

# Battery Energy Storage Systems

BESS 101

Safety and Community Impact

Land Use Approvals

*October 2024*

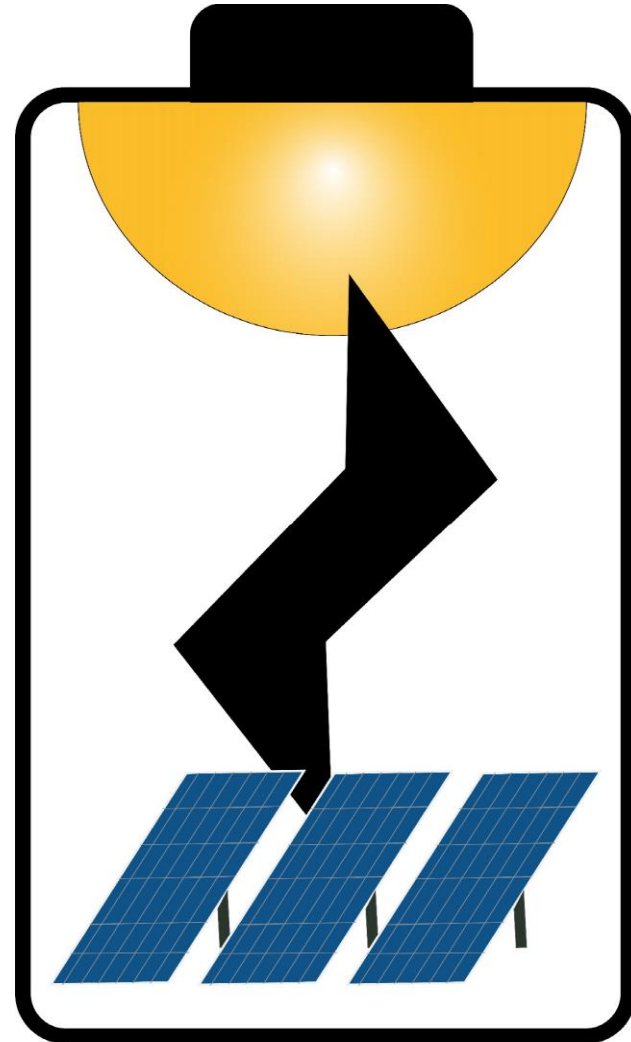
*Presented by:*

*Erin Hazen*

*Vice President, Development*

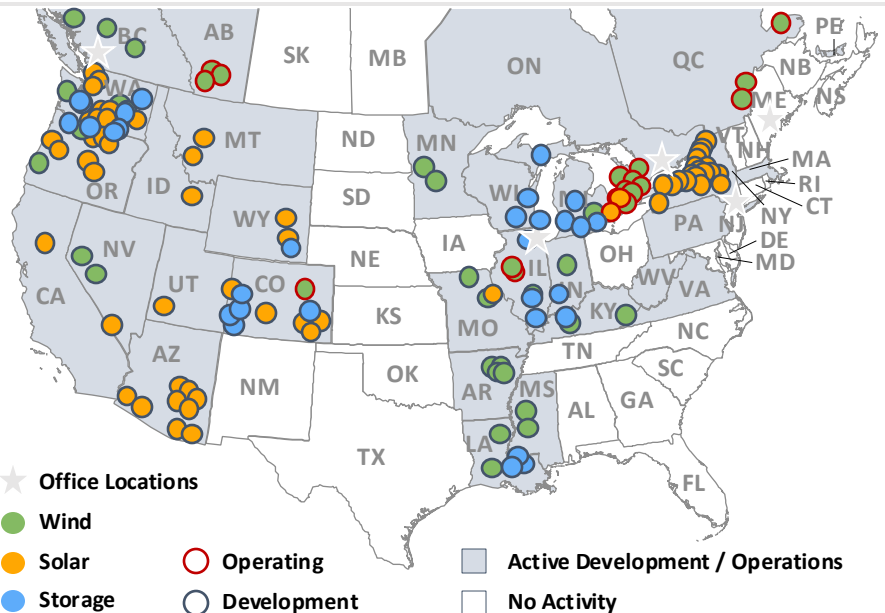
*Cordelio Power*

[ehazen@cordeliopower.com](mailto:ehazen@cordeliopower.com)



# Cordelio Power | Company Overview

## Overview of Operations and Growth

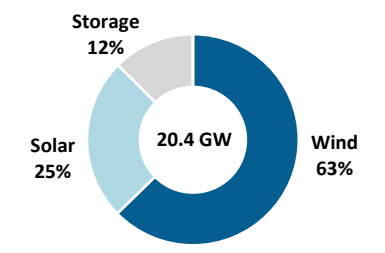
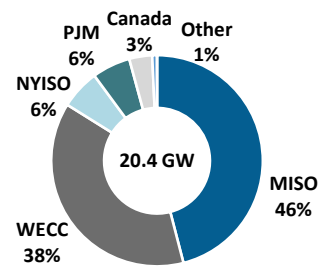


- 1
**Established IPP**
Currently operate net >1.4 GW of renewable assets across the U.S. & Canada
- 2
**250+ Years Experience**
Strong team experience developing, financing, and operating projects
- 3
**Selective Market Entry**
Growth focused in premium markets: MISO, WECC, NYISO, and PJM
- 4
**Strong Relationships**
Longstanding relationships with key financiers, offtakes, and suppliers
- 5
**Construction Expertise**
Have overseen E&C on ~500 MW of greenfield wind and BESS assets

