



Pacific  
Northwest  
NATIONAL LABORATORY

# ES Safety & Reliability Overview

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Presentation #300

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U.S. DEPARTMENT OF  
**ENERGY** **BATTELLE**

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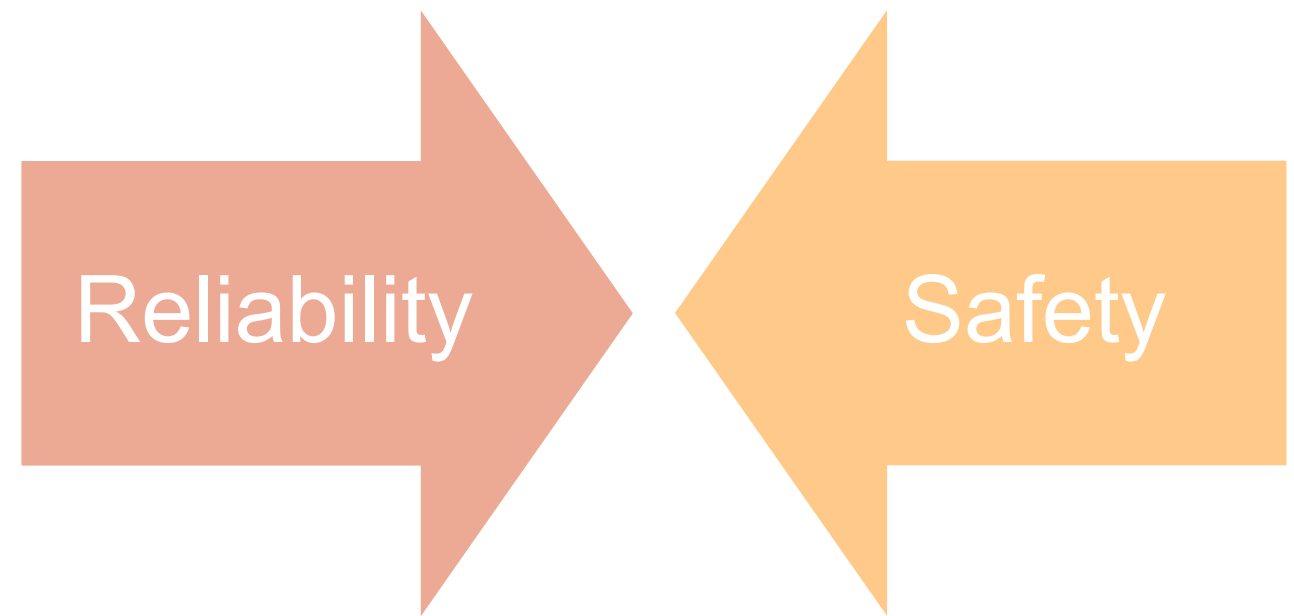
# Acknowledgement

Dr. Imre Gyuk, DOE – Office of Electricity  
Energy Storage Program



U.S. DEPARTMENT OF  
**ENERGY**

# What is Safety?



safe·ty | \ 'sāf-tē \  
*plural* safeties

- the condition of being safe from undergoing or causing hurt, injury, or loss.
- to protect against failure, breakage, or accident.

*Merriam Webster, 2022*

- The term Safety is not consistent across industries or technologies.
- With ESS does it mean zero fires?
- Is there an acceptable level of failure?
- Are Safety & Reliability mutually beneficial?

# Safety & Reliability is a Systems Approach

- Chemistry
- Cell QC
- Integration
- BMS
- Communications
- HVAC
- Fire Protection
- Explosion Control
- Workmanship

