WEBINAR

JinKO Solar

Energy Storage NEWS

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# Safer battery storage: JinkoSolar's vision for utility-scale BESS

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# Safer Battery Storage: JinkoSolar’s vision for utility scale BESS

JinKO Solar

**150GW+**

Delivered

**160+**

Covered Countries

**54k**

Global Staff

**35+**

Service Centers

**No. 1 Shipment for 4 Consecutive Years**

jinkosolar.eu

# Our Energy Storage Products


**Residential Storage System**
(1kWh-50kWh)

**C&I Storage System**
(50kWh-1MWh)

**Utility Storage System**
(≥1MWh)

# The difference is in the detail

## SunTera - Utility Scale ESS

| Items | Parameters |
|---|---|
| Type of Battery | Lithium Iron Phosphate (LFP) |
| Cell Parameters | 3.2V/280Ah |
| Max. Charge/Discharge Rate | 0.5P |
| Configuration of System | 1P384S×10 |
| Rated Capacity | 3.44 MWh |
| Rated Voltage (nom) | 1228.8V |
| Cooling Method | Water Glycol |
| Environmental temperature | -20 ~ 50 °C |
| Environmental Humidity | ≤95%RH, non-condensing |
| IP Grade | IP54 |
| Storage Temperature | -20 ~ 45 °C |
| Fire Protection | Gas Sensors + Deflagration Venting + FM200/Novec 1230/Aerosol + Water Dry Pipe |
| Dimensions (L×W×H) | 6058×2438×2896mm |
| Weight | ≈35000 kg |
| Design Life | 20 years |

# Why integrate batteries onto the grid ?

- Intermittency mitigation
- Self consumption
- Grid stabilization
- Commercial considerations

# Barriers to adoption

- Commercial viability
- Complexity
- Safety concerns

Today… Safety is an assumption

Getting it WRONG hurts us ALL

1

# Beyond the Safety Standards

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## What we know

Certification does NOT guarantee safety

Build Quality &
Control Processes

## What we need

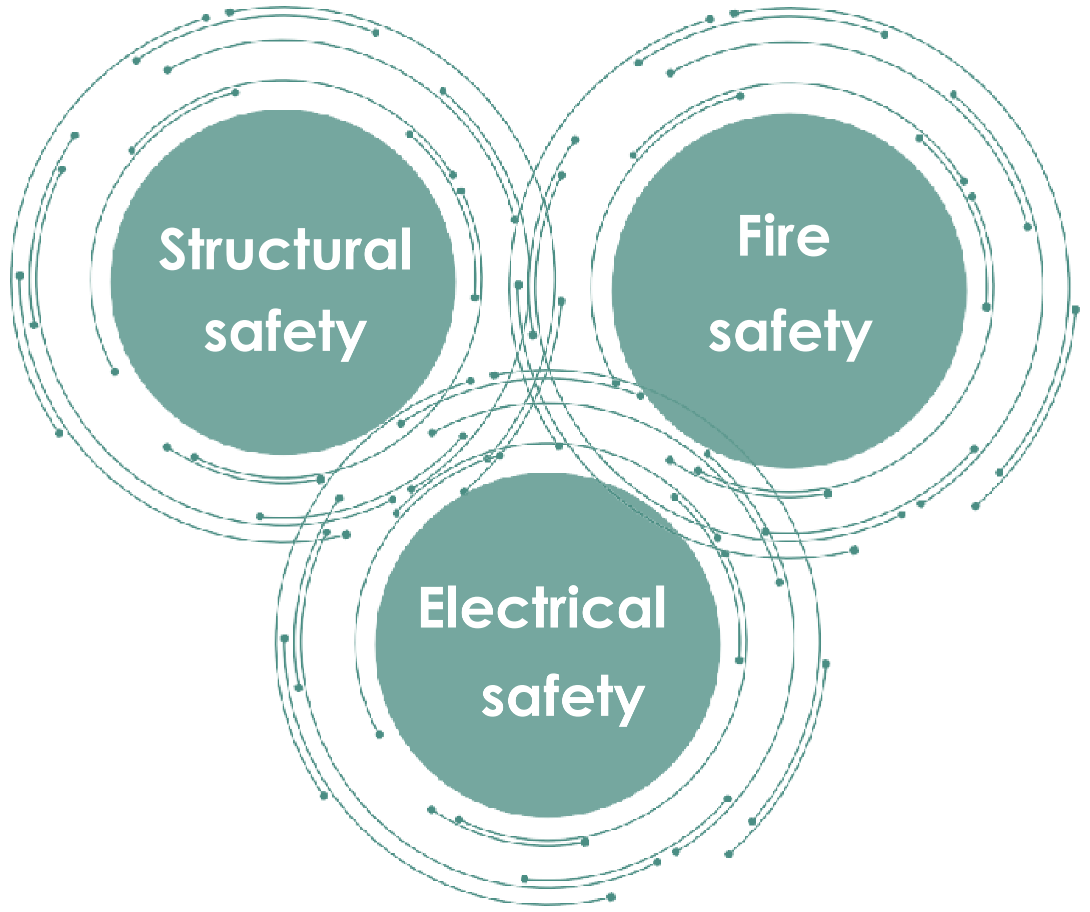
- Global alignment on what really matters
- Factory Acceptance Testing
- Site Acceptance Testing
- Personnel Safety

**Let’s get it RIGHT !!!**

# How do you build a safe battery ??

- Cells, Modules & Racks
- BMS (Command & Control)
- Fully Integrated cabinet
- Chiller & Liquid Cooling Pipework
- Separation spacing
- Safety Interlocks
- Gas, Smoke & Heat detection
- Fire Suppression (1230/FM200/Water/Aerosol)
- Ventilation
- Deflagration

# Multi-level Protection

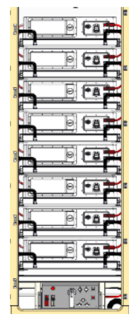



## SYSTEM

- Gas, Smoke & Heat Detection
- Aerosol & Water Fire Suppression
- Active Ventilation
- Explosion Protection
- Firebox Separation & Heat Barriers

## RACK

- Insulation Error Detection
- Redundancy
- Safety contactors

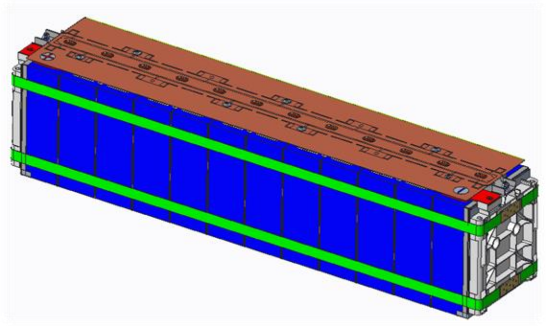


## PACK

- Liquid Cooling Jacket
- Electrical Isolation (MSD)
- Multiple Level Anti-Leak Design

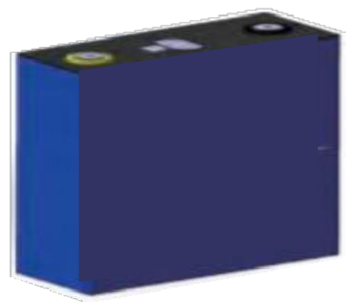
## MODULE

- Thermal Material
- Protection Board



## CELL

- LFP SAFE chemistry
- Battery Management System (BMS)
- Early warning algorithms



No Thermal Runaway

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# Fire & Explosion Prevention