## Cordelio Overview



**116** Development Projects    **24** Operating Projects    **140** Total Projects



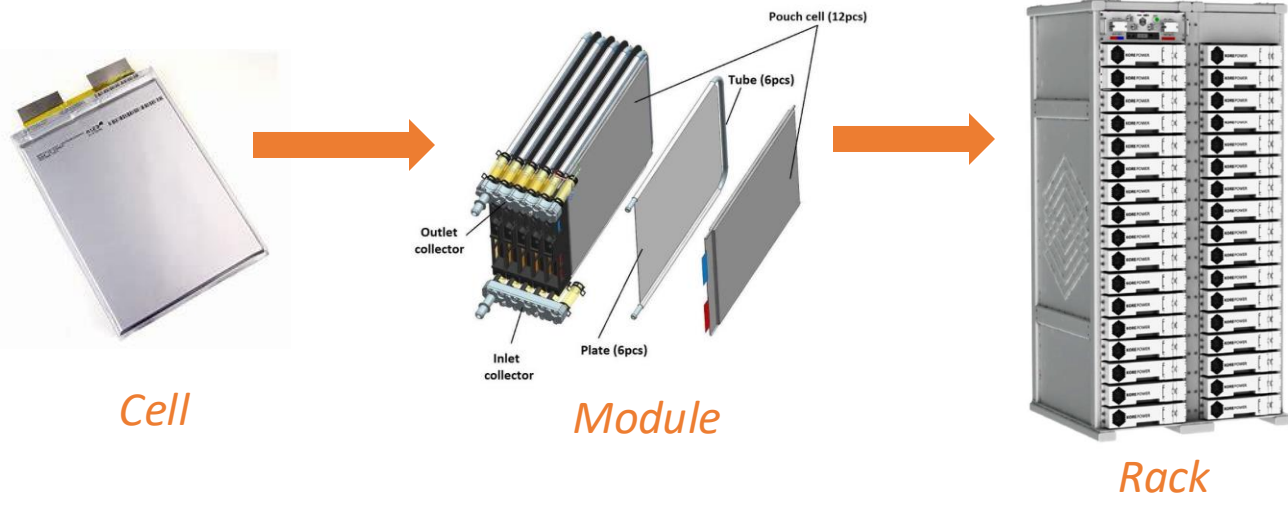
Market Composition (MW)

Breakdown by Technology (MW)

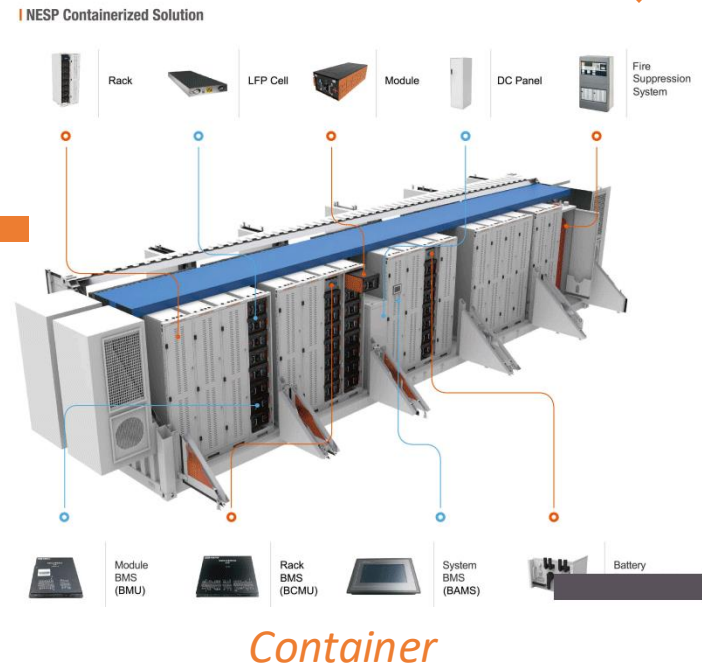
- Cordelio is a wholly-owned subsidiary of the Canada Pension Plan Investment Board (CPP Investments), the independently governed investment manager of the Canada Pension Plan
- CPPIB managed ~C\$591Bn in investment assets for the Canada Pension Plan as of December 31, 2023
- CPP Investments uses its scale and long-term investment horizon to competitively position itself in the power and renewables space, particularly focusing on low-carbon energy

# Key Elements of a BESS Site





- Cell
- Module
- Rack
- BMS
- Container
- 
- PCS/MVT
- Site
- EMS
- 
- Telemetry