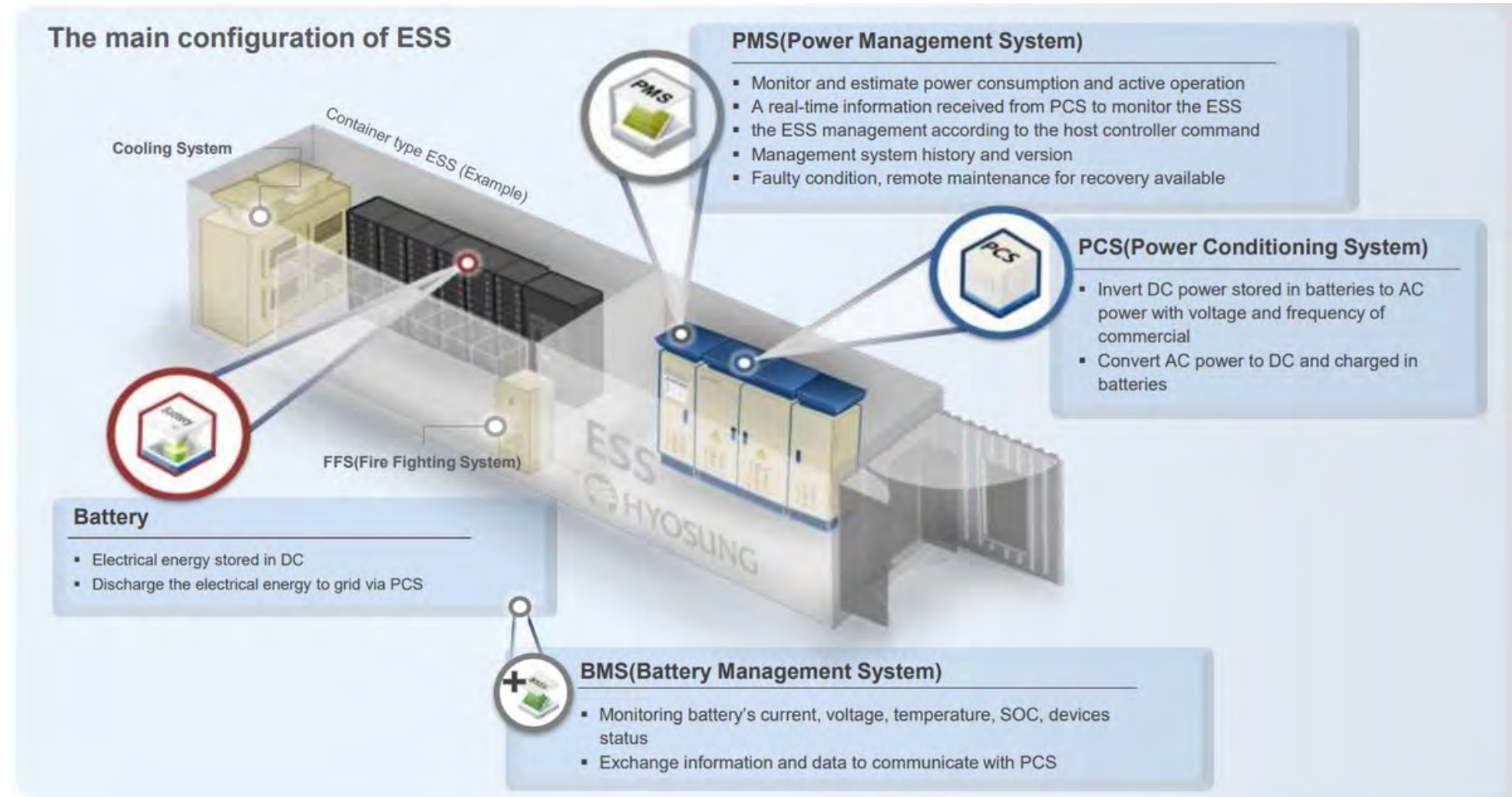


Image source: Hyosung Heavy Industries

# ESS Incidents (C&I)



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Read

## BESS Failure Event Database

Location	Energy (MWh)	Power (MW)	Module Type	Application	Installation	Event Date	System Age (yr)	State During Accident	Source
US, CA, Moss Landing	730	182.5	Tesla	Energy Shifting, Ancillary Services	Substation	20 September 2022	0.5	Operational	<a href="#">KSBW News</a>
South Korea, Incheon		103		Energy Shifting	Factory	6 September 2022		Operational	<a href="#">Teller Report</a>
US, CA, Rio Dell			Lead Acid	Solar Integration / Backup	Rural	3 August 2022	4	Operational	<a href="#">KRCR</a>
US, AZ, Chandler	40	10	LG Chem [NMC]		Substation	18 April 2022	3	Operational	<a href="#">AZ Central</a>
US, CA, Valley Center	560	140	LG Energy Solution		Substation	5 April 2022	0.2	Operational	<a href="#">Valley Road Runner</a>
Longjing, Taichung City, Taiwan	1	1		Solar Integration	Power Plant	30 March 2022	2	Operational	<a href="#">Economic Daily</a>
US, CA, Moss Landing	400	100	LG Energy Solution	Solar Integration	Power Plant	13 February 2022	1	Operational	<a href="#">KSBW News</a>