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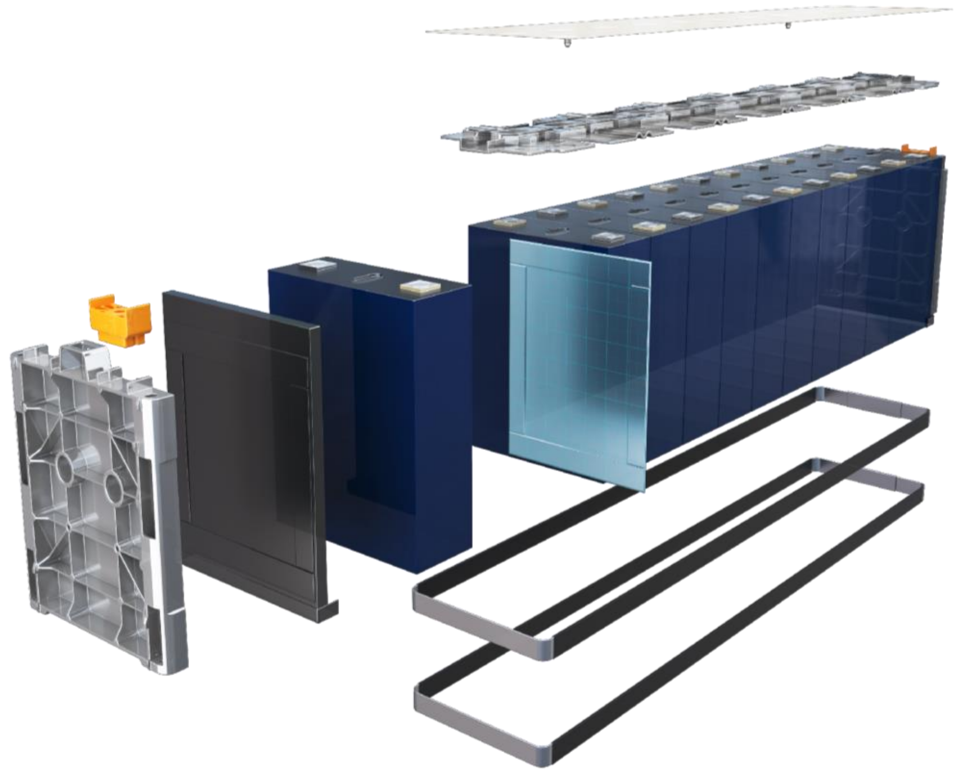
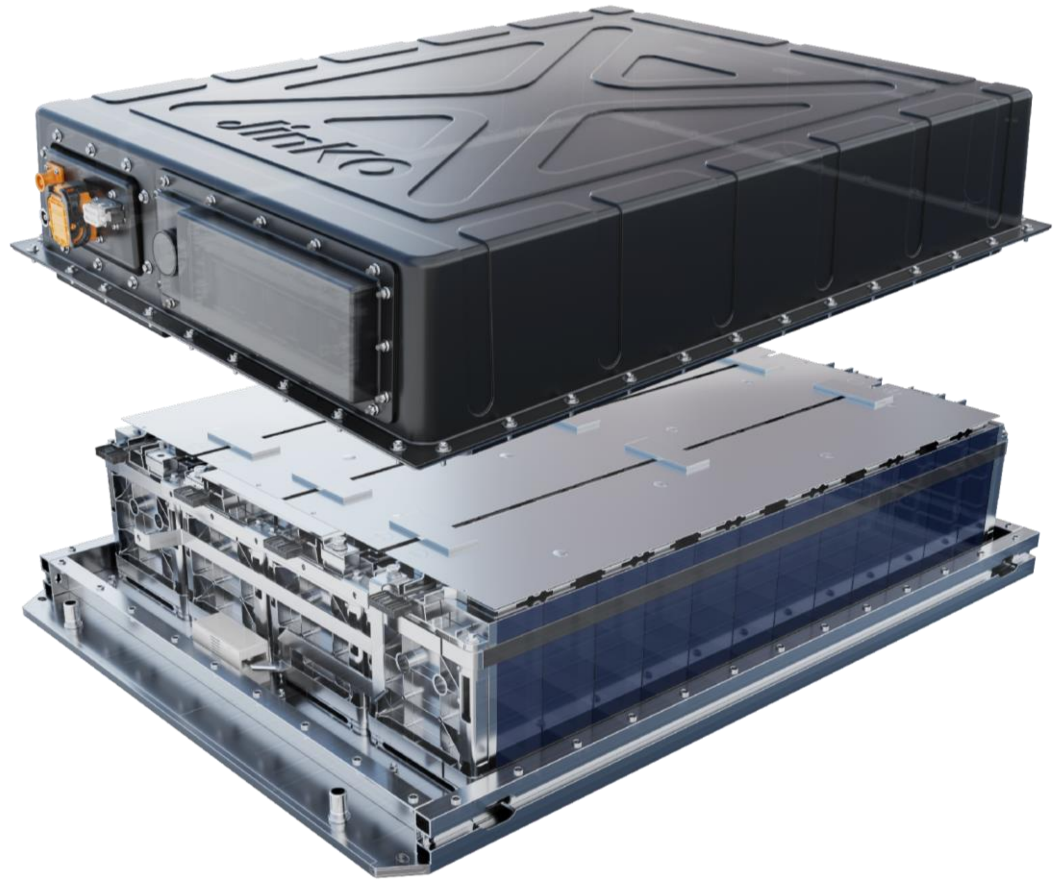
### Insulation Between Cells



### Insulation Coating of Pack Ceiling



### Active & Passive measures

- Cell: Heat insulation mica sheets are equipped between cells.
- Module: Protection board are added to module.
- Pack: High temperature insulation coating of 30-minutes heat-resistance of 1300°Celsius to contain flames and prevent propagation.
- System: Separate battery compartments to avoid the spread of thermal runaway.

- Active venting to avoid explosions.
- Internal barriers prevent uncontrolled spread.
- Internal Fire Suppression System extinguishes fire.
- JUST ADD WATER (Dry Pipe System) MANUAL FAIL SAFE.

# Intelligent Battery Management

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- Early detection and parameter tracking.
- Monitoring control and a deep understanding of the battery.

# SunTera-Building Your Trust in ESS



# ENERGY STORAGE AND SAFETY - WHY IS THIS IMPORTANT?

**JUERGEN MOELLMANN**
BUSINESS DEVELOPMENT MANAGER EUROPE

January 18, 2024

Honeywell

# WHY LI-ION BATTERY SAFETY MATTERS

The EPRI website tracked for the last 12 months 10 Stationary Energy Storage Failure Events with publicly available information and 4 additional Other Energy Storage Failure Events.

## Stationary Energy Storage Failure Events

This table tracks utility and C&I scale energy storage failure events with publicly available information.

*Note: Missing values in this table reflect unknowns.*

Show 10 entries

Search: Export

| Location | Energy (MWh) | Power (MW) | Application | Installation | Event Date | System Age (yr) | State During Accident | Source |
|---|---|---|---|---|---|---|---|---|
| US, AZ, Chandler | 40 | 10 | | Substation | 18 April 2022 | 3 | Operational | AZ Central |
| Longjing, Taichung City, Taiwan | 1 | 1 | Solar Integration | Power Plant | 30 March 2022 | 2 | Operational | Economic Daily |
| US, CA, Moss Landing | 400 | 100 | Solar Integration | Power Plant | 13 February 2022 | 1 | Operational | KSBW News |
| South Korea, Gunwi-gun, Gyeongsangbuk-do | 1.5 | 0.45 | Solar integration | Remote | 17 January 2022 | 3 | Operation. Fully charged | E2News |
| South Korea, Nam-gu, Ulsan | 50 | 10 | Peak Load Reduction | Urban | 12 January 2022 | 2 | Operational | E2News |
| US, CA, Moss Landing | 1,200 | 300 | Solar Integration | Power Plant | 4 September 2021 | 0.8 | | Vistra |
| Australia, Victoria, Geelong | 450 | 300 | Grid Stability | Rural | 30 July 2021 | 0 | Construction, Commissioning | ABC News |
| US, IL, LaSalle | 12.2 | 31.5 | Frequency Regulation | Rural | 19 July 2021 | 6.2 | | The Times |
| Germany, Neuhardenberg | 5 | 5 | Solar Integration and Frequency Regulation | Indoor/Hangar | 18 July 2021 | 5 | | RBB 24 |
| Boulouparis, New Caledonia, France | | | Solar Integration | Rural | 13 July 2021 | | | FranceTVInfo.fr |

*Source: https://storagewiki.epri.com/index.php/BESS_Failure_Event_Database*

# WHY LI-ION BATTERY SAFETY MATTERS

- Safety is mandatory when a risk for environment and health is identified.