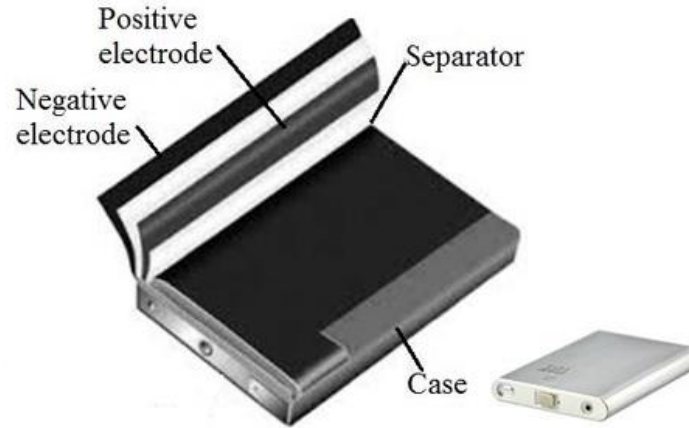
Site

**Key cell components: Positive electrode, negative electrode, separator, electrolyte.**

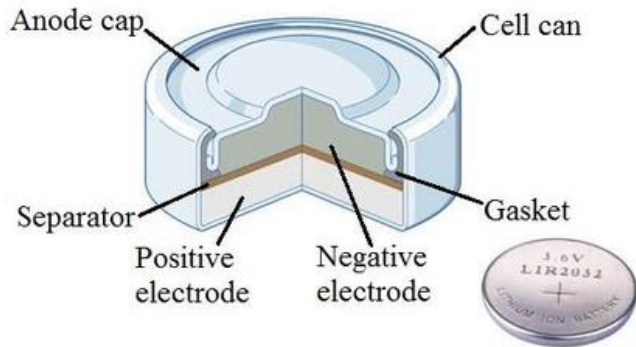
**Cylindrical cell**



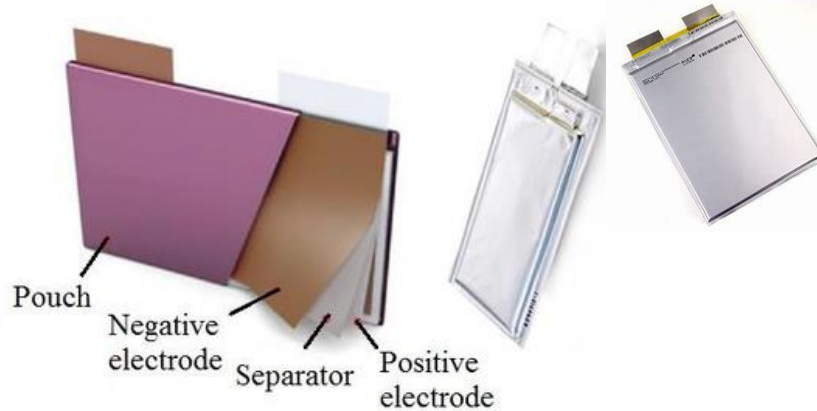
**Prismatic cell**



**Button cell**



**Pouch cell**



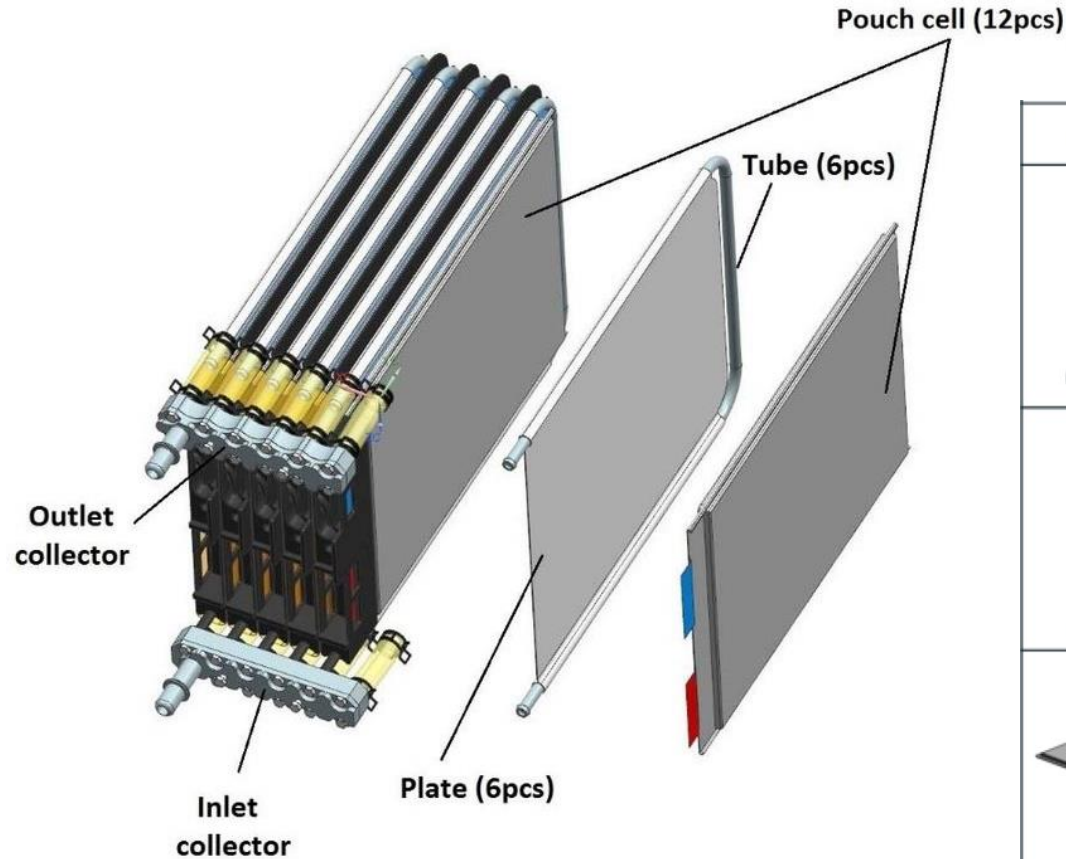
**Cell**





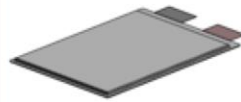
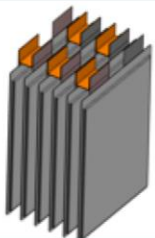
Module