South Korea, Gunwi-gun, Gyeongsangbuk-do	1.5	0.45	LG Energy Solution	Solar integration	Rural	17 January 2022	3	Operation. Fully charged	<a href="#">E2News</a>
South Korea, Nam-gu, Ulsan	50	10	SK Innovation	Peak Load Reduction	Urban	12 January 2022	2	Operational	<a href="#">E2News</a>
US, CA, Moss Landing	1,200	300	LG Energy Solution	Solar Integration	Power Plant	4 September 2021	0.8		<a href="#">Vistra</a>

Showing 1 to 10 of 50 entries

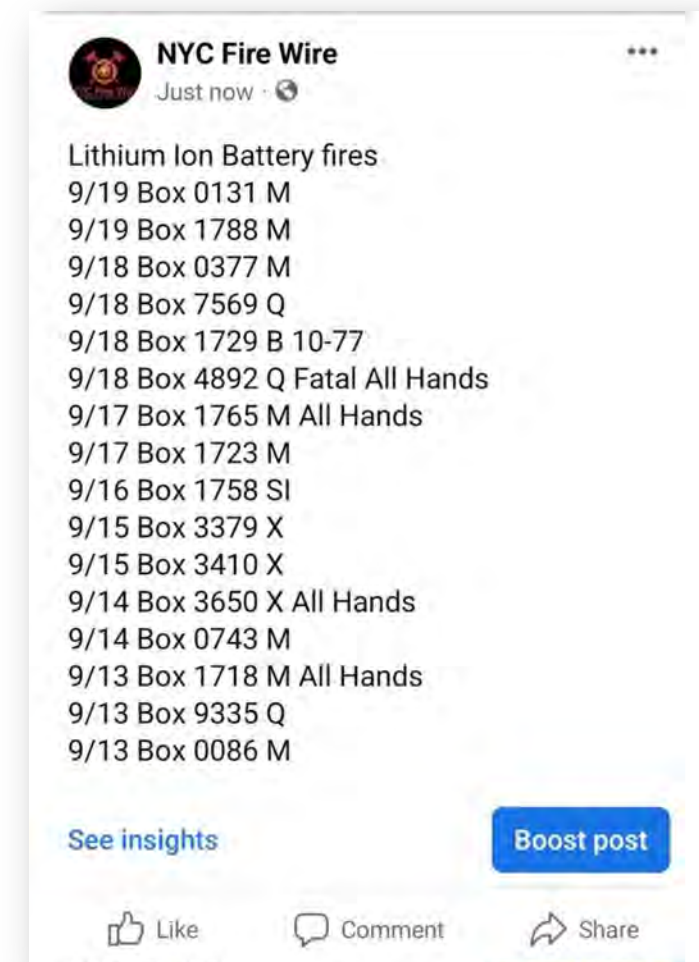
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# Trends & Barriers

- Trend – Rapid deployment IFM & BTM
- Trend – Increased availability of listed ESS
- Trend – Improved propagation resistance designs
- Barrier - Increasing fires from e-mobility devices
- Barrier - Fire suppression challenges and water use
- Barrier – Growing moratoriums to ESS projects



PNNL-SA-178155





# OE Funded Safety Efforts

- Project support for RESDP installations
- Emergency response training support for utilities, fire departments, and sister labs (NREL, ANL)
- EU Emergency Responders Support (UK, Netherlands, Sweden, Germany, Norway)
- Australian ESS Research Project support (SARET)
- NFPA Energy Storage Research Consortium member
- Active participation in key ESS Codes & Standards (NFPA, IFC, UL)