- Lithium-Ion technology has by nature a flammable and toxic risk.

- Lithium-Ion fire scenarios are different from other energy resources.

- Different requirements for risk prevention and mitigation on batteries

# WHY LI-ION BATTERY SAFETY MATTERS

The main safety concern when installing a Lithium-Ion battery system is that the battery will start to burn and the development of explosive and toxic gasses.

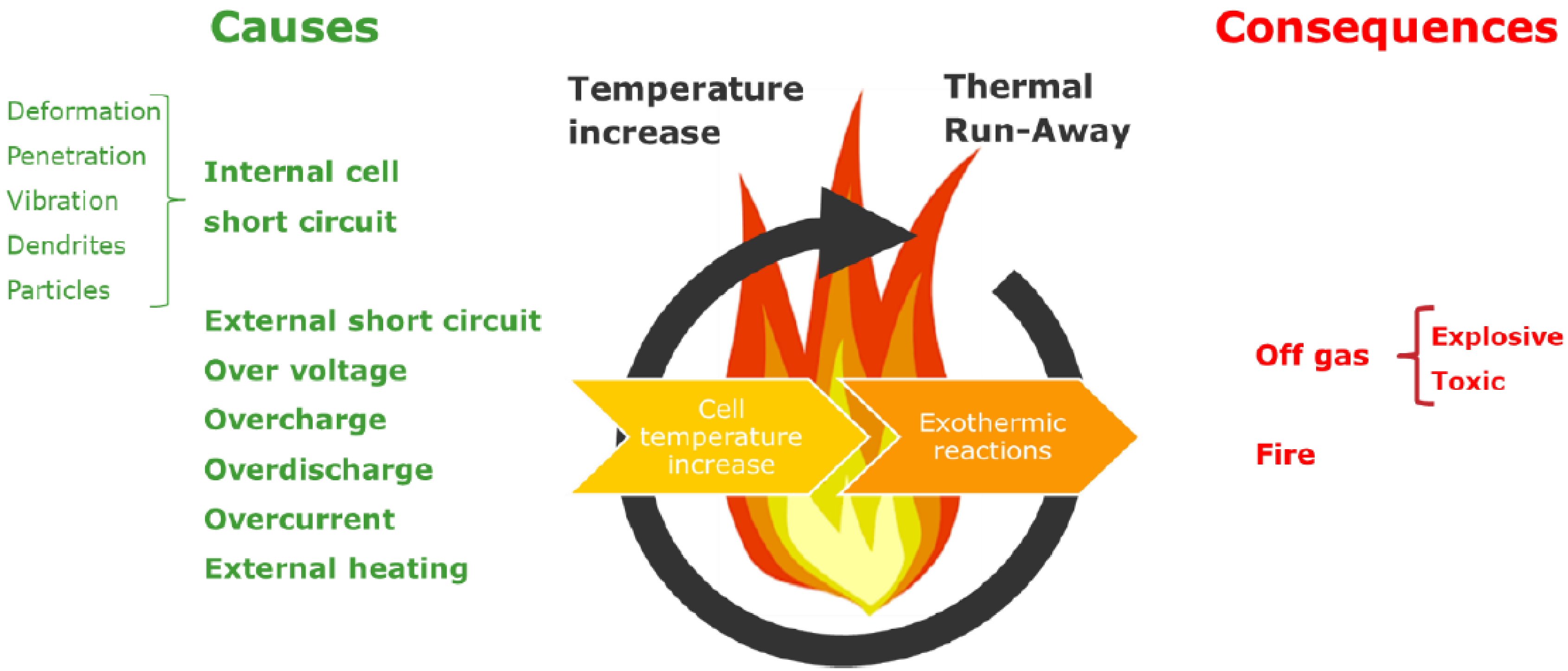



**Figure 2-1: Causes and consequences of a thermal runaway in a battery system.**

*Source: https://www.dnv.com/Publications/technical-reference-for-li-ion-battery-explosion-risk-and-fire-suppression-165062*

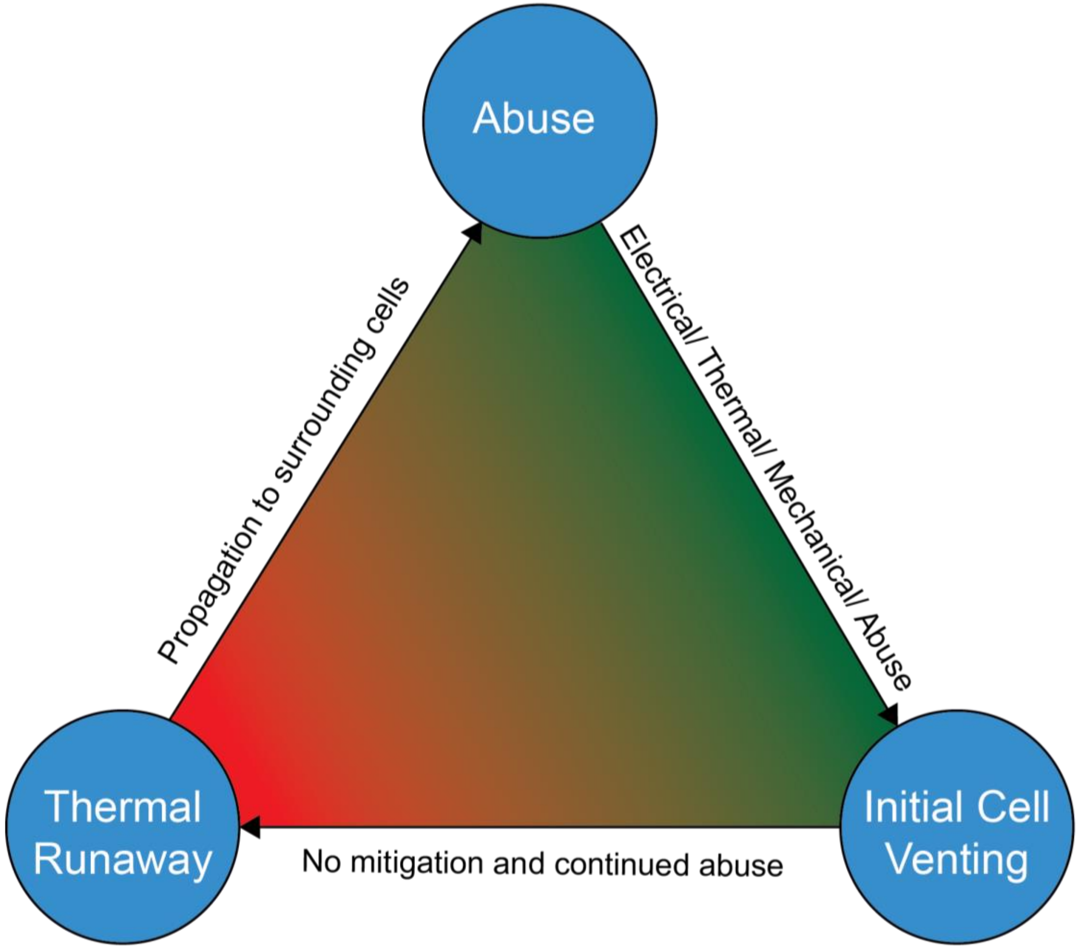
# HOW CAN SENSING TECHNOLOGY INCREASE SAFETY?