Rack  
-BMS

Container  
- PCS/MVT

Site  
- EMS  
- Telemetry

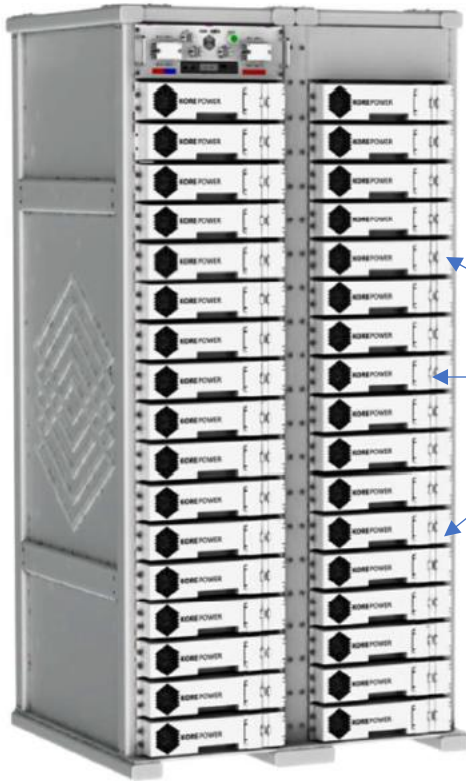


Cell type	Module
 Cylindrical	
 Prismatic	
 Pouch	

- Cell
- Module**
- Rack  
- BMS
- Container  
- PCS/MVT
- Site  
- EMS  
- Telemetry

*Current-day modules are made up of about 12 individual cells connected electrically to achieve the desired voltage and capacity.*

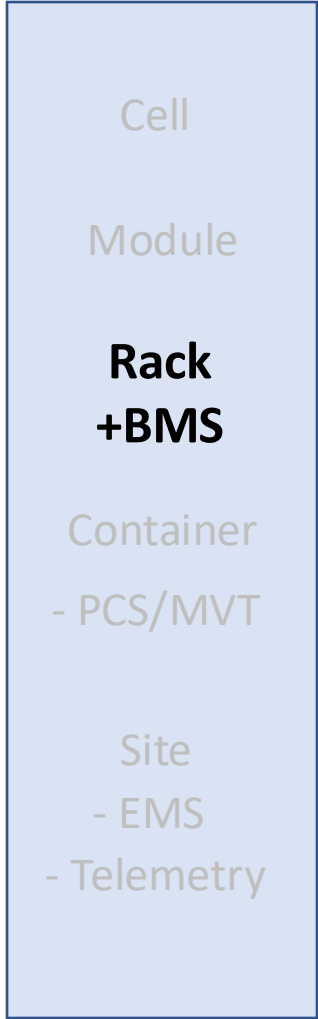




*Modules are grouped into frames to form racks.*

*Racks typically contain **BMS** units, rack switchgear, and other control components.*

Modules



**BMS – Battery Management System:**

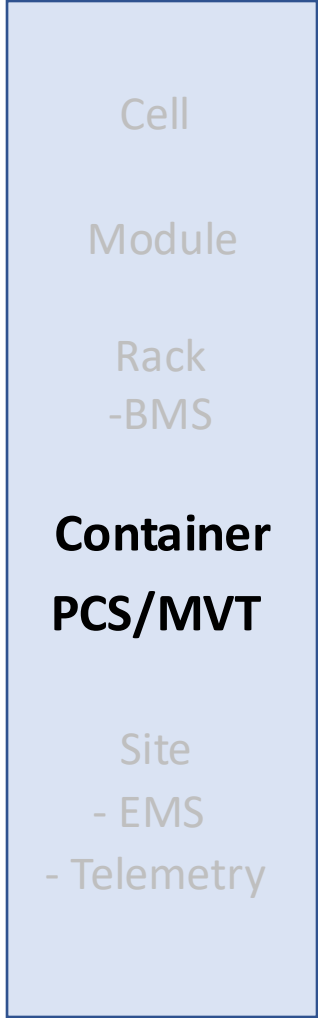
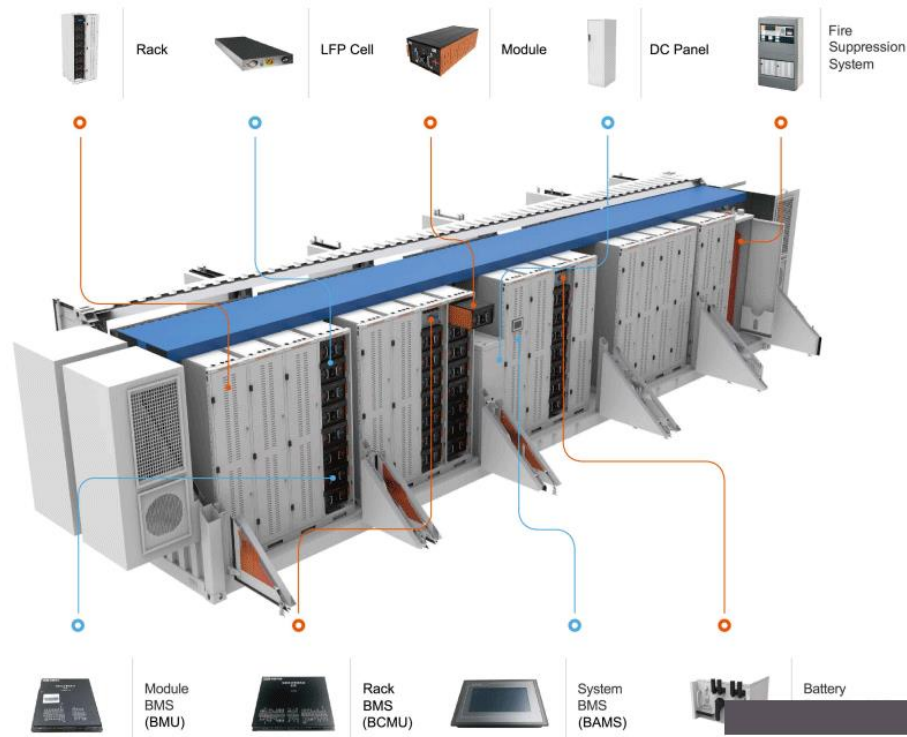
Provides critical management and monitoring to provide safe and reliable battery use.