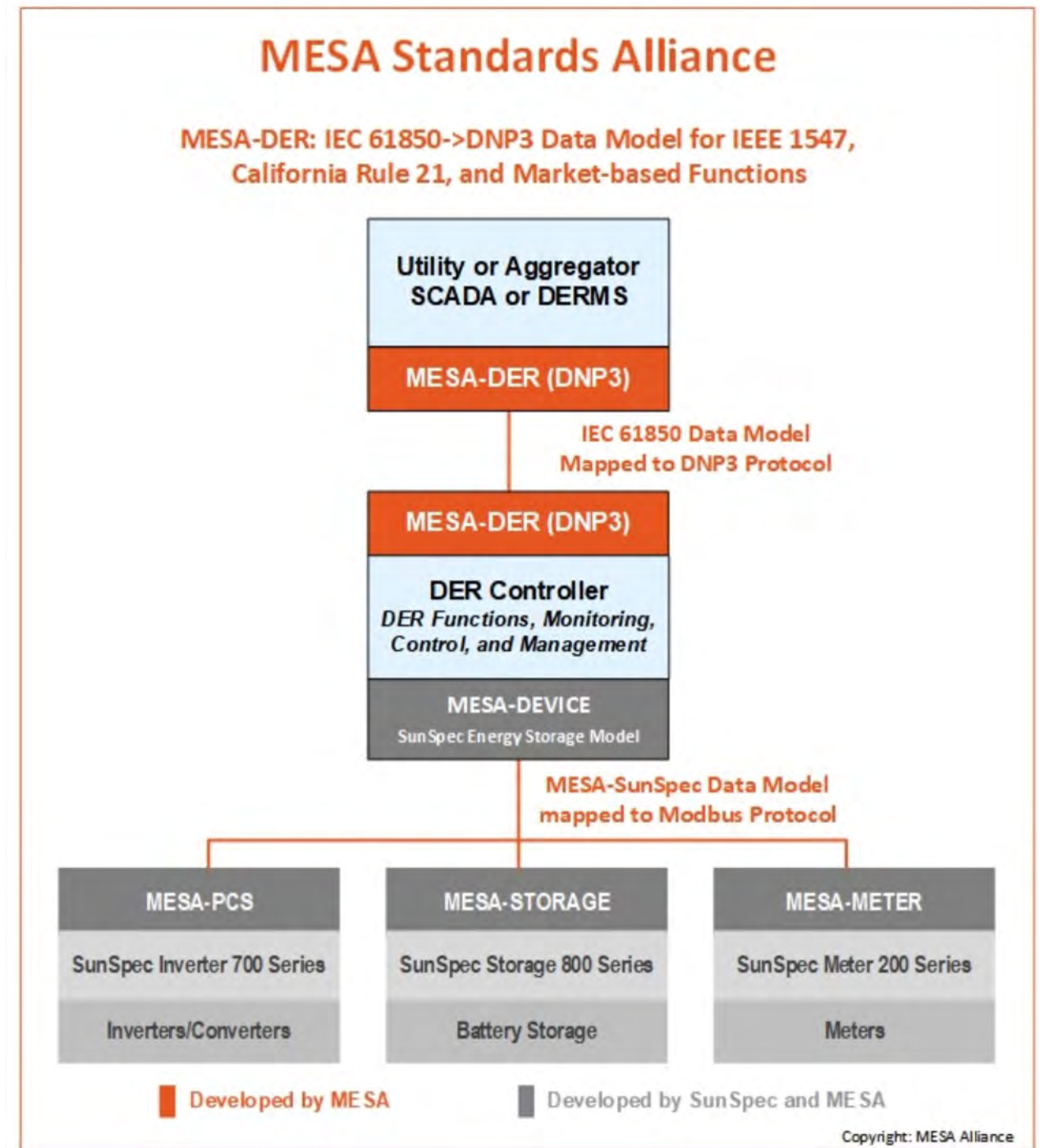
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**RESEARCH FOUNDATION**  
RESEARCH FOR THE NFPA MISSION

# Reliability Efforts

- Completion and publication of IEEE 1547.9 ES Interconnection Guide
- MESA Testing & Certification WG (PNNL led) for the MESA DER Standard
- IEEE P2686 BMS Standard & IEEE P2688 EMS Standard (SNL led)

