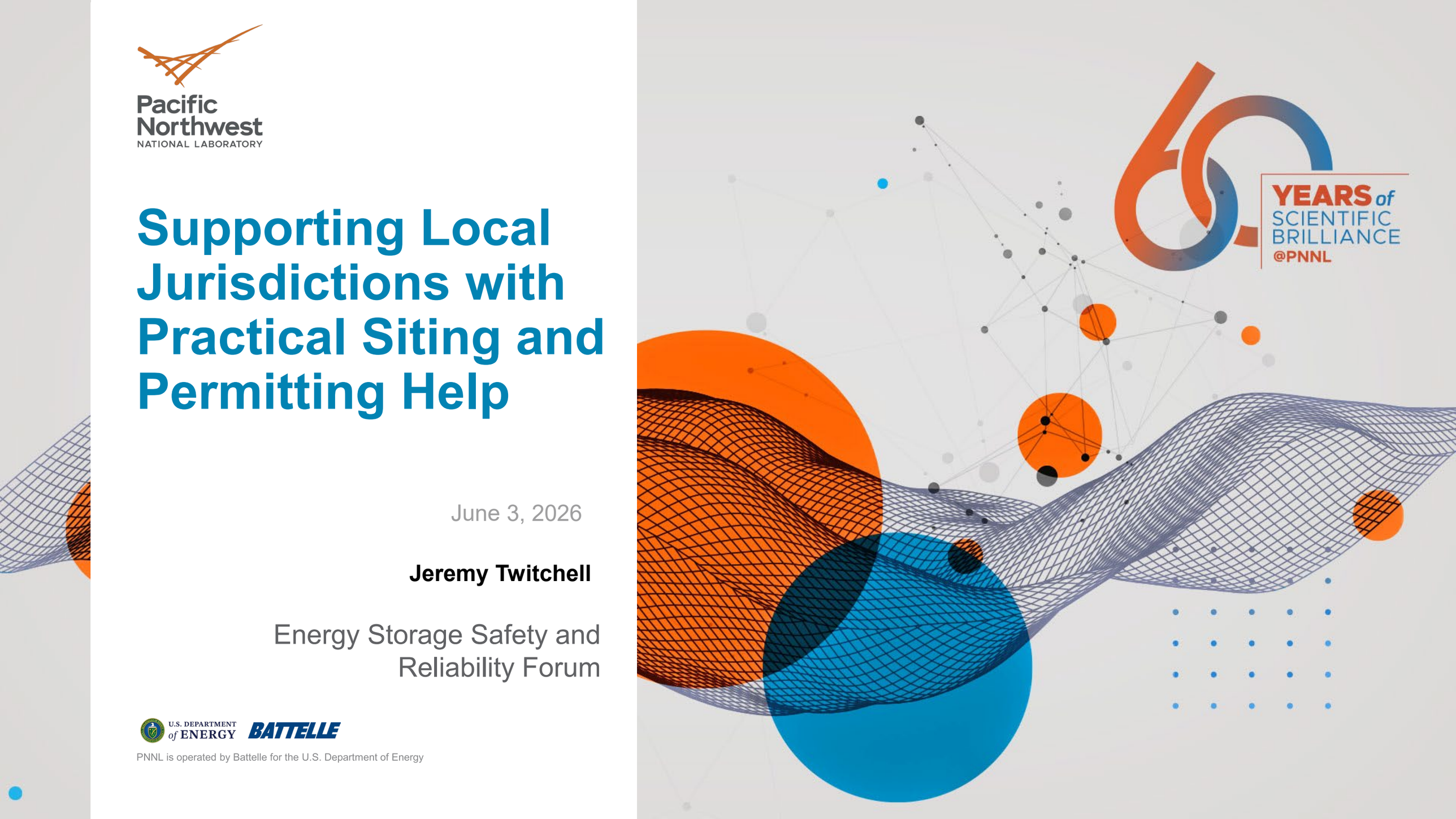
Pacific Northwest
NATIONAL LABORATORY

Supporting Local Jurisdictions with Practical Siting and Permitting Help

June 3, 2026

Jeremy Twitchell

Energy Storage Safety and Reliability Forum



U.S. DEPARTMENT of ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

Acknowledgment

The work in this presentation was funded by the U.S. Department of Energy, through the Office of Electricity's Energy Storage Program.

