

Energy Storage Safety - Utility Scale Considerations

Lecturer : Brandon Blair

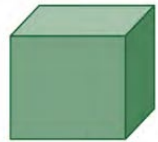
2025.2.11

CONTENT

1. Evolution of Codes and Standards
2. Validation through Testing
3. Safety and Quality through lifecycle

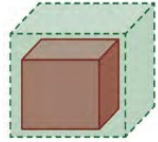


Codes and Standards Landscape



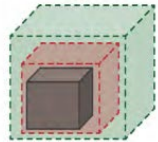
BUILT ENVIRONMENT

- iCodes – IFC, IRC, IBC
- IEEE – C2, SCC 18, SCC21
- NFPA 5000, NFPA 1, ISA



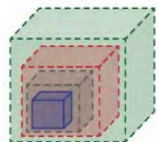
ENERGY STORAGE SYSTEMS

- UL 9540, MESA
- ASME TES-1, NECA
- NFPA 791



INSTALLATION / APPLICATION

- NFPA 855
- IEEE C2
- DNVGL GRIDSTOR
- NFPA 70
- IEEE 1635/ASHRAE 21
- FM GLOBAL 5-33
- UL 9540 A
- IEEE P1578
- NECA 416 & 416



SYSTEM COMPONENTS

- UL 1973
- CSA 22.2 No. 340-201
- UL 1974
- IEEE 1547
- UL 810A
- IEEE 1679 Series
- UL1741



Evolution of Key Standards

1st Release of
UL 9540 &
9540A (back in
2016 & 2017)

1st Release of UN
38.3 (destructive
tests for shipping)

4th Edition of
UL 9540A

1st Release of
NFPA 855

UL performs first
enclosure level
large test

3rd Edition of
UL 9540

Sungrow performs
largest burn tests in
industry on PT1 & PT2

Upcoming
Edition of
NFPA 855

2019

2020

2021

2022

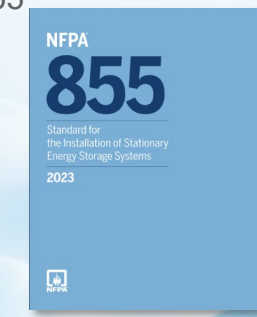
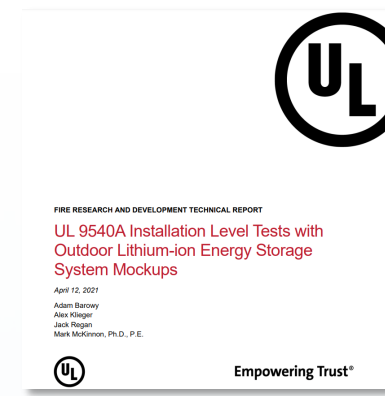
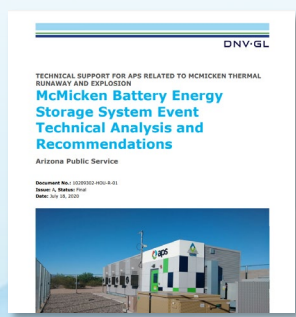
2023

2024

2025

2026

McMicken
Battery
Incident



Hand Calculations to Validation via Testing

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{u}) = 0$$

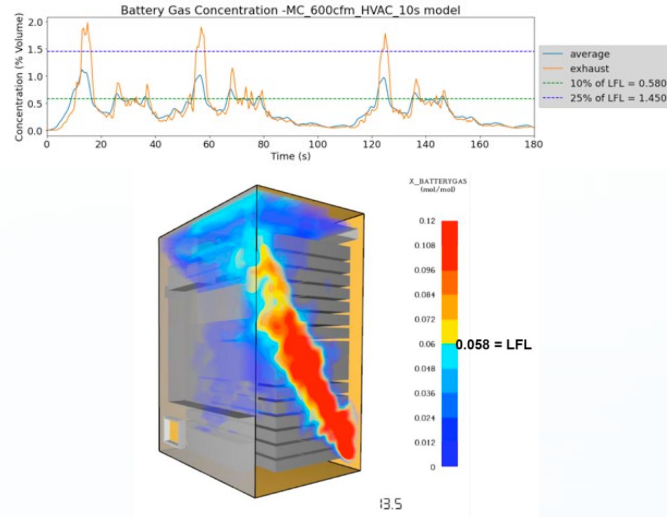
$$\frac{\partial(\rho \mathbf{u})}{\partial t} + \mathbf{u} \cdot \nabla(\rho \mathbf{u}) = \nabla \cdot \boldsymbol{\sigma} + \rho \mathbf{f}$$

$$\frac{\partial E_t}{\partial t} + \nabla \cdot (E_t \mathbf{u}) = \nabla \cdot \boldsymbol{\sigma} \mathbf{u} - \nabla \cdot \mathbf{q}$$