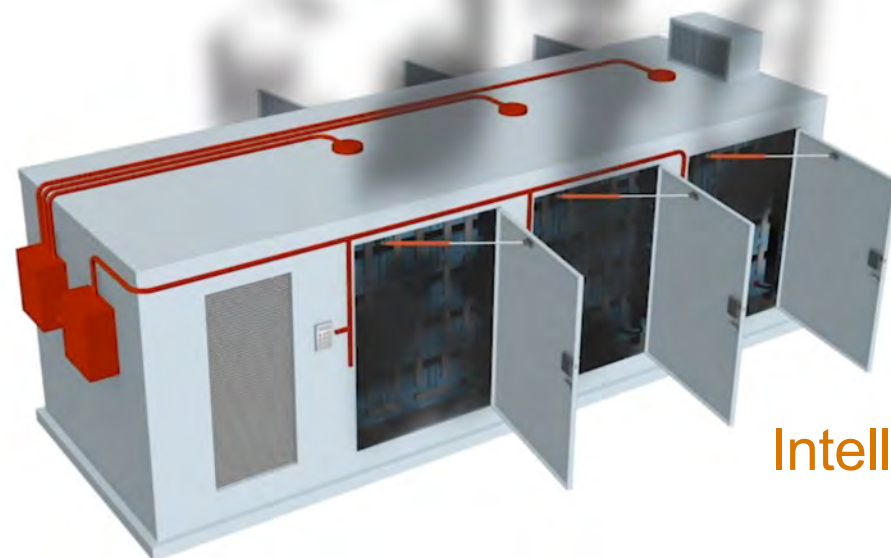




# NFPA 855 Explosion Control

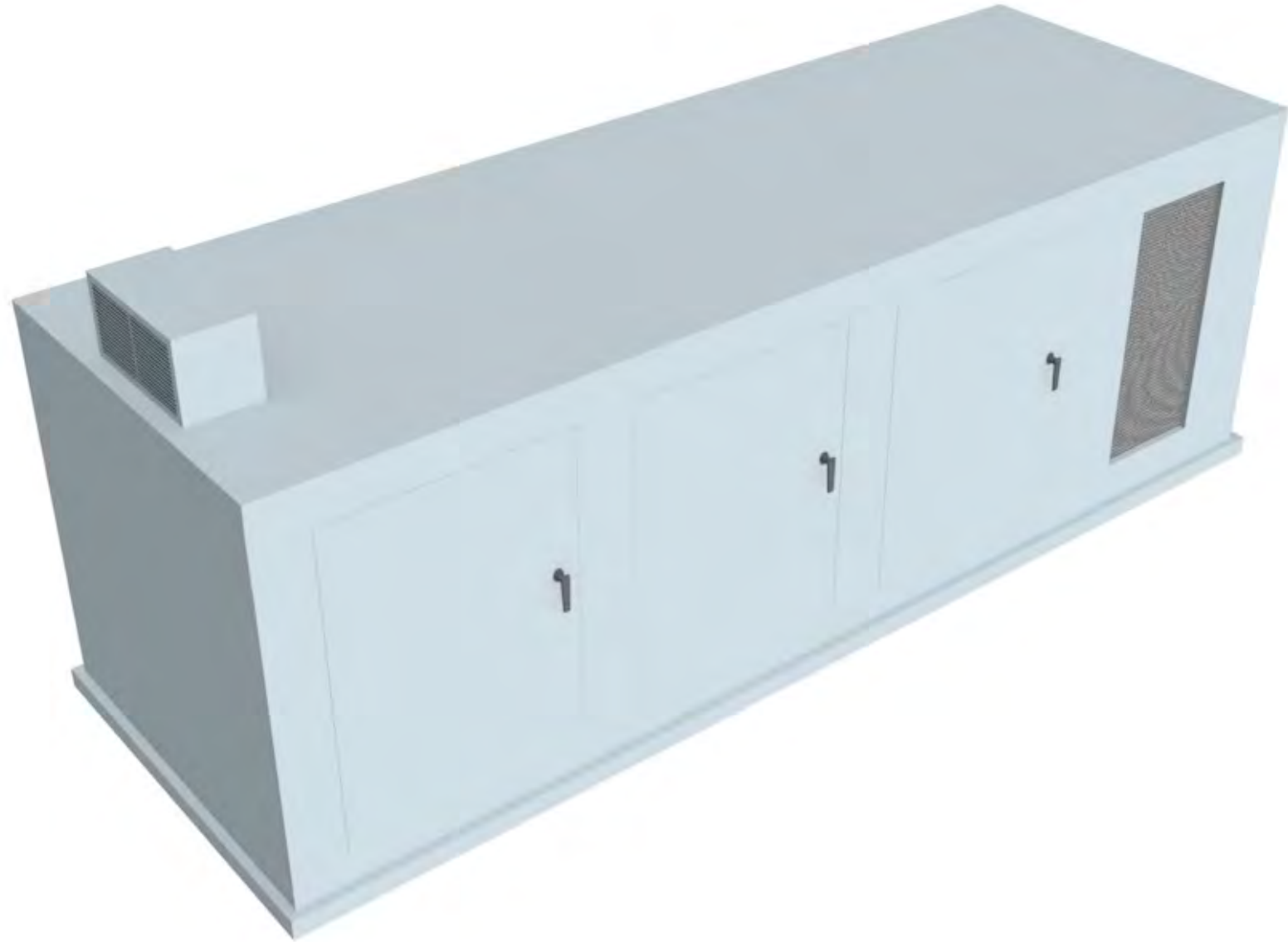
Three options for meeting requirement in room, building, cabinets, or walk-in enclosures:

1. NFPA 68 – Deflagration Venting.
  - Blow-out panels to protect structure from explosion based on max gas production in cell tests.
2. NFPA 69 – Deflagration Prevention.
  - Exhaust system designed to keep below 25% of LEL in area.
3. Performance Based – Where Large Scale Fire Test has shown that no pressure will be ejected.



IntelliVent™



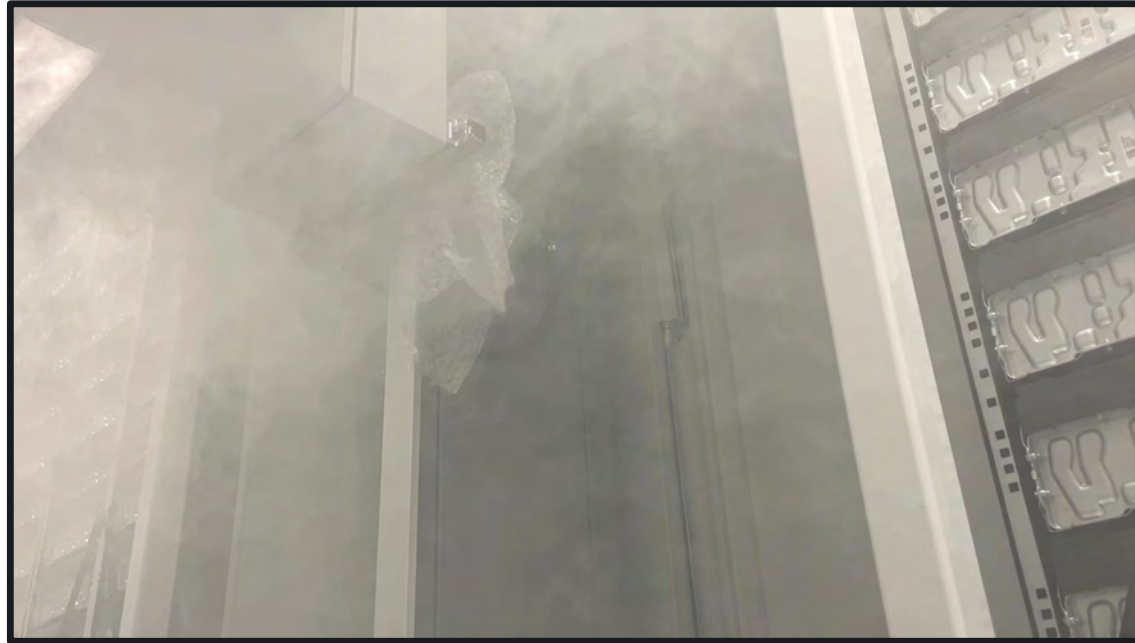


**PNNL Invention**

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**INTELLIVENT**

# IntelliVent™ testing at Snohomish PUD



## Remaining Gaps

- Fire suppression agents/methods
- Deflagration prevention methods
- Further research in thermal runaway propagation prevention
- Emergency energy discharging



New ESS in transport w/LFP cells

Source: Jimu News



# Thank You

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