The prevention phase is the first and most important step in protecting lithium-ion BESS systems from failures and fires. It focuses on identifying early warning signs like unusual temperatures, gas releases, or environmental issues before they become serious safety threats.

Why off-gas matters

One of the earliest signs of a problem inside a battery is off-gas release, tiny amounts of gas that escape when the battery starts to overheat or fail. These gases can include carbon monoxide, carbon dioxide, hydrogen, and other flammable or toxic compounds.

Even a small release can signal that something isn't right. And while batteries with more charge release more gas, even low-charge batteries can be dangerous because they may ignite later, when least expected.



Detecting Early Trouble

Autronica uses several technologies to detect off-gas quickly and accurately:

IR (INFRARED) SENSORS:

Fast and reliable at spotting hydrocarbons (flammable gases), with no need for frequent calibration.

CO AND CO2 SENSORS:

These measure carbon gases, which are among the first to appear when something goes wrong inside the battery.

CATALYTIC SENSORS:

Good at detecting hydrogen and methane, giving fast results. They need occasional testing to stay accurate.

ELECTROCHEMICAL DETECTOR:

These use chemical reaction between target gas & electrode to detect smallest traces of gas before there are visible signs of trouble.

Beyond Gases – What Else We Monitor

The prevention phase isn't just about gas. It's about keeping an eye on every part of the system, from the inside out:

TEMPERATURE AND HUMIDITY SENSORS:

Help avoid condensation or overheating.

DUST AND PARTICLE SENSORS:

Alert when too much dust builds up inside the container.

CORROSION SENSORS:

Watch for signs of damage from humid or salty air.

WATER SENSORS:

Detects leaks or flooding, both serious hazards around batteries.

THERMAL CAMERAS:

Spot hotspots in control panels or wiring.

VIBRATION SENSORS:

Pick up on shaking that could loosen wires or damage components.

GROUND FAULT MONITORS:

Make sure the electrical grounding is intact and safe.

All these sensors feed information to the main control system in real-time. Autronica's sensors are designed to work together, giving early alerts and helping operators act quickly, long before there's smoke or fire.

In short, the prevention phase is about watching, listening, and reacting before a battery problem becomes a crisis. With Autronica's technology, this phase builds the foundation for a safer, more reliable BESS facility.

2. DETECTION PHASE

Fast action when every second counts

Once early warning signs like off-gas have been detected in a BESS unit, fast response becomes critical. The detection phase is about spotting and acting on smoke, heat, or fire conditions before they escalate into major incidents.

Why speed matters

When a battery system is still operating i.e. supplying power or charging, even a small anomaly can rapidly lead to thermal runaway. That's when things get out of control. So the faster a threat is detected, the better the chances of avoiding a full-blown fire.

Autronica's system is built for speed and precision. It uses smart detectors for both off-gas and smoke, with rapid response times to trigger safety actions.

Tough environments, reliable performance

BESS units are often located in harsh settings: extreme heat or cold, high humidity, vibration, or dust. They also tend to operate around the clock, sometimes without people on-site. That's why detection systems must work reliably with little maintenance and offer remote monitoring.

Autronica's low-maintenance detectors are de-

signed specifically for BESS environments. They can be connected across the facility and integrated with local or remote monitoring systems.

Smart detector placement

Each section (or rack) of a BESS unit is usually separated to help contain potential fires. It's essential to place at least one smoke detector with built-in heat and CO sensors in every segment. Additional detectors should also cover utility or control areas, where electrical faults could spark danger.

If multiple BESS containers are operating together, flame detectors are used to monitor larger areas.

Automatic safety responses

Autronica's system is programmed to react automatically. When off-gas is detected, the system can isolate the affected area by cutting power and starting ventilation to remove any flammable gases. This prevents buildup and lowers the risk of explosion or fire.

The logic behind these actions is managed through a 'cause-and-effect' setup, meaning the right steps happen fast and in the right order. And thanks to high false-alarm immunity, unnecessary shutdowns are avoided, saving time and money.

Built to last

Autronica fire panels and detectors are built to perform for up to 20 years without degradation in normal conditions. They're certified to Safety Integrity Level 2 (SIL2), which ensures high reliability. Even better, new upgrades are backward compatible, so your system can grow and improve over time.

Scalable for any facility

Whether your site has a few units or a large, multi-container setup, Autronica scales to fit. Up to 64 control panels and 15,000 detectors can be connected into a single system, all working together to keep your site protected.

3. SUPPRESSION PHASE

Stopping fires before they spread

When it comes to lithium-ion battery fires, putting them out is no easy task. These fires can create their own oxygen, produce extreme heat, and burn in ways that make traditional extinguishers less effective. That's why the suppression phase needs a highly specialized approach, and why Autronica's system is designed to act fast and smart.

