Tutorial 3: Worst Case Scenario - What if systems fail?

ENERGY STORAGE SYSTEMS
SAFETY & RELIABILITY FORUM

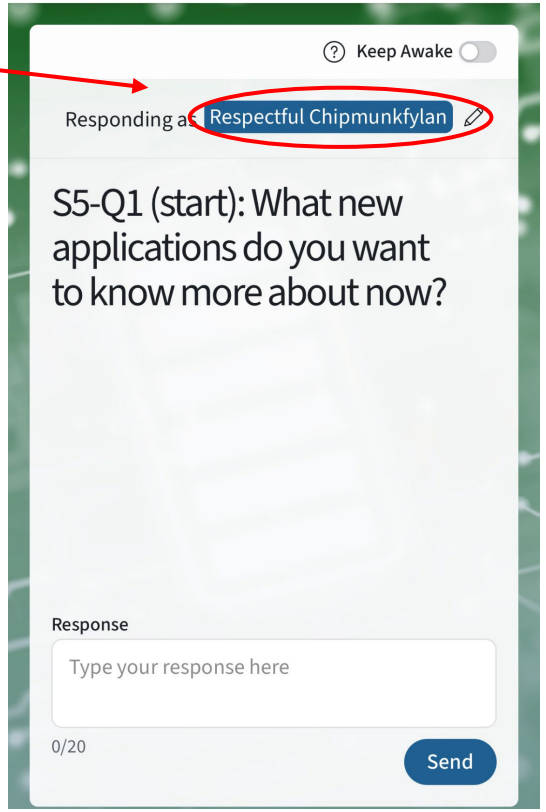
Learning Objectives

- Attendees will learn about working with AHJ's, best practices for emergency planning response, and unique decommissioning case studies.

Poll Questions

Please visit Poll Everywhere via the **QR** code below (mobile) or at **pe.app/essrf** (laptop). If you would like to add your name, please update with the "pencil" icon. If not, feel free to remain anonymous

Respond at
pe.app/essrf



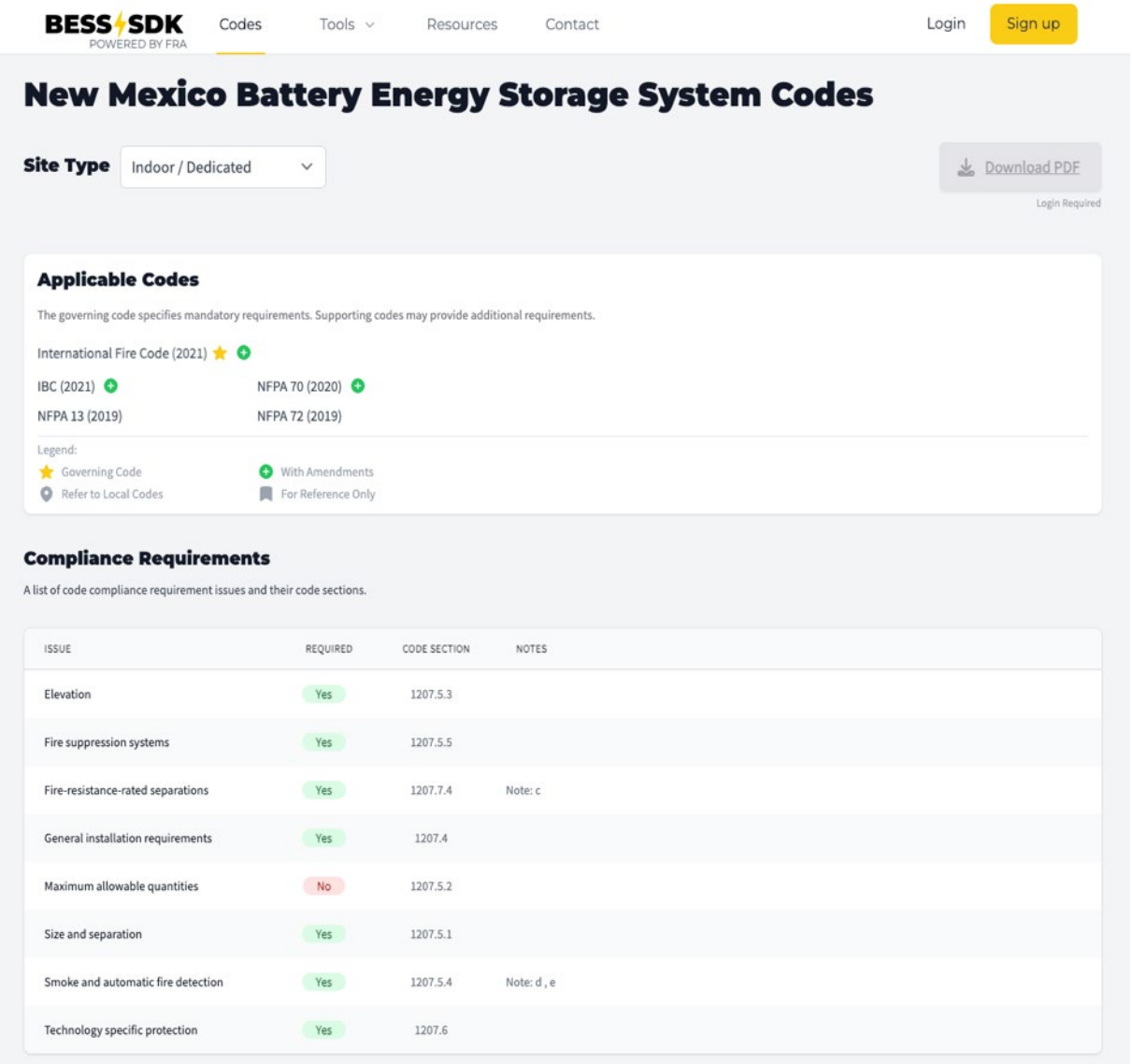
Poll:

What are the most common causes of BESS failures?

a) Cell defects
b) Integration Workmanship Issues
c) Water leaks/Intrusions
d) Operations/controls Failure

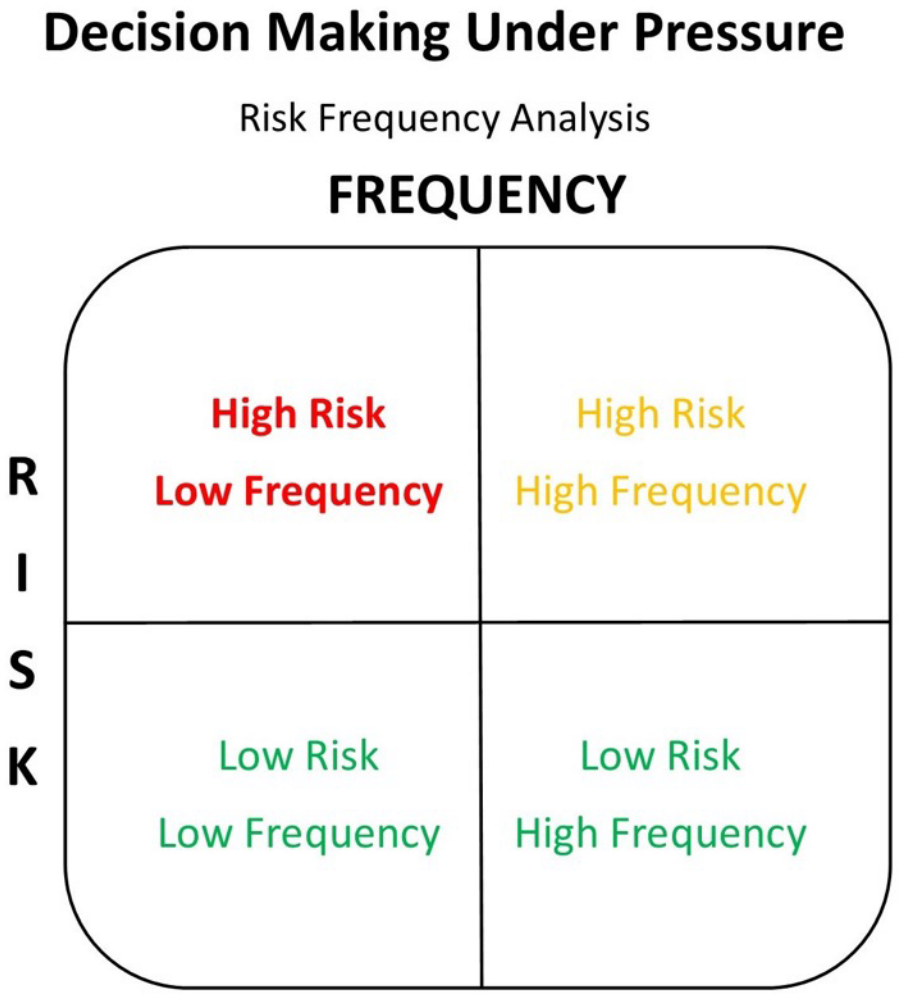
Working with AHJ's

- Ensuring knowledge of locally adopted codes
  - Zoning, building, fire
- Early engagement with all stakeholders
  - Education and communication
- Ensure proper use of listed system and components
- Early identification of specific BESS equipment
- **Equipment tested, certified, and installed to the most current edition of NFPA 855**



ERP Training

- Emergency Planning & Training required by NFPA 855 (4.3.1)
  - For operations staff as well as responders
- Table-top exercises to simulate various events and coordinate resources. Plan A, B, & C
  - Unified command structure based on ICS
  - Incident based on ERP, modeling from plume models, and other scenario inputs
- Conduct drills across all shifts – **Seldom used skills**
- Decommissioning plan (planned and unplanned).