- Lithium-Ion batteries follow a common failure process:
  - Abuse Factor – Initial Cell Venting – Thermal Runaway

- Preventing thermal runaway requires early detection of cell venting

- New gas sensing technology provides reliable cell venting detection

- Preventing fires by early gas detection is a common process for decades, i.e. oil & gas industry



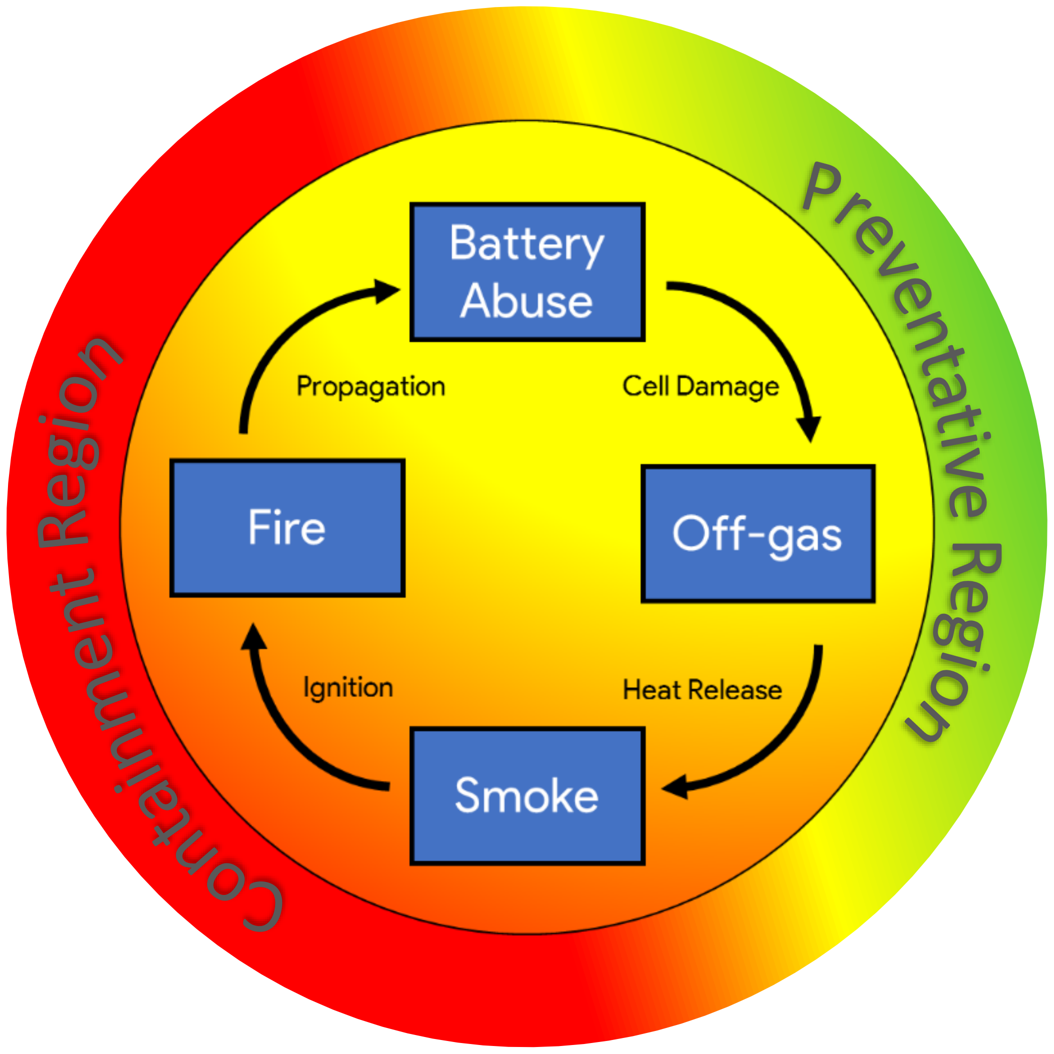
# BATTERY FAILURE STAGES

- **Stage 1: Abuse Factor**
  – Thermal, electrical, or mechanical abuse

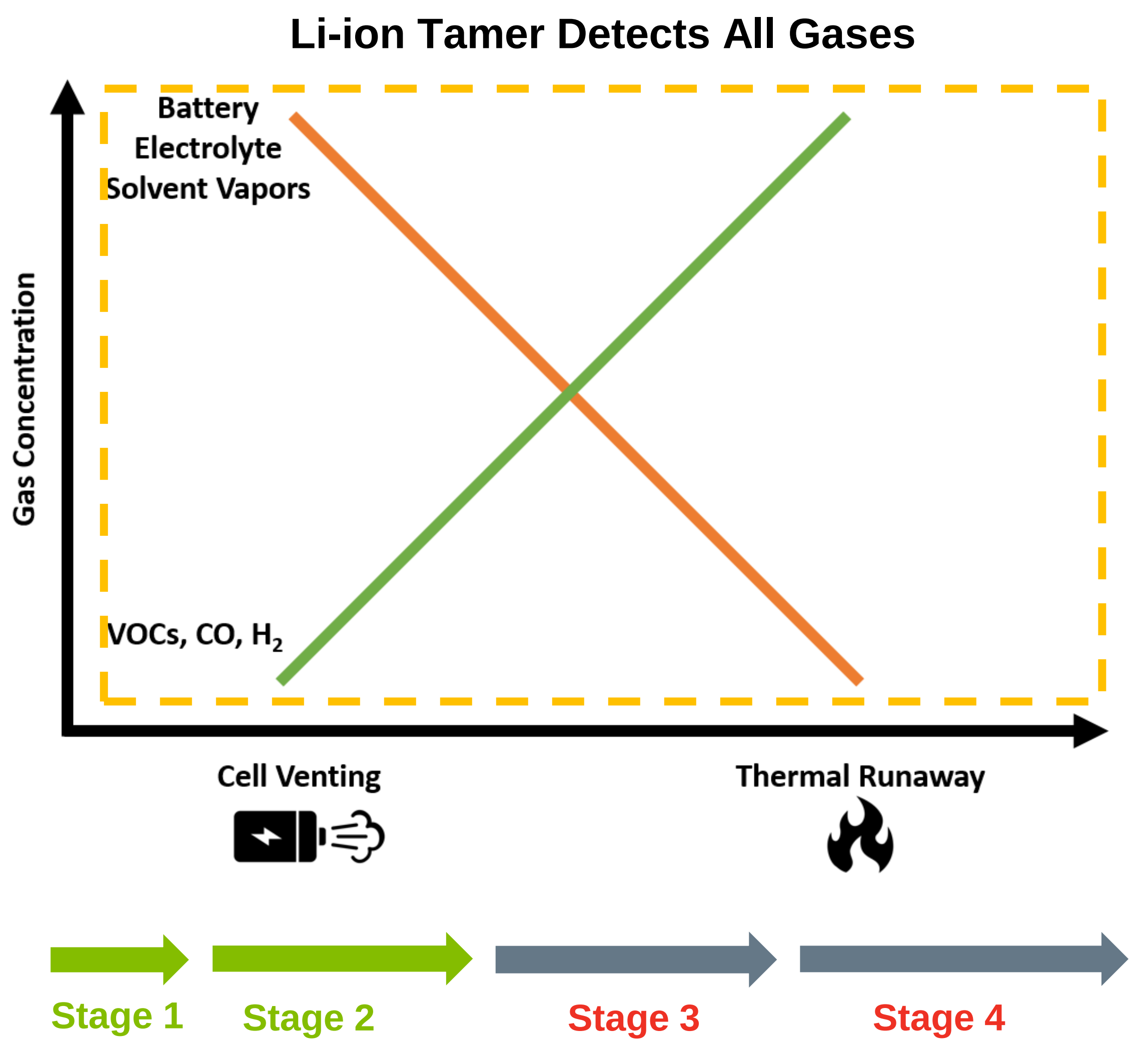
- **Stage 2: Off-Gas Generation**
  – Golden Time

- **Stage 3: Smoke Generation**
  – Catastrophic failure is imminent

- **Stage 4: Fire generation**
  – Propagation Occurrence



# CELL VENTING VS THERMAL RUNAWAY




3rd party testing data with GC-MS, FTIR

**Stage 2**

**Cell venting gas composition:**

45% Battery Electrolyte Solvent Vapours (DEC, DMC)
<0.1% $H_2$
0% CO
55% Rest (water vapor, $CO_2$, etc.)