The Navier-Stokes equations, in simplified vector form

	A	B	C	D	E	F	G
1	Seconds	dt	Cell gas in	Fan flow	Cell gas out	Cell gas remain	Cell gas % out
2	0	0	0	0	0	0	0.00%
3	5	5	6.734848485	353.875	0	6.734848485	0.00%
4	10	5	6.734848485	353.875	0.741255635	12.72844133	0.02%
5	15	5	6.734848485	353.875	1.400926671	18.06236315	0.04%
6	20	5	6.734848485	353.875	1.987992529	22.8092191	0.06%

Excel Spreadsheets



Simulations

Large Scale Testing

TEST REPORT

Sungrow Battery Energy Storage System (BESS) PowerTitan 1.0 Large Scale Burn Test Report

SUNGROW POWER SUPPLY CO., LTD.

Document No.: 10489604-SHA-R-01

Issue: C Status: Final

Date: 19 July 2024

TEST REPORT

Sungrow Battery Energy Storage System (BESS) PowerTitan 2.0 - Large Scale Burn Test Report

SUNGROW POWER SUPPLY CO., LTD.



Lifecycle approach to Safety and Quality

SUNGROW

- **Product**

- Quality management from procurement to shipment
- Component and total solution compliance
- Validation through testing
- Documentation and quality deliverables

- **Construction**

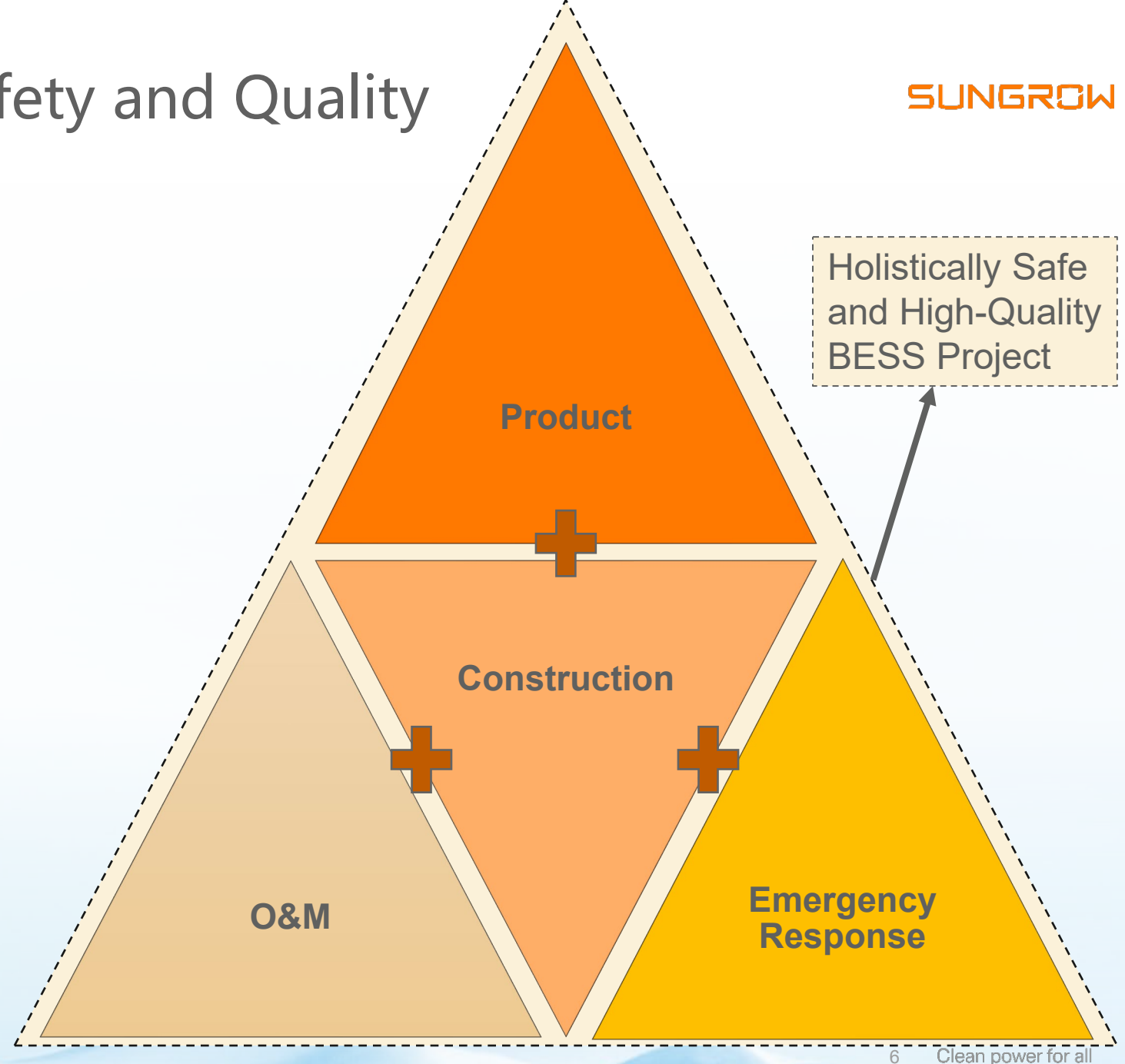
- Proper transportation, lifting, storage
- Proper site + product safety protocols and using qualified personnel performing installation and commissioning
- Functional validation