I also want to acknowledge the invaluable efforts of Devyn Powell and Prathit Dave in this work.

Agenda

- Motivation and topline message
- Local impacts of energy storage
- Designing storage zoning ordinances
- Understanding storage moratoria
- Socializing codes and standards
- Code update strategies
- Summary

Motivation and Topline Message

Background

- OE funds our team to identify regulatory barriers to storage and provide objective research and assistance to states as they address those barriers
- Siting and permitting is a topic of significant interest with our state partners
- We've worked on siting and permitting with state agencies, local jurisdictions, and utilities in the following states:
  - California
  - Iowa
  - Maryland
  - Massachusetts
  - Michigan
  - North Carolina
  - Rhode Island
  - South Carolina
  - Washington

Key takeaways from these engagements

- Battery energy storage is fundamentally different than other local land uses
- Battery storage risks are generally misunderstood in terms of both probability and severity
- Neighbors of proposed battery storage projects often feel blindsided

Motivation

- Every energy storage project requires approval from an authority having jurisdiction (AHJ)
  - Usually a municipal or county planning commission; sometimes a state agency
- One of the key benefits of lithium-ion technologies—energy density—creates two key challenges for those jurisdictions
  - Smaller project footprints mean storage can be built in close to other land uses
  - Thermal runaway is a unique—and widely misunderstood—risk in land use planning
- Our work tries to meet local jurisdictions where they are and objectively inform them about the benefits, risks, and impacts of energy storage and how they can mitigate risks through codes, standards, and ordinances

Topline Message: Codes and Standards Matter

- Codes and standards do not eliminate the risk of thermal runaway
- Codes and standards reduce the risk of thermal runaway and its severity

Impact of Codes and Standards: A Tale of Two Failure Events

Moss Landing, California, is the site of three separate energy storage projects, two of which have experienced thermal runaway events:

- One at a project designed and built before NFPA 855 and UL9540A were published (older project), and
- One at a project built after their publication (newer project)

Pacific Gas & Electric

LA Times

Incident 1: September 2022 (Newer Project)
Runaway Event Contained

Project Description: 182.5 MW/730 MWh consisting of 128 individual, cabinet-style containers (Tesla Megapacks) **built subject to NFPA 855 and UL9540A**.

- On Sept. 22, 2022, water penetration into one of the cabinets caused a fire
- The fire was contained to the unit, which burned for six hours and then emitted smoke for 12 more hours
- First responders assumed a defensive perimeter, but did not actively engage the fire
- The lost unit accounted for about 0.5% of the facility's capacity
- The project returned to service about three months after the fire