**Stage 3 & 4**

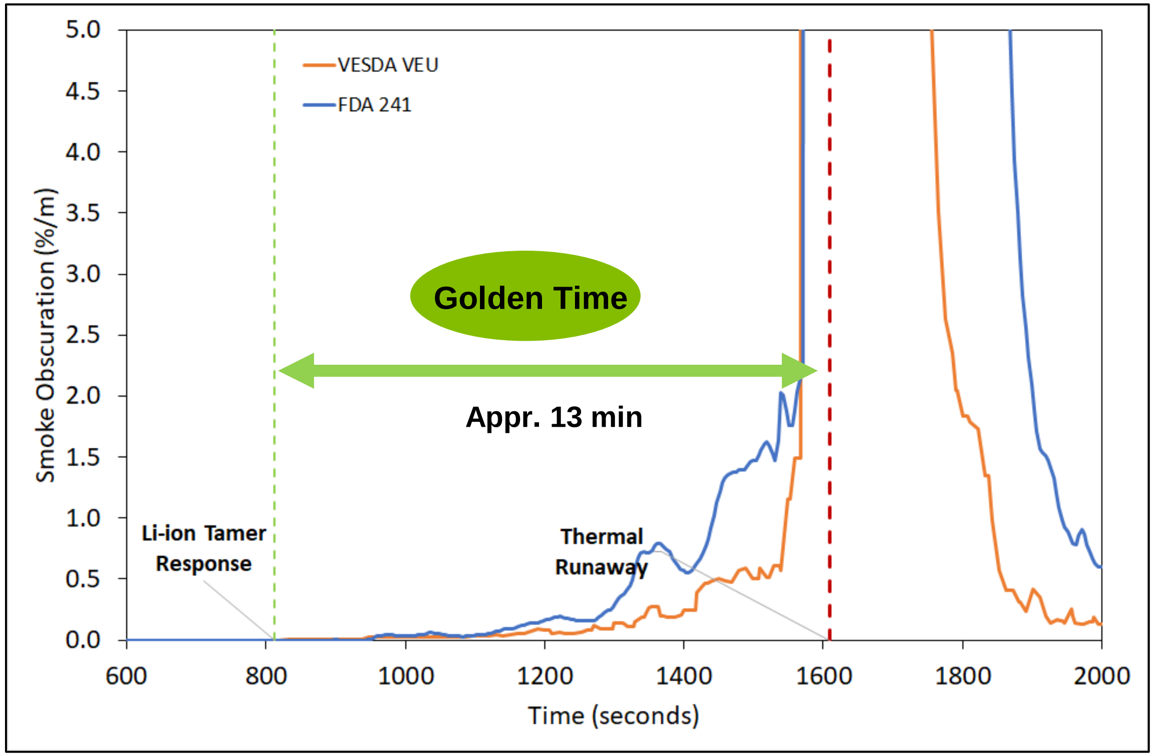
**Thermal runaway gas composition:**

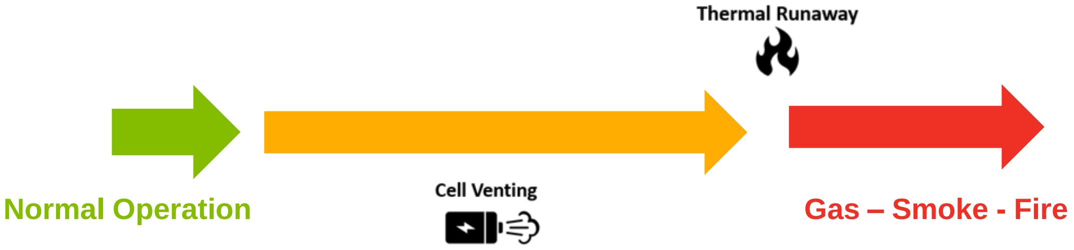
5% Battery Electrolyte Solvent Vapours (DEC, DMC)
15% $H_2$
32% CO
15% tVOC (Propane, Butane, Ethane, Methane, etc.)
33% Rest (water vapor, $CO_2$, etc.)

# DETECTION PERFORMANCE

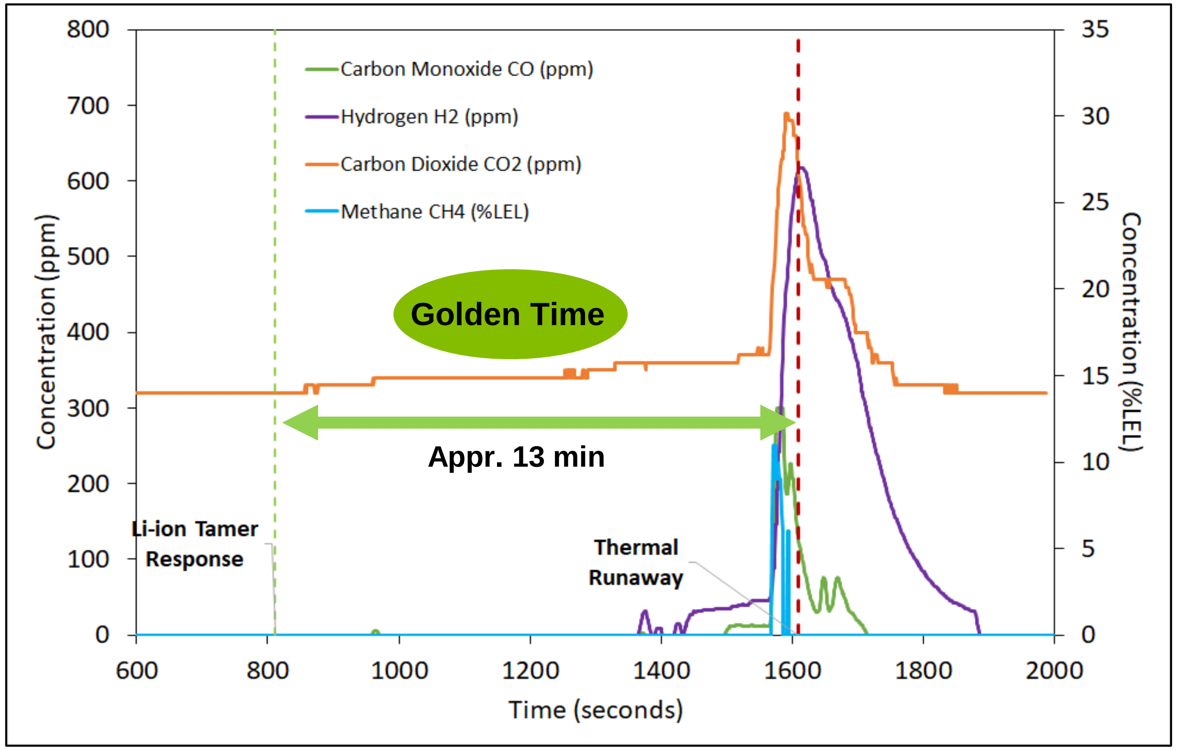
**Test Setup:**
- Open Space
- Chemistry: LFP
- Form: Prismatic
- Abuse: Over-Charge