## Racks are combined into steel containers.

These containers are the site building blocks and each can store about 0.5 MWh.

Containers include:

- temperature control system; HVAC or liquid-cooling
- Fire suppression systems
- Gas detection system
- Placement of the inverter (PCS) varies by OEM. Some are inside container, others are external pad-mounts, others are combined with transformer cabinet



### PCS – Power Conversion System

- AKA: inverter. Converts DC power to AC and vice versa.

### MVT – Medium Voltage Transformer

- AKA: Generation Step-Up (GSU) transformer. Usually ~480-800V (inverter side) stepped up to ~34.5kV



*Site is made up of container + PCS/MVT building blocks, auxiliary power equipment, communications/telemetry, EMS, protection/switchgear, circuit breaker, and metering*



## EMS – Energy Management System

Site controls (PPC)

- Coordinates work of BMS, PCS, and other components of the BESS
- SCADA
- Cyber security
- Market Participation/Bid analysis
- Performance Analytics
- Optimizations
- Monitor operations



Cell

Module

Rack

-BMS

Container

- PCS/MVT

**Site  
- EMS**

**Telemetry**

# Community Impacts



A BESS project is a significant taxpayer on compact footprint.

Poses no burden on schools, roads, water, sewer

In most jurisdictions, the steel enclosure and the batteries they hold qualify as business personal property. Batteries represent the majority of a project's capital cost.

Real property is limited to the foundations, control house, and site

AHJs need to pay attention to this distinction when considering how the project benefits tax revenue



Construction period : 6-10 months, plus 1-2 months of commissioning

Local trades: earth moving/site work, concrete, cranes, fencing.

High voltage electrical work and substation construction may rely on specialized crews from outside local area

## **ITC Eligibility depends on Apprentices!**

- Labor hours requirements: 12.5-15% of total construction performed by apprentices
- Strict journeyworkers-to-apprentice ratios





Containers are placed on concrete pads--or increasingly, on steel skid and helical piles



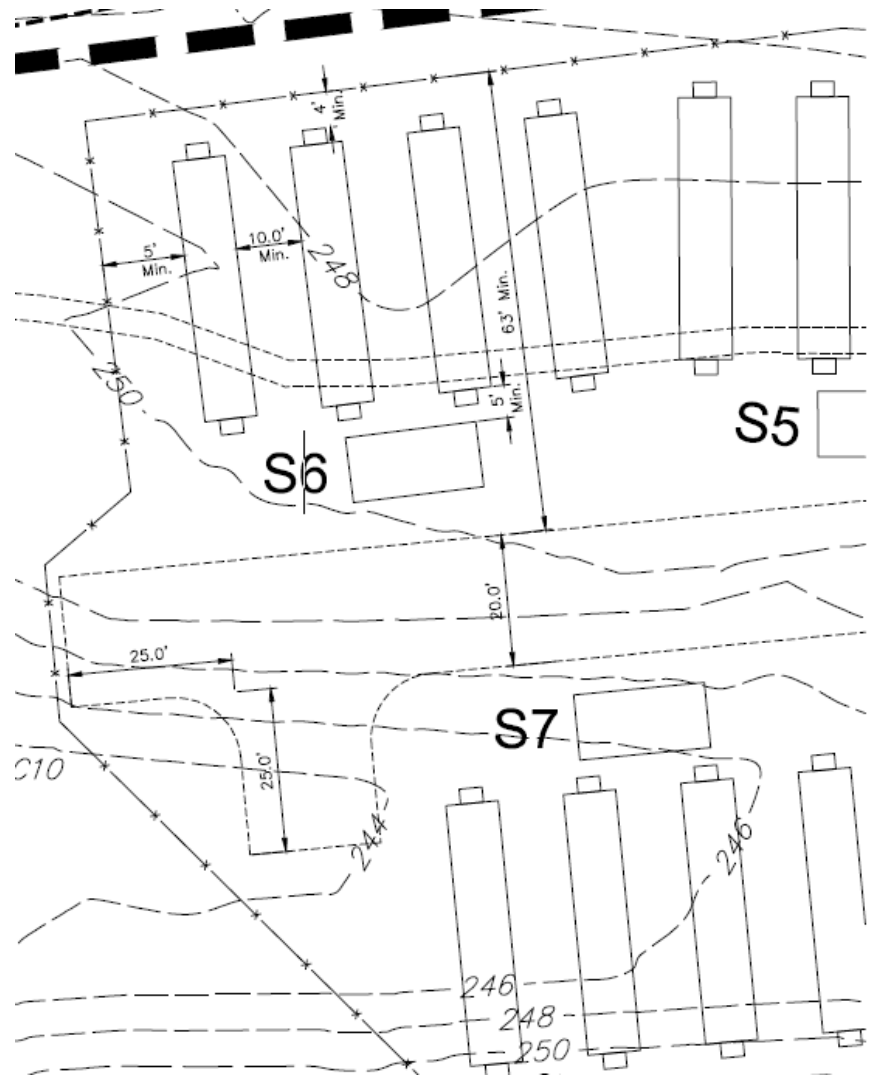
Battery enclosures usually 8.5-9ft high, 40-50ft long