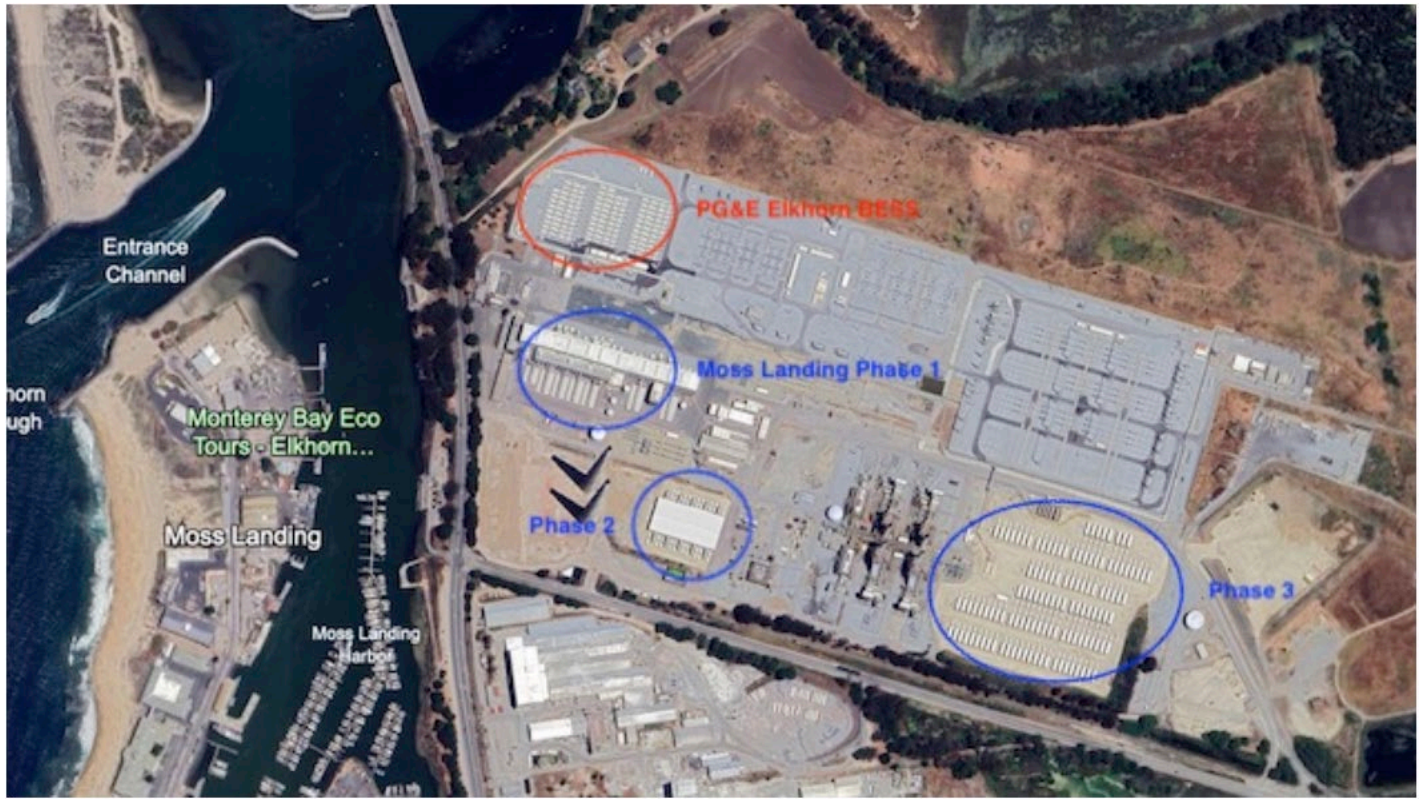
Response Best Practices

- ERP based on LSFT to support minimal intervention with expected event duration
  - Pros & Cons of offensive/defensive approaches.
  - Water is a double-edged sword; it absorbs heat, but is conductive and may exacerbate contamination, event duration, and mitigation.
- Early resource requests
  - Hazmat Unit
  - Air/water monitoring onsite & downrange (local/state EPA)
  - Support for shelter/evacuations as needed (LEO)
  - Media outreach (PIO)
  - Owner/Operator mitigation personnel (IFC)