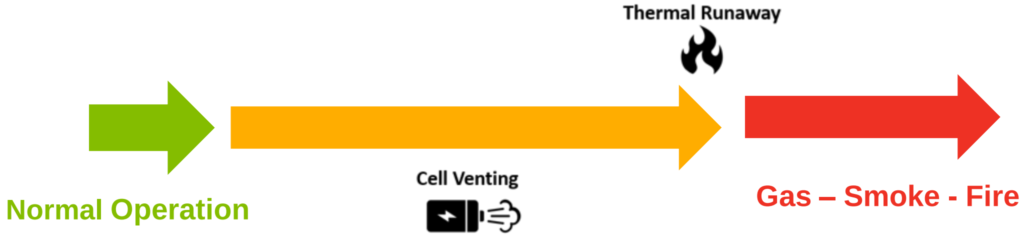
## Li-ion Tamer vs. Aspirating Smoke Detection




## Li-ion Tamer vs. Conventional Gas Detection

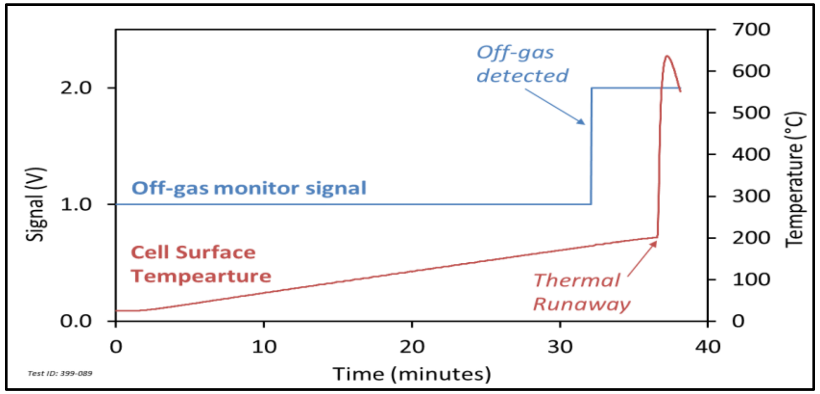


# COMPILED FAILURE DATA - OVERVIEW

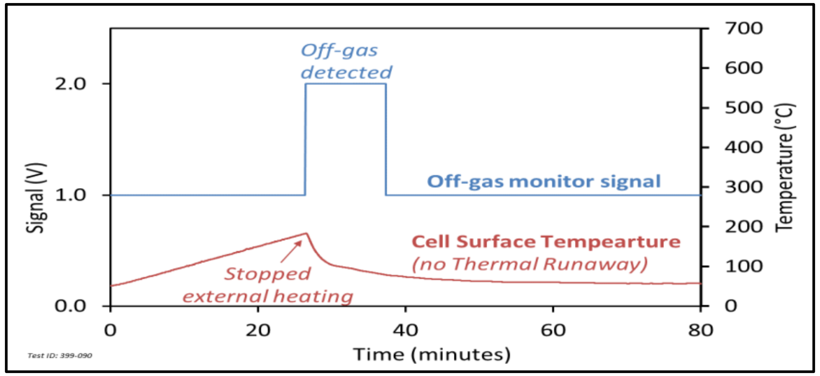
## Test 1: Early Warning

- UL 9540A test method distinguishes between venting and thermal runaway
- Off-gas detection can provide early warning
- Independent of chemistry, capacity and form factor




## Test 2: Barrier to Thermal Runaway

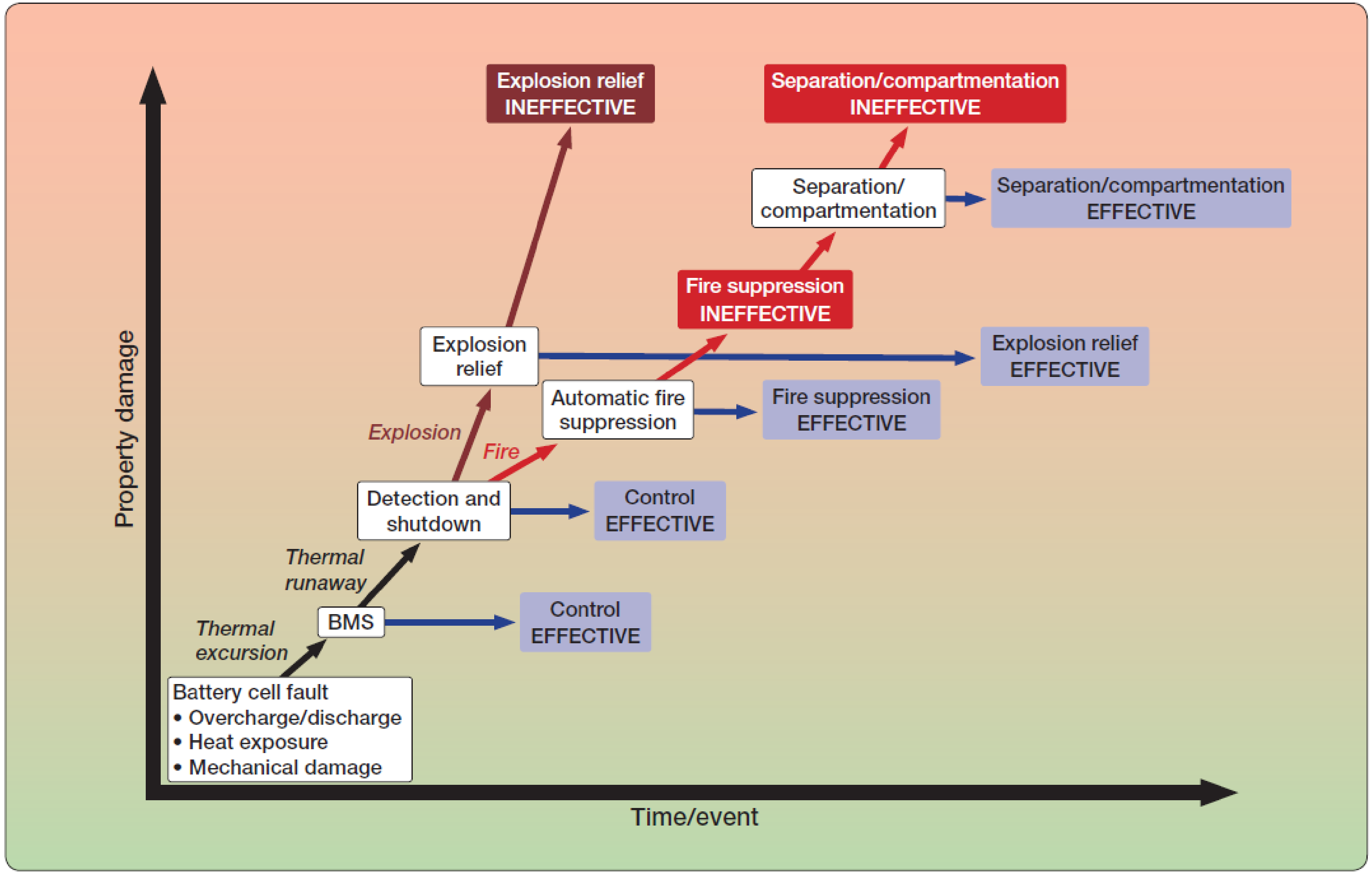
- Off-gas monitoring can enable mitigation
- Isolate from charge/load when off-gas occurs
- Provides an effective barrier to thermal runaway