Why battery fires are so complex

Battery fires aren't like regular fires. Once they start, they can quickly spread from cell to cell in a chain reaction. As the fire burns, it can generate oxygen internally, which means removing air from the room might not stop it. Plus, the batteries are full of different materials: flammable liquids (Class B), electrical charge (Class C), metals (Class D), and polymers (Class A). These mix into what's known as a deep-seated fire, one that's hard to reach and even harder to extinguish.

What a good suppression system needs to do

To be effective in a BESS environment, a suppression system must:

- Stop the fire from spreading
- Cool the batteries and surroundings
- Put out flames quickly and completely
- Avoid causing damage to equipment
- Be easy to install and operate under tough conditions

Autronica's Suppression Solutions

Autronica offers three complementary fire suppression technologies for BESS, each selected to match the unique demands of battery fires:

1. AEROSOL SYSTEMS

These systems use sealed steel canisters containing a dry chemical compound. When triggered, the aerosol fills the container and disrupts the chemical reactions that sustain the fire. It's compact, doesn't need pressurization, and works even in rough environments.

2. HIGH-PRESSURE WATER MIST

Water mist works by cooling the fire, blocking oxygen, and slowing the spread of heat and flames. Sprayed at high pressure, the fine mist covers more area with less water, reducing damage while increasing effectiveness, especially in enclosed BESS units.

3. CLEAN AGENT SYSTEMS

Clean agents like nitrogen are stored in pressurized tanks and released through specialized nozzles. These agents reduce the oxygen level around the fire and can also cool components. They leave no residue, making them ideal for sensitive electrical equipment.

Automated and integrated for speed

All three suppression options are fully integrated with Autronica's detection system. As soon as a fire is confirmed, the system automatically deploys the appropriate suppression method. This ensures that action is taken immediately with no delay or need for human intervention.

The combined detection and suppression system has been thoroughly tested and is already in use across multiple battery storage sites.

With Autronica, the suppression phase is not just about reacting, it's about stopping fires before they take hold, protecting both people and infrastructure from serious harm.

Total safety, seamlessly integrated

Protecting an entire BESS facility means more than just responding to individual threats, it requires a fully connected safety network that sees everything and reacts fast.

Autronica's centralized safety system ties together all fire detection loops across the site. With capacity to support up to 15,000 loop devices and 64 control units, it ensures full coverage even in large-scale installations. The result? A single, unified view of every alert, event, and status across the facility.

The Human-Machine Interface (HMI) provides real-time updates for each battery system. It doesn't just track alerts, it gives full diagnostic insight, including detailed temperature readings from every detector. This makes it easy for operators to assess the health of the entire system at a glance.

Through the Autromaster platform, operators can remotely monitor multiple sites from a secure central hub. Whether managing one location or many, everything is visible and under control helping teams act quickly, reduce downtime, and maintain the highest standards of safety.

Autronica's integrated approach brings together prevention, detection, and suppression - and wraps it in a scalable, remotely accessible system that keeps every corner of your BESS facility protected.

Why Autronica

COMPREHENSIVE END-TO-END SAFETY LIFECYCLE:

Autronica is the only provider delivering a fully integrated safety lifecycle - encompassing prevention, detection, and suppression - specifically engineered to address the complex risks associated with lithium-ion Battery Energy Storage Systems (BESS).

GLOBAL EXPERTISE WITH LOCALIZED SUPPORT

Autronica combines globally recognized certifications with tailored, on-the-ground support - ensuring each installation receives expert guidance from design to deployment and beyond.

INTELLIGENT, AUTOMATED RESPONSE MECHANISMS:

Real-time detection initiates automatic, cause-and-effect-driven actions - such as power shutdown, ventilation activation, and fire suppression deployment - ensuring rapid mitigation without the need for manual intervention.

ENGINEERED FOR HARSH ENVIRONMENTS

SIL2-certified detectors and systems are rugged, low-maintenance, and built to operate reliably for up to 20 years, even in the most demanding environmental conditions.

SPECIALIZED FIRE SUPPRESSION FOR BATTERY HAZARDS:

Autronica offers three complementary suppression technologies - aerosol, high-pressure water mist, and clean agents—specifically designed to combat deep-seated, multi-class battery fires that conventional systems are unable to control effectively.

ADVANCED EARLY WARNING CAPABILITIES:

Utilizing a sophisticated array of smart sensors - including infrared, catalytic, CO/CO_2, aspirating, thermal, and vibration - Autronica's system detects off-gas emissions, temperature deviations, and environmental threats well before visible signs of failure emerge.

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