Incident 2: January 2025 (Older Project)
Total Facility Loss

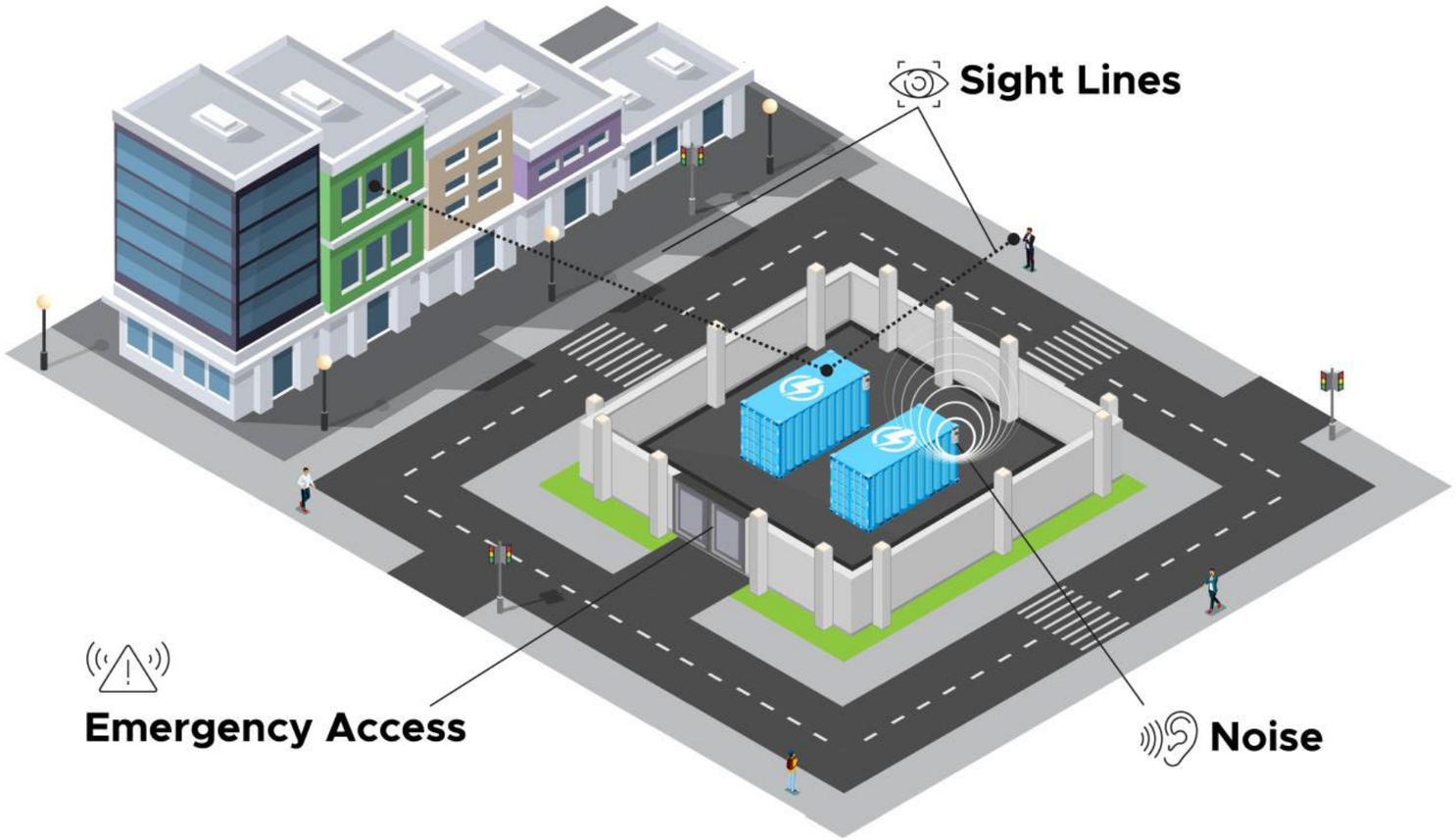
Project Description: 300 MW/1200 MWh consisting of racks of batteries housed in the former powerhouse of a retired power plant **that were built prior to NFPA 855 and UL9540A**.

- On Jan. 16, 2025, a thermal runaway event spread through the full project
- The cause remains under investigation
- The fire burned for two days and then briefly reignited about a month later
- The project will be a complete loss, while ash and debris damaged neighboring BESS projects and kept them offline for months
- Metal fragments from the fire have been detected miles away from the facility

Pacific Northwest
NATIONAL LABORATORY

Local Impacts of Energy Storage

Local Community Impacts of Energy Storage



- Visual
- Noise
- Odor
- Runoff
- Safety

Report: Energy Storage in Local Zoning Ordinances

Impacts and Implications

 **Visuals**	Lithium-ion technologies are modular, so projects can take many different shapes	→	Standards require 7-foot fences around battery projects, but jurisdictions may want to consider higher fences, secondary screening for aesthetic purposes
 **Noise**	Inverters, ventilation, and transformers all make noise; total noise level dependent on their number and location	→	Noise mitigation can be achieved through a combination of screening and setbacks; noise assessments likely needed on a case-by-case basis
 **Odor & Gas**	Only present in a failure state	→	Shelter-in-place orders and air monitoring may be appropriate during a failure event, but no long-term air impacts have been identified in previous events
 **Runoff**	Runoff from battery projects most likely to occur during water-based fire suppression	→	Fire suppression strategies should use water as little as possible; closed stormwater systems may be preferrable