Approx 10ft spacing between containers, 4-5ft clearance to any fence

Highly flexible layout options to fit site

Make sure developer's roads accommodate fire department turn radii, outriggers

**Energy density continues to improve –current BESS on the market allow 80-120 MWh per acre**



Some suppliers are working on stackable containers – not seeing these deployed yet

Security fencing topped with barbed wire required due to high voltage equipment, but can be made more attractive with privacy slats, plantings, landscaping

Battery enclosures can be generally hidden from ground-level view behind fences.

Projects usually include a small substation-- some of this structure will be taller than the fence

Minimal lighting required—reasonable to ask developers for dark sky compliance, no light trespass



Typical view from inside and outside the fence





Air-cooled BESS (typical OEM specs):

Measured at 3 feet from equipment

HVAC: 75 dBA

Inverters 79 dBA

Main Transformer: 82 dBA

Due to accretive effect of noise from grouped equipment, a group of battery enclosure and inverters can be expected to emit around 85-90 dBA

## Distance is the best mitigation

Sound levels drop by 6 dBA over twice the distance traveled.

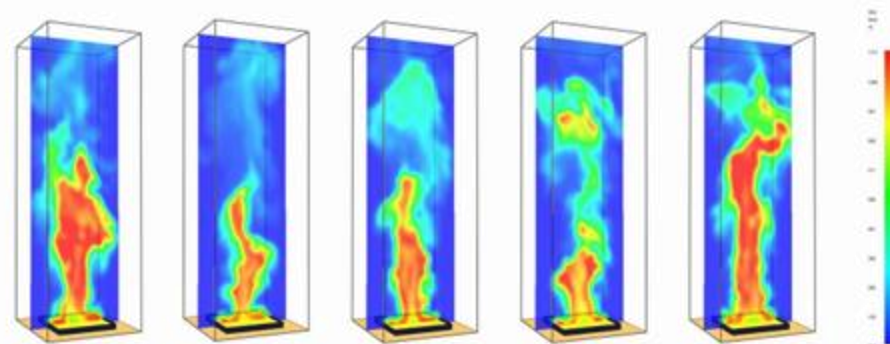
10dB reduction in sound = 50% reduction perceived “volume”

Decibels	Distance BESS to Receptor (ft)
90	3
84	6
78	12
72	24
66	48
60	96
54	<b>192</b>
48	<b>384</b>
42	768
36	1536
30	3072

## Hey Developers, Listen up!

## Ensure proper siting to avoid community noise annoyance

## Fire Hazard is usually #1 community concern



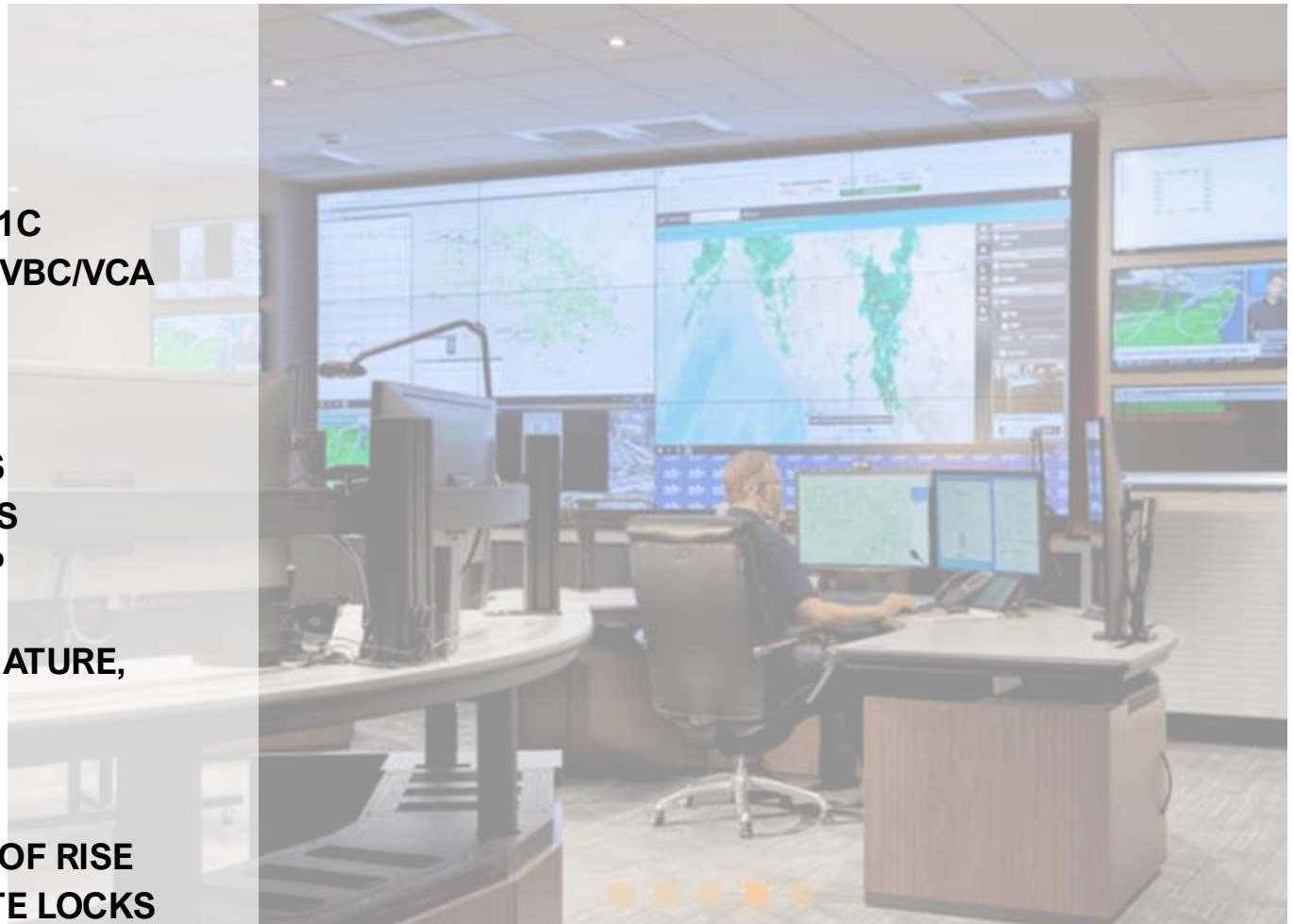
Successful developers....