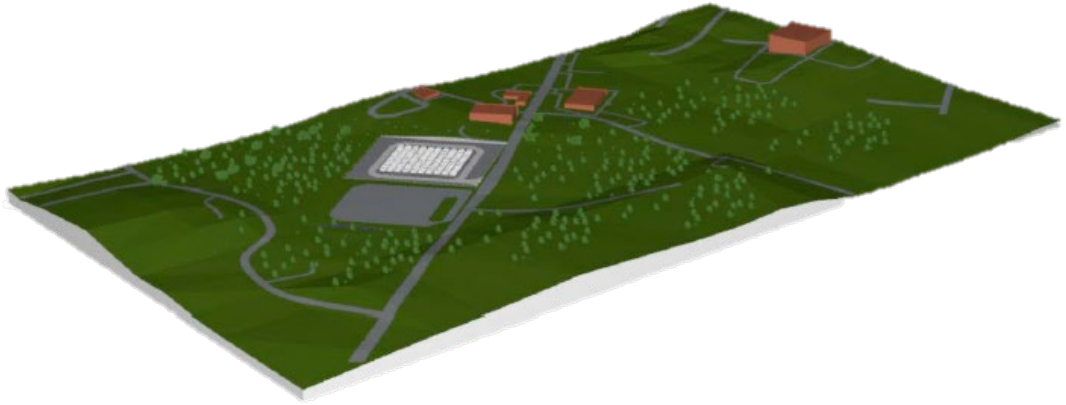
Credit: CBS8

Credit: Hithium

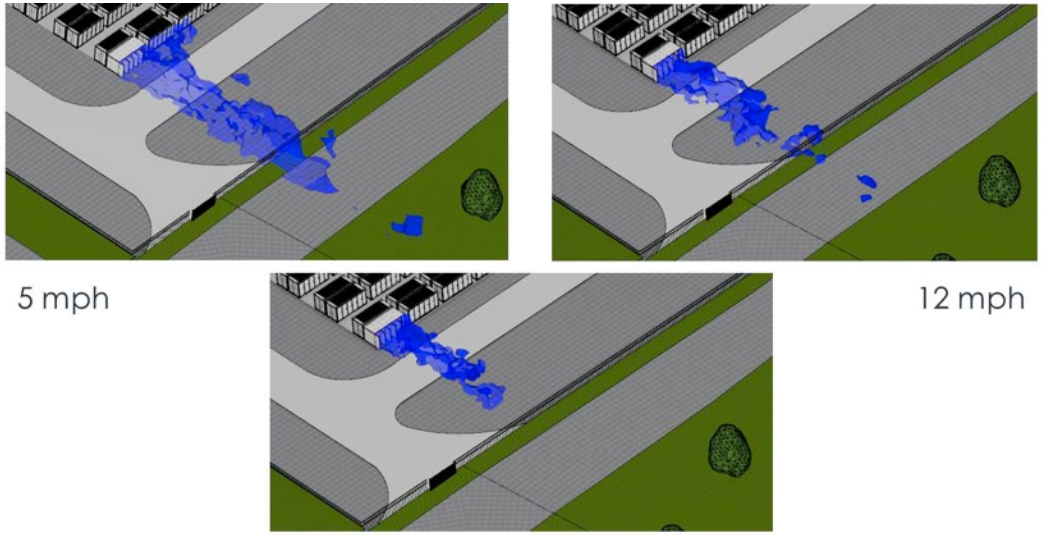
Case Study: Moss Landing/Elkhorn BESS "Successful Failure"



Plume Modeling



- Analysis performed by Fire Risk Alliance utilized both flaming and non-flaming dispersion modeled in Fire Dynamic Simulator (FDS).
- Process Hazard Analysis Software Tool (PHAST) used for parametric models of hazardous materials to inform FDS.
- Model based on aggregated data set from UL9540A and LSFT data. Not a site-specific plume model.
- Toxicity based on 3 thresholds systems:
  - Immediately Dangerous to Life & Health (IDLH)
  - Emergency Response Planning Guidelines (ERPG)
  - Acute Exposure Guideline Levels (AEGL) – most conservative.



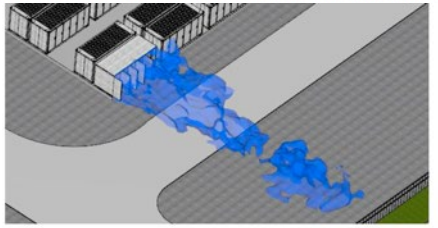
Plume Modeling

- HF is extremely reactive and very difficult to measure
- CO:HF ratio of 7:1 used as HF is not measured in UL9540A.
- Pre-combustion values used (lower plume height)
- Extents are at breathing height and instantaneous measurements. Not representative of sustained concentrations.
- Using this model, toxic values measured at fence (100’)