Designing Storage Zoning Ordinances

Why Zoning Ordinances Matter

- By grouping similar functions and land uses in proximity with one another, zoning ordinances “automate” the decision-making process by allowing conforming projects to be quickly reviewed and approved
- Local jurisdictions can use ordinances to send clear signals to developers about
  - Where storage projects should be sited,
  - How they should be screened from neighboring uses, and
  - How big they should be
- Only non-conforming uses (those that don’t fully comply with the requirements of the zone) need to be closely scrutinized and considered for a conditional use permit (or similar)
  - Absent zoning ordinances, every storage project will require a lengthy conditional use permit review

Anatomy of a Storage Zoning Ordinance

- Our review of existing storage ordinances identified key common elements:

- Technology Types
- Size Thresholds
- By Right/ Conditional Permitting

- Noise Limits
- Aesthetic Requirements
- Setbacks
- Lighting

- NFPA/IFC Requirements
- Decommissioning Plan and Bond
- Site Plan
- First Responder | Coordination

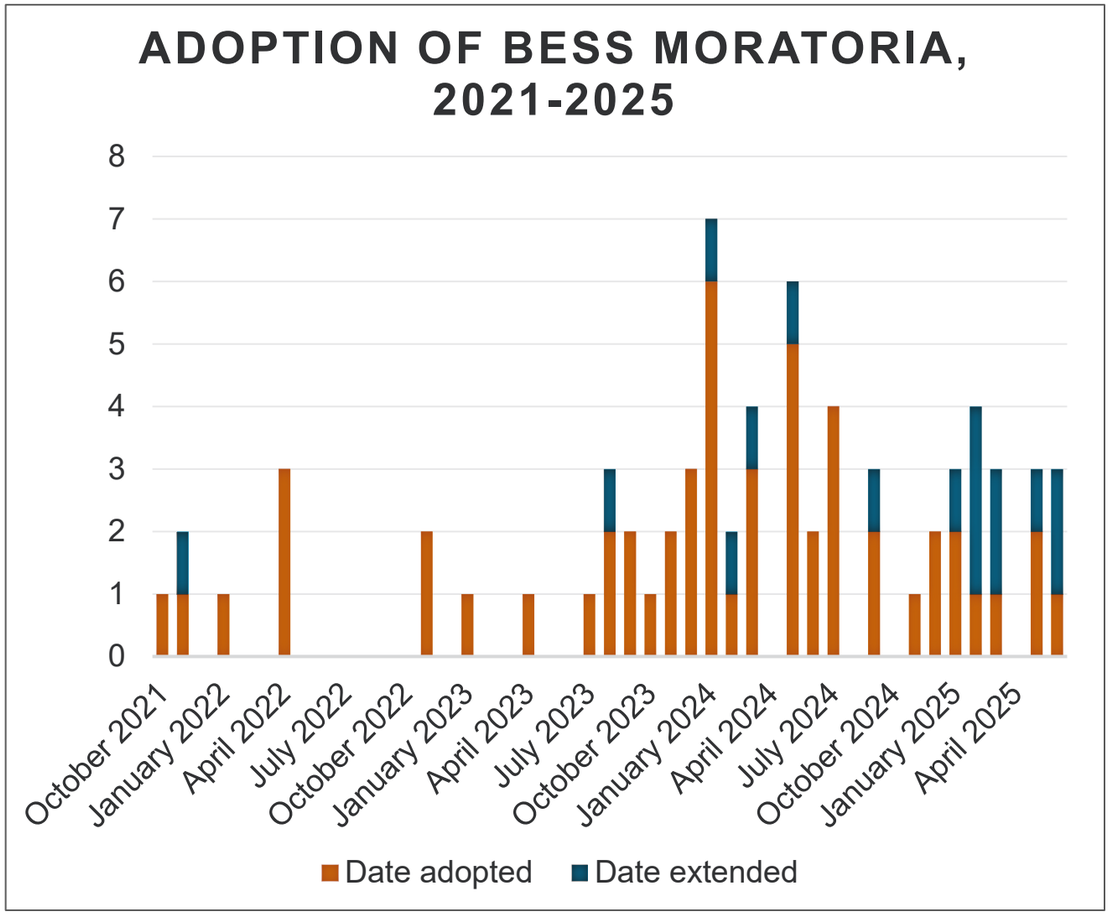
Report: Principles and Options for Designing Battery Energy Storage Zoning Ordinances