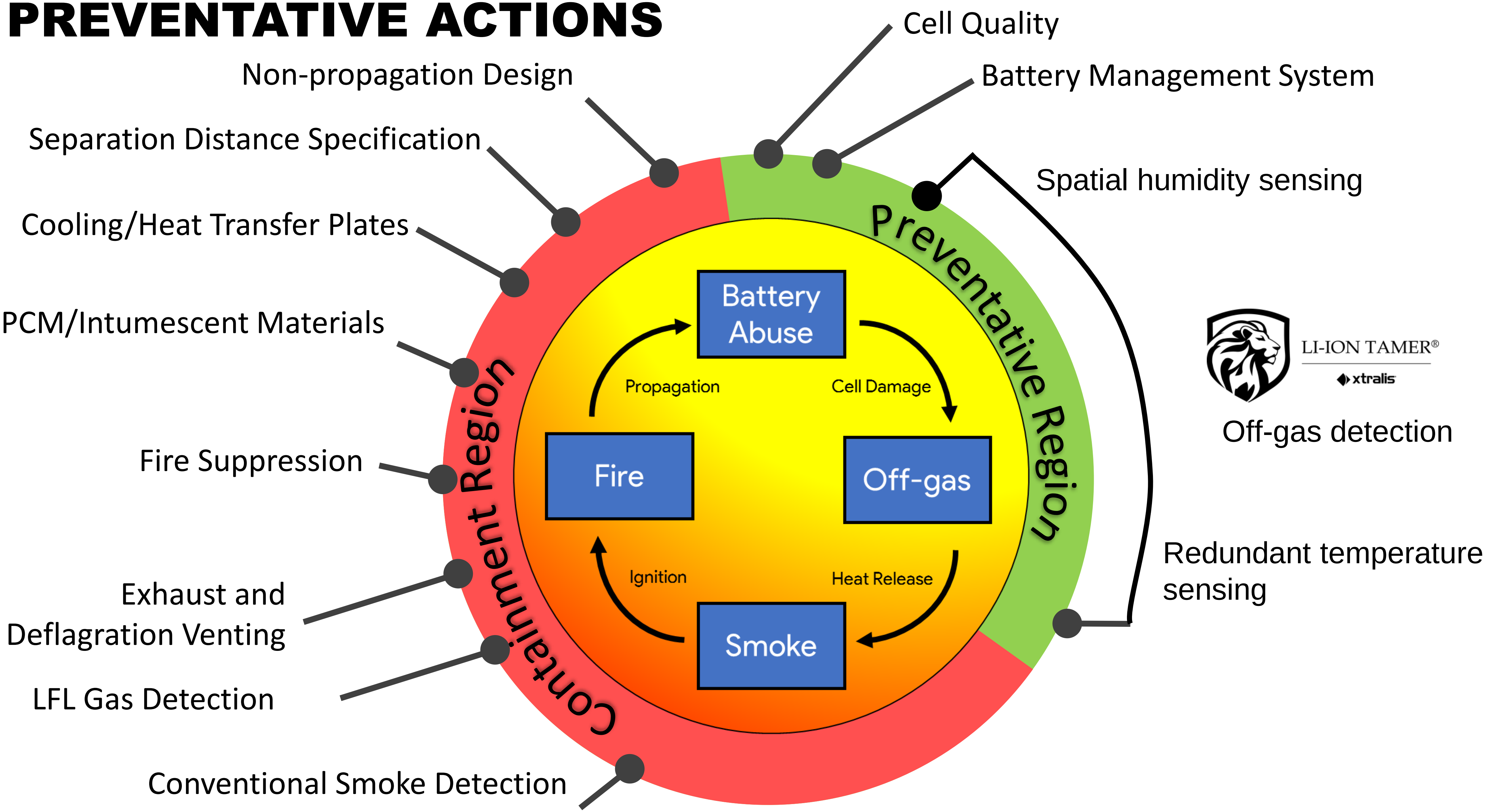

**Li-ion Tamer is >95% successful in preventing thermal runaway when the abuse factor can be isolated.**

# PREVENTATIVE ACTIONS

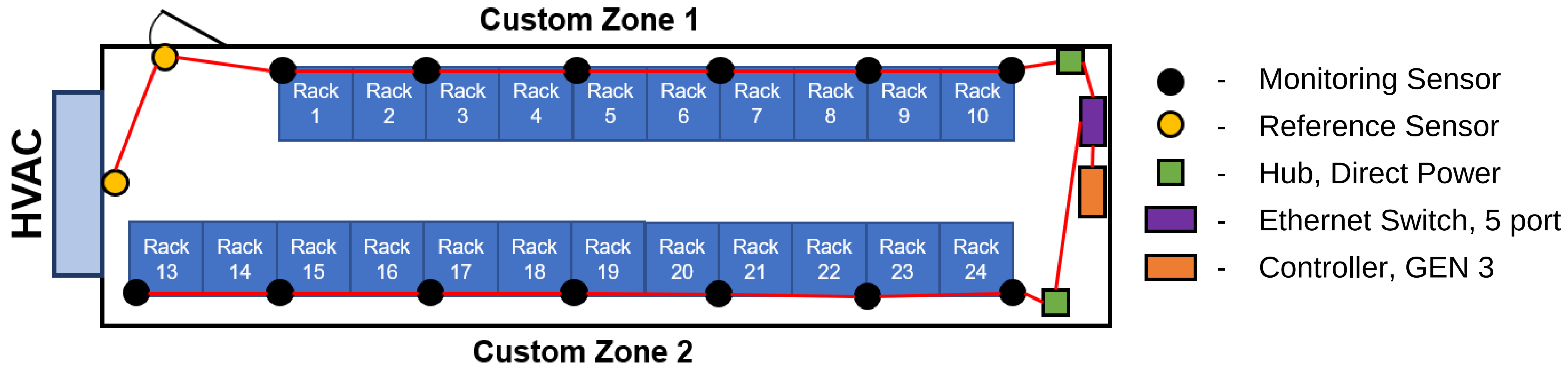
FPA Need to Know Guide RE1 – Battery energy storage systems: commercial Lithium-ion battery installations



# PREVENTATIVE ACTIONS



# LI-ION TAMER SYSTEM LAYOUT EXAMPLE



# 3RD PARTY REPORTS AND GUIDANCE

- FPA - Need to Know Guide RE1 – Battery energy storage systems: commercial Lithium-ion battery installations

  3 Risk control recommendations

  7. For critical and significant BESS installations, install early detection of off-gases/ electrolyte-vapour from thermal runaway events, interlocked to shut-down and disconnect the BESS. This may be combined with deployment of an extinguishing agent flooding system (based on the fire control strategy).

- DNV - GL Report (Jan 12th 2020)

  *"…LEL sensors and voltage do not provide a mechanism for early warning.* ***In comparison, the Li-ion Tamer® sensor indicates only seconds after off-gassing occurs. In addition, testing was performed where a cell was being overcharged and charging stopped when off-gas was released as indicated by the Li-ion tamer®. The cell temperatures ceased to increase, and off-gassing started to decline until the cell was considered stable****. Thus, demonstrating it is feasible to 'pull back' a cell after it has begun off-gassing but before thermal runaway occurs.* ***Meaning early detection, coupled with correct system shutdown measures is an important safety barrier." - (section 3.4.1)***

- FM Global – Property Loss Prevention Data Sheets – Electrical Energy Storage Systems (5-33; rev. July 2023)

  2.5.3.3 Early Intervention Thermal Runaway Prevention

  2. Off-gas detection: Provide gas detectors capable of detecting the volatile oxygen compounds associated with the off-gas event that precedes thermal runaway.