  - Very conservative values based on CO:HF ratio and 30 min continuous exposure duration.

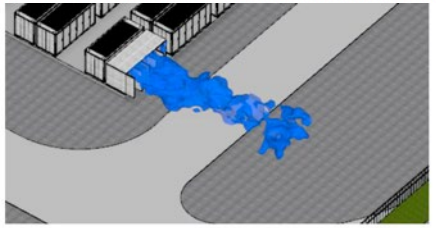
Table 17. CO toxic gas extents at breathing height

Endpoint Criteria	Wind Speed (mph)	Maximum Radial Horizontal Extent from Initiating containerized BESS (m)	Maximum Radial Horizontal Extent from Property Line* (m)
AEGL-2 (83 ppm)	5	73.7	43.6
	12	47.5	17.4
	20	24.5	Does not reach property line
ERPG-1 (200 ppm)	5	32.8	2.7
	12	24.2	Does not reach property line
	20	17.6	Does not reach property line
AEGL-3 (330 ppm)	5	24.5	Does not reach property line
	12	17.3	Does not reach property line
	20	12.9	Does not reach property line
ERPG-3 (500 ppm)	5	18.2	Does not reach property line
	12	13.4	Does not reach property line
	20	12.4	Does not reach property line
IDLH (1200 ppm)	5	9.2	Does not reach property line
	12	5.9	Does not reach property line
	20	6.2	Does not reach property line

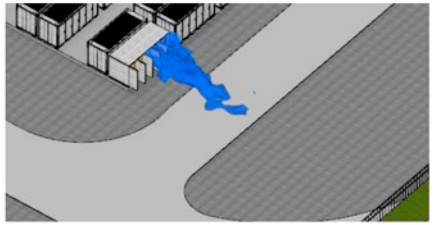
*30 m downwind of the initiating BESS unit



5 mph



12 mph



20 mph

Poll:

Plume modeling should be part of a complete permit package?