Pacific Northwest
NATIONAL LABORATORY

Understanding Storage Moratoria

Tracking Energy Storage Moratoria

- A review of moratoria and bans against battery storage at the local level identified 56 moratoria in 14 states that were adopted between 2021 and 2025
- Moratoria are commonly adopted to allow local planners the time to develop an informed zoning ordinance for BESS. 13 jurisdictions that initially issued moratoria in this review have since adopted BESS zoning ordinances.
- Some moratoria are extended or are adapted into bans.



Drivers of Moratorium Adoption

Some common drivers of moratorium adoption, based on text of adopted moratoria and local news coverage:

- Fire safety concerns are very common.
- Lack of familiarity with BESS technologies, including unclear information about risks and lack of first responder training
- Noise and visual impacts, especially when potential projects may be sited in residential or mixed-use zones.
- Property value impacts
- Imbalance between impacts (highly local) and benefits (diffuse for grid-connected systems)
- Conflicts between BESS and other land uses, particularly agriculture

> The Town of Oyster Bay has approved a six-month moratorium on the establishment of Battery Energy Storage Systems (BESS) in the Town of Oyster Bay.
>
> "While these battery storage systems have been identified as playing a critical role in achieving climate goals by New York State, they are not without their potential safety risks as various concerns have been recently exposed," said Town Supervisor Joseph Saladino. "Four fires at BESS facilities in New York State have highlighted these dangers and have raised concerns over public safety and the safety of first responders."

Oyster Bay, NY

> If something "catastrophic" did occur that would force the closure of those three arteries, well, that would represent a big problem and "something that really has to be evaluated," said Schneiderman, noting that East Hampton Town "came close" to calling for the evacuation of residents within a mile radius of the BESS facility there when it caught fire earlier this year.

Southampton, NY

> The commissioners extended a moratorium on the batteries until March 31, 2025. Explaining this decision, they said that the local fire departments and first responders are not equipped and staffed to safely deal with these energy storage systems were they to catch on fire.
>
> "When the electric is generated from the solar panels, if it is not distributed to the grid, it is stored in batteries that are then stored in, like, large storage containers," Porter said. "How would it be addressed if those storage facilities were malfunctioning and caught on fire?"
>
> He said the moratorium will remain in place until these batteries can safely be put in place.

Caroline County, MD

> However, Supervisor John Vasquez repeatedly stated that this is not a ban on storage facilities, only a pause in permitting, until the county can determine where will be the best places to allow the projects and other safety measures that are needed. Protecting prime agricultural land will be part of the consideration.