- Learn UL9540(A) and educate community what it means
- Meet early & often with fire departments during development
- Provide access to fire safety experts
- Offer on-site fire department orientation training before COD and regularly thereafter
- Partner with high quality suppliers and learn their fire safety philosophy – it varies!

## Remote Operations Centers have constant eyes on the facility

- ROC personnel can drill down to conditions of each container, rack, module and individual cell

**AC POWER**  
**REACTIVE POWER**  
**FREQUENCY**  
**POWER FACTOR**  
**OUTPUT AMP 1A/1B/1C**  
**OUTPUT VOLTS VAB/VBC/VCA**  
**HEAT SINK TEMP**  
**BATTERY SOC**  
**SOH**  
**DC VOLTS, DC AMPS**  
**MAX/MIN CELL VOLTS**  
**MAX/MIN CELL TEMP**  
**MAX/MIN RACK SOC**  
**CONTAINER TEMPERATURE,**  
**HUMIDITY**  
**HVAC STATUS**  
**GAS SNIFFERS**  
**SMOKE, TEMP RATE OF RISE**  
**DOOR ALARMS, GATE LOCKS**



**GROUND FAULT DETECTION** - detect faults and disconnect the system before a serious problem occurs. Removing current from a defective cell usually sufficient to prevent incident escalation.

**GAS SNIFFER** – sensors detect the earliest evidence of off gas and can trigger preventative or mitigating measures (eg, cooling system activation and ventilation) before thermal runaway begins.

**FAST STOP** - automatically triggered in response to incipient gas or smoke detection and sudden changes in battery operating parameters. Manual fast-stop can also be performed by operators or first responders.

**FIRE ALARM SYSTEM**- includes smoke and temperature detectors (which trigger external horn, strobe light, and F-stop), an external horn + strobe light, and an optional aerosol cannister.

**DEFLAGRATION PANELS**- In the event of gas build-up, NFPA 68 Deflagration panels direct the force of an explosion upwards in the event of high pressure build up inside the container.

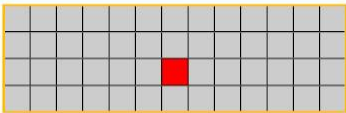
## UL 9540A Fire Testing

Only the Minimum Number of Cells Are Heated to Initiate Thermal Runaway



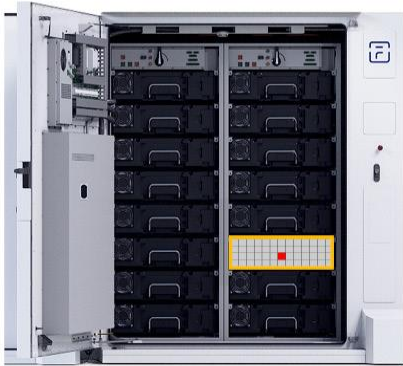
### Cell-level Testing

One cell is heated.



### Module-level Testing

The minimum number of cells are heated to create thermal runaway propagation within a battery module.



### Unit-level Testing

The minimum number of cells are heated to create thermal runaway propagation within a battery module inside a fully populated enclosure.



### Installation-level Testing

Same as unit-level test with the addition of fire suppression safety features deployed.