Yes
No

Decommissioning

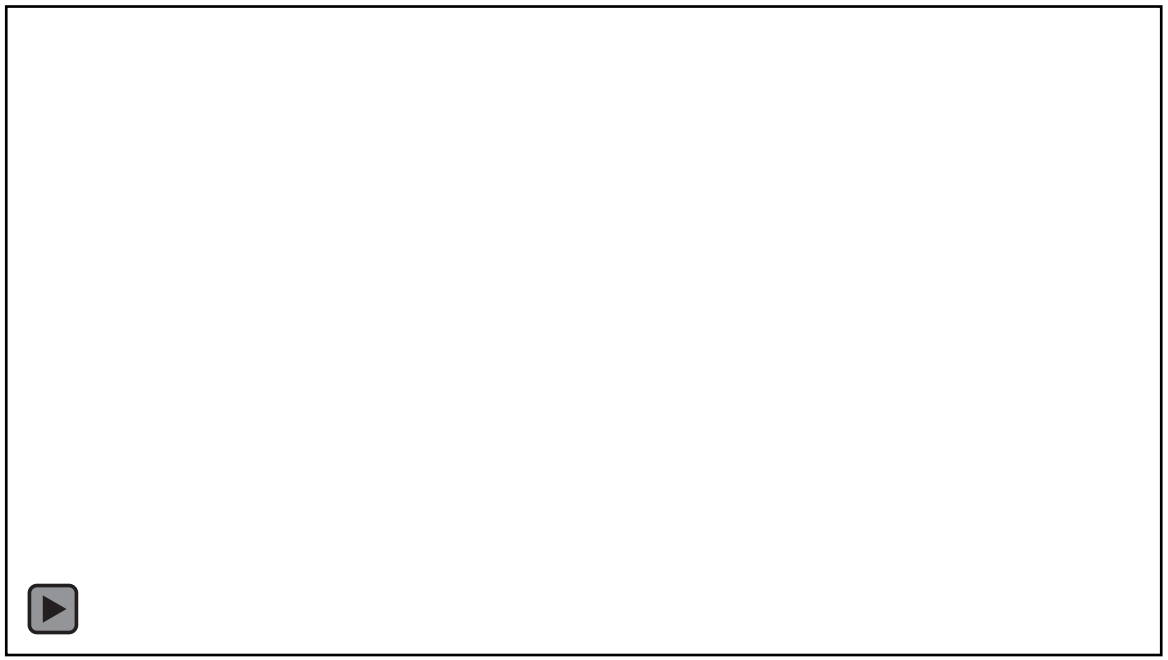
- Planned vs Unplanned
  - Planned is across the board from liability, to + recycling value, neutral, or expense. Shipping location is huge unknown 10yrs down the line. Site restoration is another huge factor. Blind spot for industry.
  - Unplanned expense can exceed CAPEX

- EPA developing best practices
  - “Maui Method”
  - LA County Fires
  - Gateway BESS
  - Moss Landing

Credit: Bloomberg

LA Wildfires and Battery Shredding

When you need to turn batteries into “not batteries”