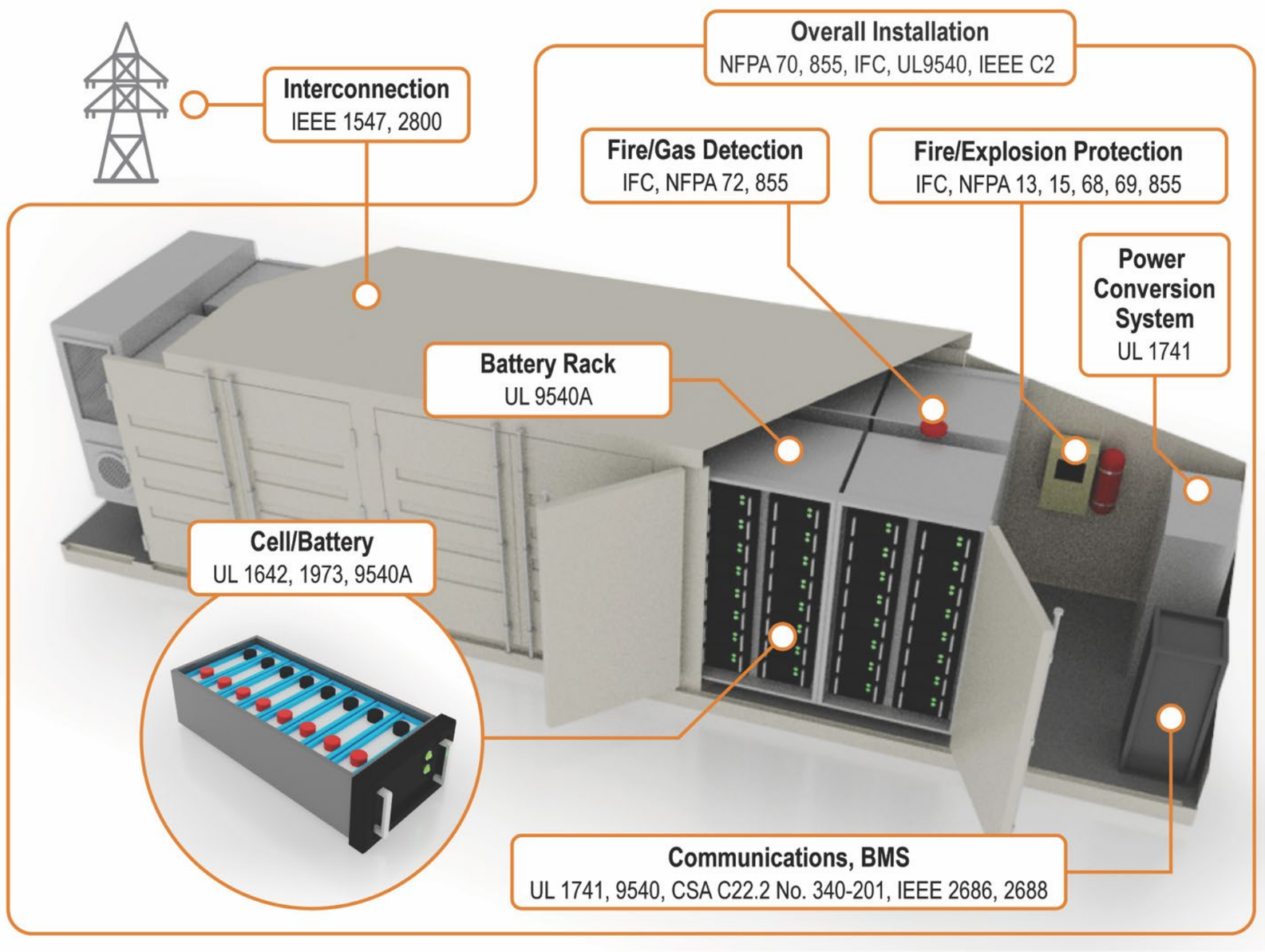
Solano County, CA

Socializing Codes and Standards

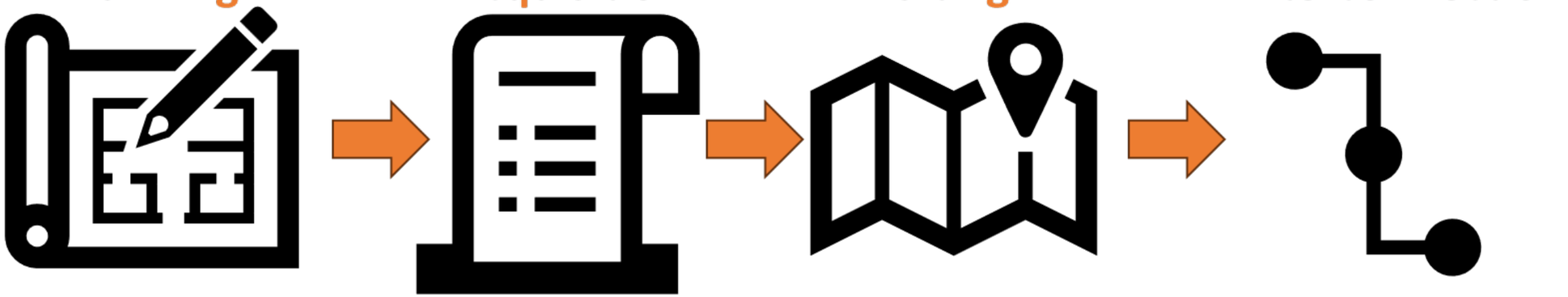
Pacific Northwest
NATIONAL LABORATORY

There are lots of battery storage safety standards

- If you are designing a system, you need extensive knowledge of them all
- But if your role is to review or approve a project (such as regulator, local zoning official, or member of the public), a working knowledge of a few key standards is sufficient



Storage Deployments Involve Many Stakeholders



UL 9540 & 9540A

- Plan review
- Planning input and comments
- Investment review and approval

NFPA 855

- Certificate of Public Convenience and Necessity
- Permitting
- Project review
- Ordinance drafting
- Project review and input

IEEE 1547 & 2800

- Approval of interconnection processes

Key
- Relevant codes and standards
- Regulatory role
- Local jurisdiction role
- Public Role