- **O&M**

- Proper site + product safety protocols and using qualified personnel for O&M
- Following OEM manuals and best practices for operations (preventative maintenance, response time etc.)
- Robust LTSA and extended warranties

- **Emergency Response**

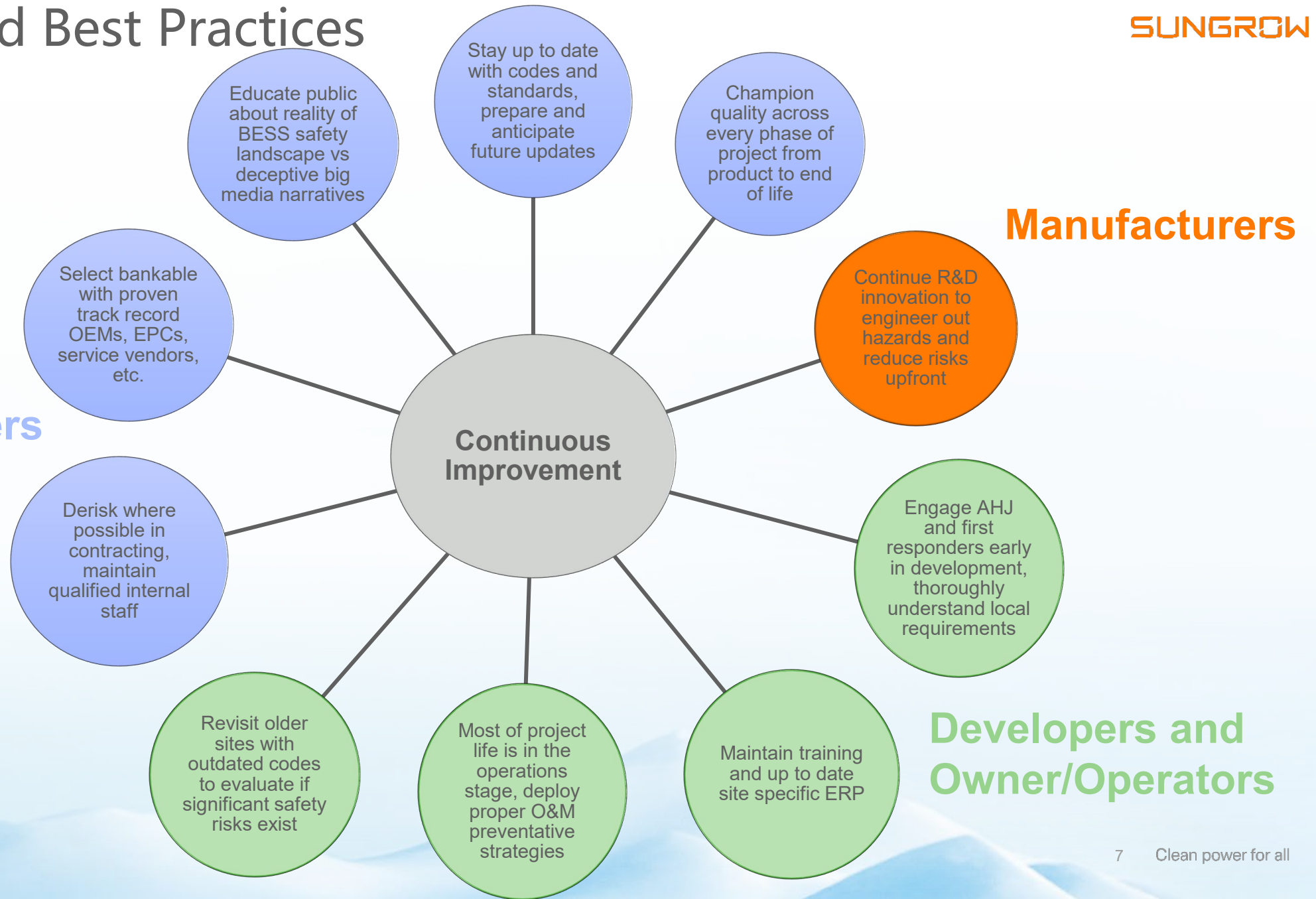
- Maintain up to date ERP
- Education and training of site operators and first responders
- "Pre-incident" Training



Trends and Best Practices

SUNGROW

All Project Stakeholders



THANKS