## STEP 1 – PREVENT

Lowering the risk of a probably maximum loss (PML) scenario depends on the ability to prevent a fire from starting. This ability is enhanced by early warning of a battery failure using an advanced electrolyte vapor sensor, like Honeywell Li-ion Tamer. During the early stages of a cell failure, it is possible to measure the presence of electrolyte vapor from a cell before the situation deteriorates into a thermal runaway. The system can be configured to automatically electrically isolate the affected cell or battery rack using the Battery Management System. Other preventive actions can also be automatically initiated - like increasing ventilation and cooling.

## STEP 2 – DETECT

Once the incident escalates to the point of generating heat and smoke, detection systems must activate as early as possible to limit the damage. Aspirating Smoke Detectors (ASD), like the Xtralis VESDA-E series, provide early warning with excellent nuisance alarm rejection. The pipework design for smoke detection can also profoundly affect performance. BESS facilities can use cooling fans combined with an HVAC to generate air movement through the battery rack. Cool air flows through the battery racks while hot air gets expelled via the HVAC. Positioning custom pipe networks feeding the smoke sensors allows for targeted detection from the most likely sources of fire.

## STEP 3 – CONTROL

A fire alarm control panel is critical for managing detection devices, monitoring the system's health, and activating preventive measures. Control panels allow technicians to take individual devices out of service for maintenance and to replace components without taking the whole system offline. Modular and flexible systems allow BESS facilities to adjust their system as their needs change or as new detection technologies become available. Honeywell systems, like the ESSER FlexES control unit, offer built-in redundancy to ensure maximum system reliability and an easy-to-use operating display panel.

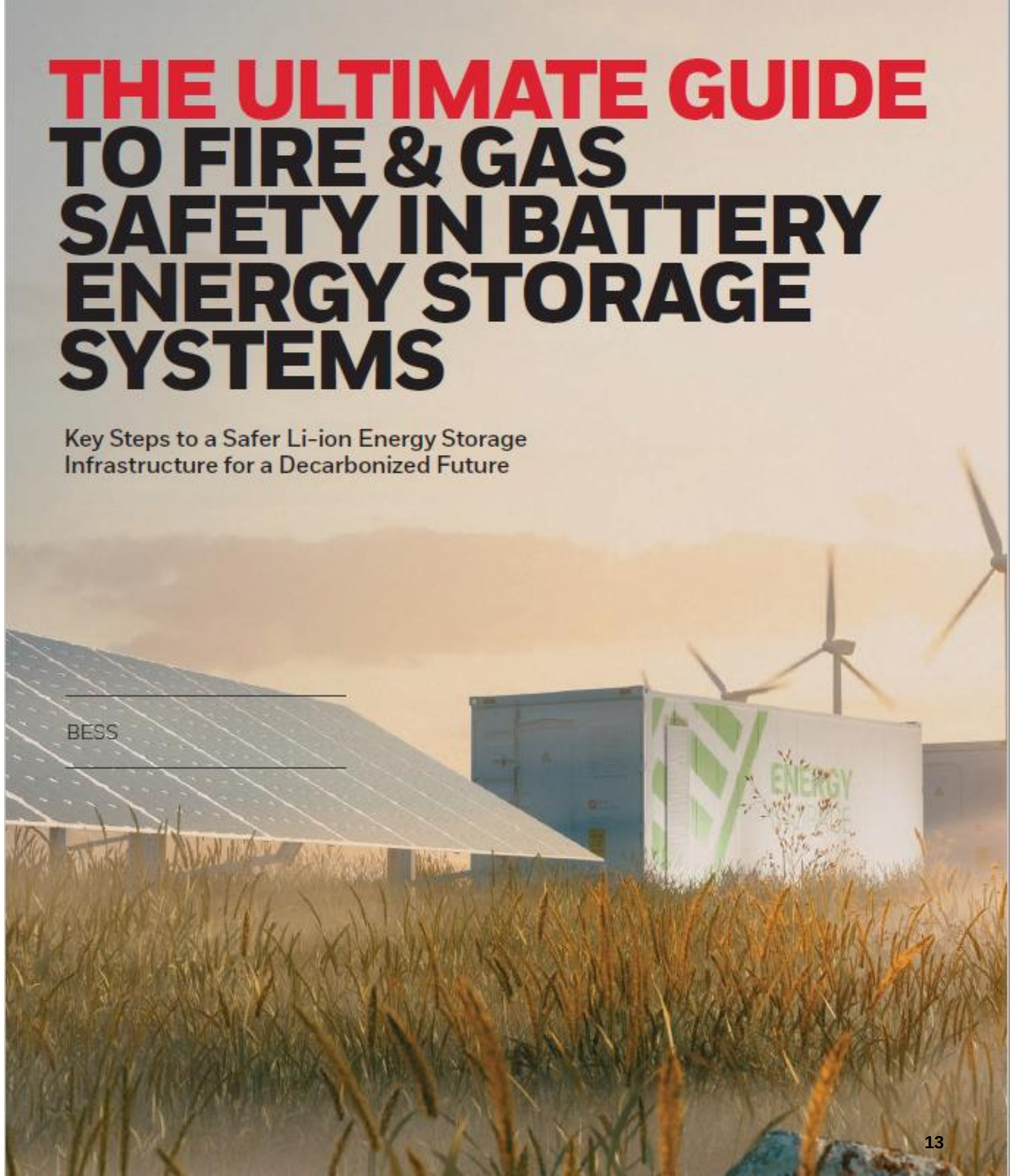
## STEP 4 – CONNECT

Many BESS facilities are in remote locations where they support the integration of renewable energy sources, like wind farms, into the electrical grid. Remote visibility of the real-time status of the facility and the fire protection sensors is vital to enhance timely and data-based decisions. A cloud platform, like Honeywell CLSS, offers several features that improve safety. For example, push notifications to mobile devices ensure that specific staff are instantly alerted of information relevant to their role. Service and system reports allow for better planning of interventions and a reduction in downtime. Honeywell CLSS also logs device testing, servicing, and maintenance for compliance reporting.

# THE ULTIMATE GUIDE TO FIRE & GAS SAFETY IN BATTERY ENERGY STORAGE SYSTEMS

Key Steps to a Safer Li-ion Energy Storage Infrastructure for a Decarbonized Future

BESS



# HOW DOES ENSURING SAFETY IMPACT THE ENERGY STORAGE BUSINESS CASE?

**Asset Availability**

**Restoration & Insurance Costs**

**Public Perception**

# LESSON LEARNED

- **Li-Ion Battery Risks**
  - Heat and Gas Generation (Electrolyte Solvent Vapour Off-Gas Event)
    - Flammable gas release  fire hazard
      - e.g., Electrolyte Vapour, $H_2$, VOC’s, CO, $CO_2$
    - Toxic gas release  Toxic hazard to people, environment and equipment
      - e.g., CO, $NO_2$, HCl, HF, HCN, benzene, etc.
      - The DNV test weighting the Immediately Dangerous to Life or Health (IDLH) values with the released gas amounts, CO $NO_2$ and HCL will first reach its IDLH values.

- **Reducing Risks by Multiple Layer of Protection**
  - Battery Quality
  - Battery Management System and Data Analytics
  - Early Off-Gas (Electrolyte Solvent Vapour) Detection
  - Early Smoke Detection with Aspirating Smoke Detection
  - Suppression System

# LI-ION TAMER® GEN3


2023 WINNER

DCD >Awards

Mission Critical Tech
Innovation Award

HIGHLY COMMENDED

ENERGY STORAGE
AWARDS

PRODUCT OF THE YEAR
2023

# Questions?

# THANK YOU

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