Credit: US EPA

Before

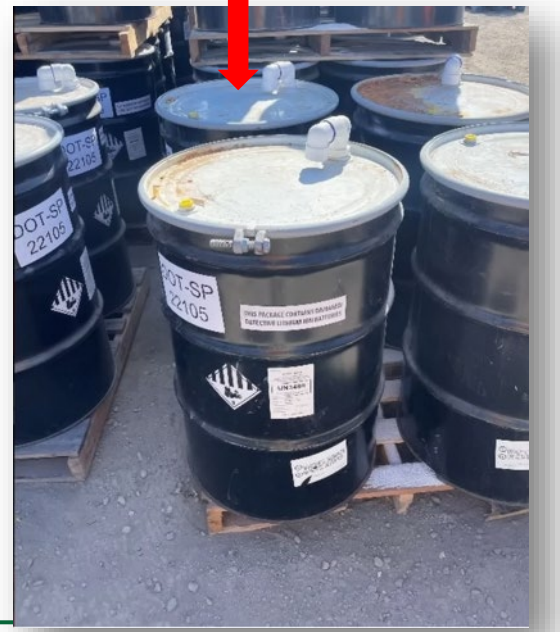
After

Case Study: Gateway BESS

May 15, 2024	Initial Fire
May 31, 2024	Fire Contained
December 2024	Building Disassembled
January 2025	Battery Removal Start
September 2025	Applied for DOT Permit
October 2025	Special Permit Obtained
January 2026	Last Batteries Shipped to Recycler

Credit: US EPA

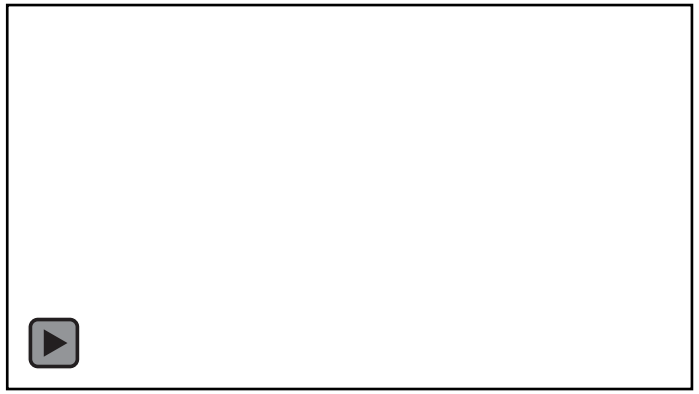
Case Study: Gateway BESS

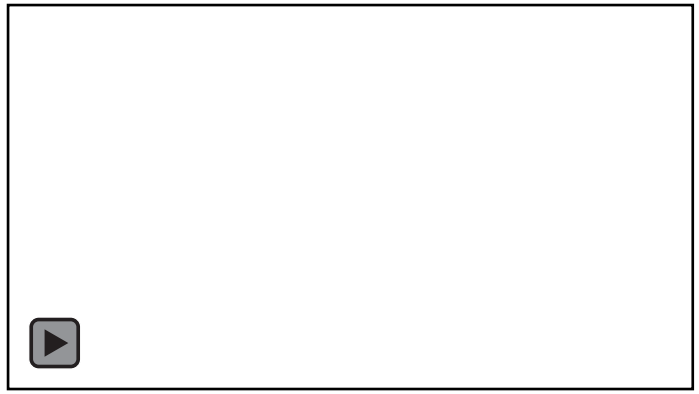


Credit: US EPA

Case Study: Moss Landing BESS

Jan 16, 2025	Initial Fire
Jan 18, 2025	Fire out
Feb 18, 2025	Reignition
Feb 22, 2025	Delinking of undamaged modules begins
Mar 13, 2025	Delinking complete
July 2025	Fire debris removal begins
Aug 2025	Building stabilization Begins
Sept 2025	Batteries removal begins (Phase 1)
Feb 2026	Batteries removed from undamaged sections of the building
Ongoing	Access to damaged building for battery removal (Phase 2)





Poll:

Should O&M be mandatory for C&I BESS installations?

Yes
No

Looking Forward…

- What will be the drivers of safer systems?
  - New technologies and system designs
  - Predictive analytics
  - Insitu sensing and notification
  - Improved workmanship and experience
  - Codes & Standards
  - AI Impacts

ES Manufacturers

PEAK ENERGY CATL ANTORA

Analytics/Sensing

NXP ACCURE SigmaSense

Codes/Standards

NFPA CSA GROUP UL ICC INTERNATIONAL CODE COUNCIL

JUNE 2, 2026

THANK YOU

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References

UL Fire Safety Research Institute
US EPA Considerations for Safe Installation
US EPA Moss Landing Fire Response
US EPA Battery Collection Best Practices Toolkit
Fire Risk Alliance – Storage Development Kit