Implications for Siting and Permitting Stakeholders

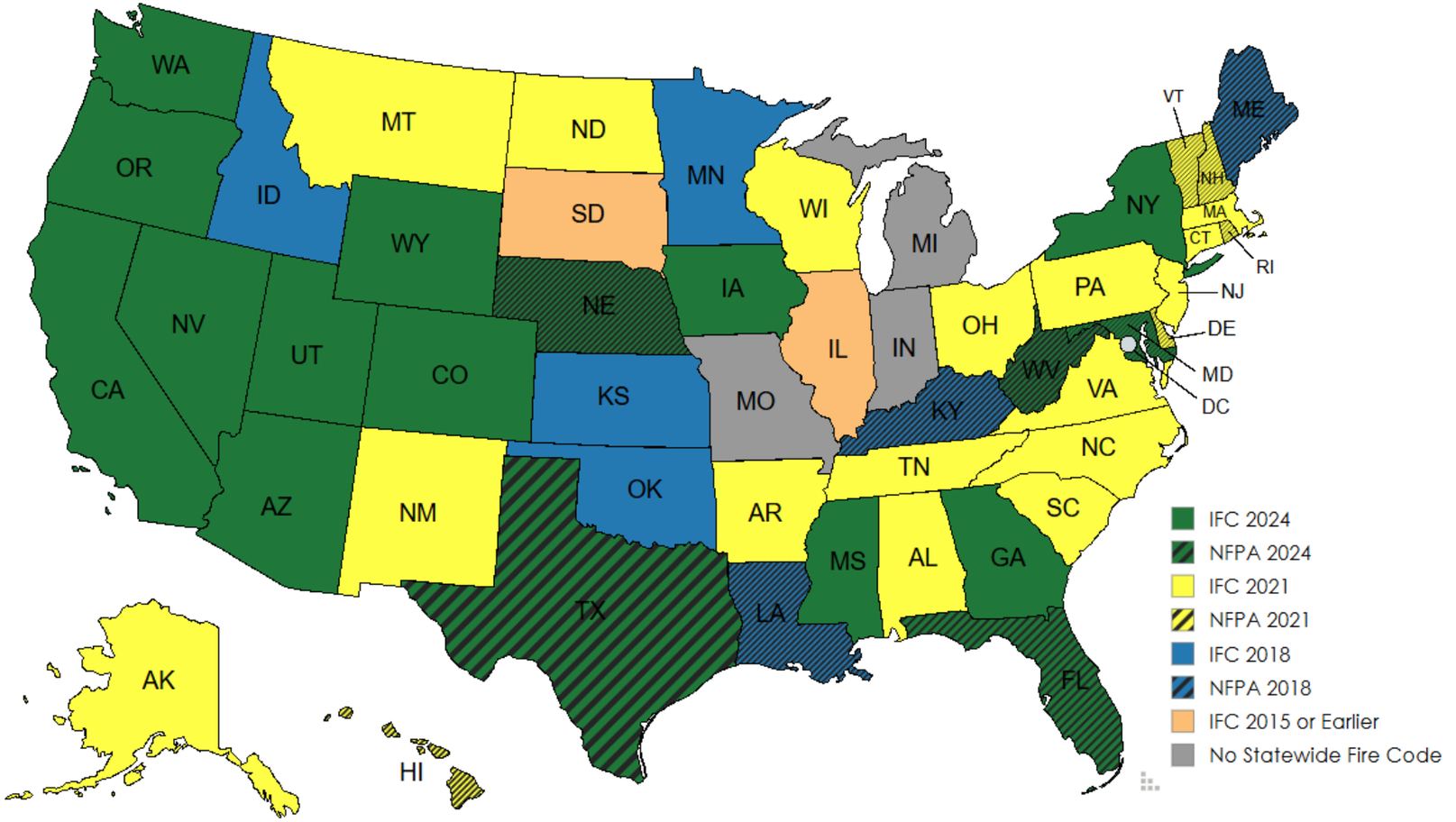
	Implications for:		
Code/Standard	**Regulators**	**AHJs**	**Public**
UL 9540/9540A	• Is the utility modeling UL-compliant technologies?	• How did the proposed technology perform in UL9540A testing? • How did the UL9540A test outcome inform the design of this project?	• Will a thermal runaway event require shelter-in-place or evacuation orders?
NFPA 855	• Should local engagement requirements be attached to approvals?	• What is the emergency plan for a proposed project? What training has been provided? • What is the decommissioning plan for the project? • Would a decommissioning bond be appropriate?	• What is your thermal management strategy? • How will you mitigate facility noise?
IEEE 1547/2800	• Do regulatory rules and utility tariffs reflect best practices for interconnection?	• Where does the project stand in the utility's interconnection process? • How long is project commissioning expected to take?	• What will traffic and noise be like during the commissioning process? How long will it last?

Pacific Northwest
NATIONAL LABORATORY

Code Update Strategies

Code Update Challenges

- Fire code updates are time-consuming and expensive, and many states are one or more cycles behind as a result
- For a dynamically evolving code like NFPA 855, being behind means missing out on significant protections



Code Update Strategies

- **Authority Vested in State Agency:** Allows agency to more nimbly adopt new versions of the codes through simple rulemakings
  - Michigan (Public Service Commission), Indiana (Department of Homeland Security)
- **Emergency Temporary Rule:** Places new battery standards in effect until full code update process is completed
  - Washington
- **Supplemental Code Cycle:** Enables timely adoption of codes and standards on different cycles (such as IFC and NFPA)
  - California
- **Adoption by Reference:** Places most current version of code in state statute, removing the need for updating each cycle
  - Nevada

Summary

Summary

- Allowing energy storage into a jurisdiction and protecting jurisdiction residents are not mutually exclusive objectives
- Energy storage systems have impacts and risks that are material and must be taken seriously
- Codes and standards provide a framework for managing the safety risks of energy storage
- Socializing the benefits of codes and standards with regulators, local jurisdictions, and the public is critically important in providing a stable permitting framework for energy storage

Pacific Northwest
NATIONAL LABORATORY

Thank you

Jeremy Twitchell
jeremy.twitchell@pnnl.gov
971-940-7104