Cell-level off gas data

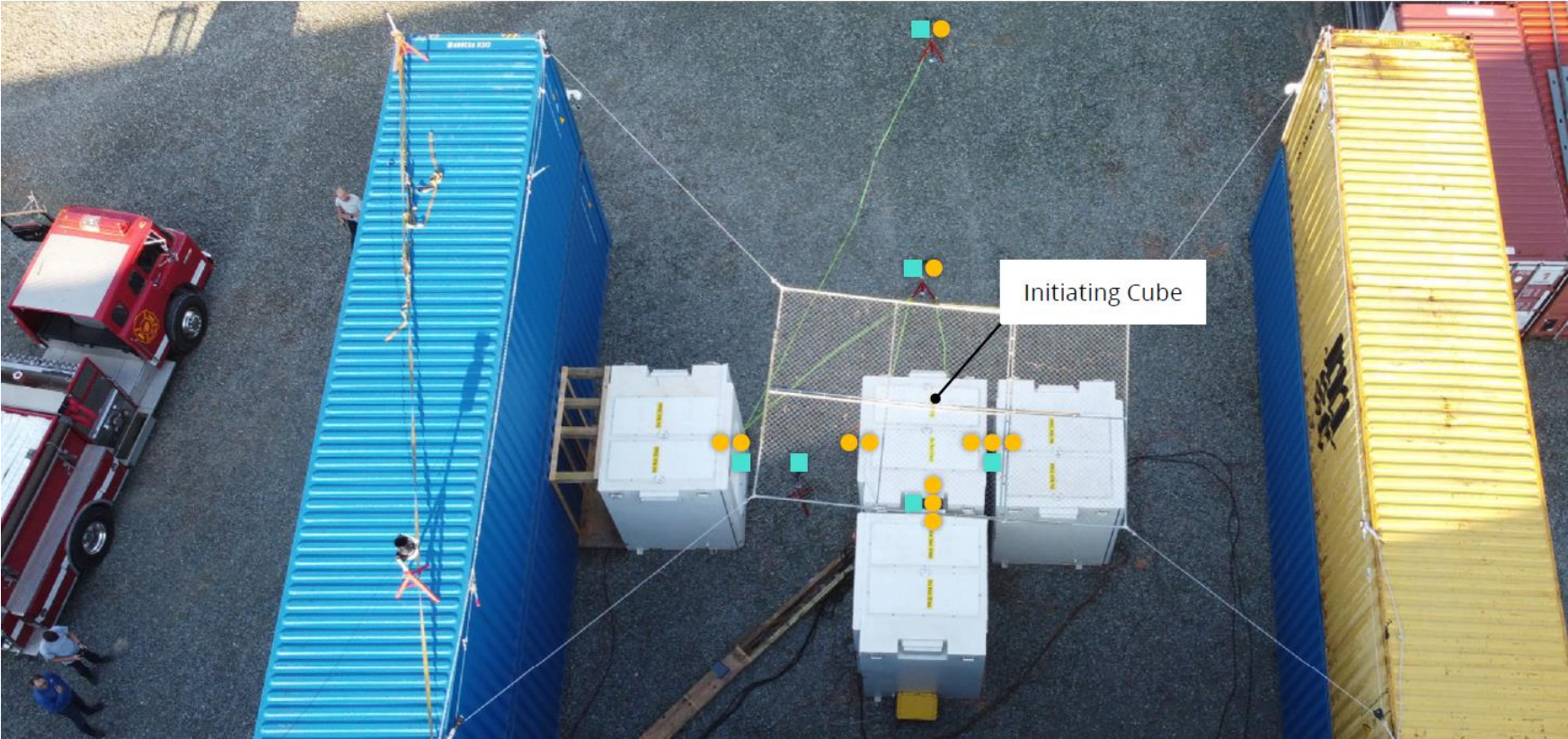
Number of cells forced into thermal runaway and total volume of off gas

- Product design (NFPA 68/69)
- CFD simulations
- Deflagration testing

**Remember this number:  
175° F**

## Fluence Beyond Industry Standards Burn Test

● THERMOCOUPLES    ■ HEAT FLUX



## Gas sampling hood



### Continuous monitoring

- Oxygen sensor
- Standalone Flame Ionization Detector (FID) for total hydrocarbons
- Gas Chromatography Conductivity Detector (GCTCD) for hydrogen
- Fourier Transform Infrared (FTIR) for CO, CO<sub>2</sub>, acid gases, and alkylcarbonates

### Discreet Sampling

- Tedlar Bag
- Absorbent Tube
- Gas chromatography mass spectrometer (GCMS) for total gas composition

## Look beyond the popular media headlines

TESLA & Fluence testing: Smoke constituents similar to Class A household fire

Fluence testing: Plume drift max: 80-100ft

Excellent report on air quality impacts of BESS fire by **Cottam Solar Project (UK)**:

**Environmental Statement  
Addendum:  
Air Quality Impact Assessment  
of Battery Energy  
Storage Systems (BESS) Fire**

Prepared by: Tetra Tech Limited  
August 2023

PINS reference: EN010133  
Document reference: EX1/CB.4.17.2  
APPF Regulation 5(2)(a)



**Continuous improvement needed to  
reduce risk of thermal runaway.....**

**BUT.....**

**Numerous studies demonstrate that BESS  
is not a broad risk to community health**



# Ordinances



Many zoning paths for BESS approval

BESS ordinances remain uncommon but municipalities increasingly interested to enact

**Some decent examples– tough but fair**

- [New York – NYSEERDA's Model Law](#)
- [Johnson County, Iowa Ordinance 08-24-21-02](#)

Tip: A utility electric substation is a good land use analog for BESS facilities in terms of function, safety, and community impact.

Makes sense for an ordinance to allow BESS as a Special Use in districts where electrical substations are permitted as a special use.

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Land Use Approvals

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*Vice President, Development*

*Cordelio Power*

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