Update on Energy Storage System Safety Roadmap Codes and Standards Activities

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DOE OE Peer Review
Santa Fe, NM

Purpose and Expected Outcome

Purpose

- Reinforce the relevance and importance of ongoing efforts to foster successful application of safe energy storage technology through the availability of updated standards and model codes.

Expected Outcome

- An understanding of the value of the ongoing work and the foundation laid through past successes that continues to support energy storage technology development and deployment.

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Energy Storage Safety Challenge

- What is safe (or not safe)?
- How does one assess if something is or is not safe?
- What criteria are used to make an assessment?
- How are criteria developed, adopted and applied?
- When is an assessment needed?
- Who can perform an assessment?
- Who can designate something as safe?
- How can they apply the results of an assessment?
- Can the answers change over time?
- Why would the answers change?
- If they do change how are the new answers developed and implemented?

> “Hindsight is a wonderful thing but foresight is better, especially when it comes to saving life, or some pain.”
>
> William Blake

Standards and model codes, when adopted and applied, are the basis for technical communication between all stakeholders involved in technology development and deployment and are the benchmark by which these and other questions can be answered.

Without standards and model codes there is no uniform basis for technical communication and as such no way to answer these questions in a way all stakeholders can understand and authorities having jurisdiction (AHJs) responsible for safety can apply.

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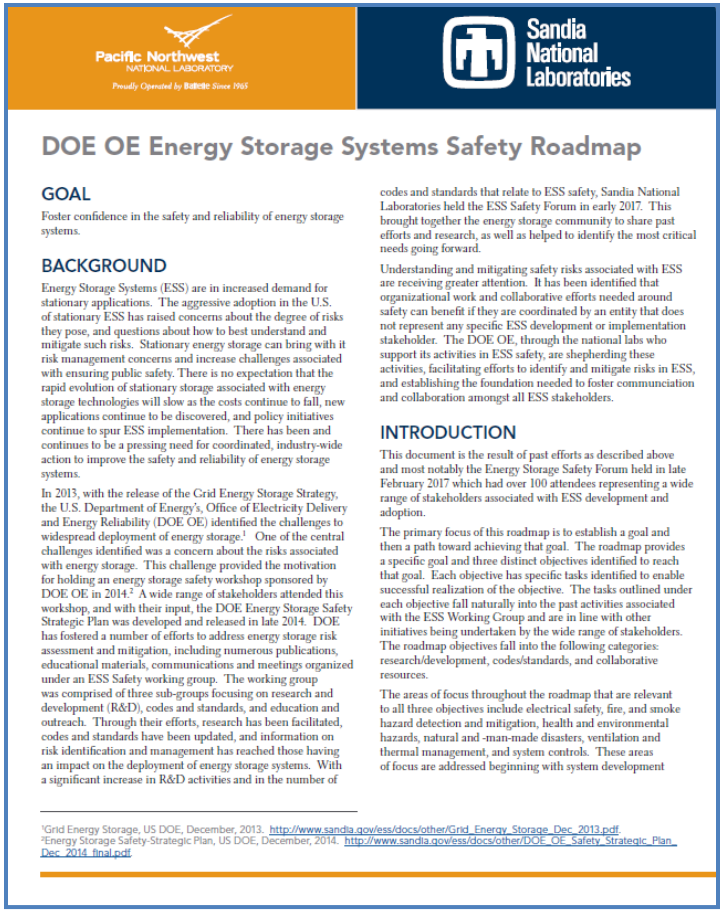
“Without rules there would be chaos.”

ESS Safety Roadmap - Standards and Model Codes

- **Objective**
  - Apply R&D outputs to support efforts focused on ensuring that codes and standards are available to enable the safe implementation of energy storage technology in a comprehensive, non-discriminatory, and science-based manner.

- **Activities**
  - Review and assess codes and standards that affect the design, installation, and operation of energy storage systems.
  - Identify gaps in knowledge that require research and analysis that can serve as a basis for future criteria in those codes and standards.
  - Identify areas in codes and standards that potentially need revision or enhancement and can benefit with the support of activities conducted under R&D.
  - Develop input for new or revisions to existing codes and standards through individual stakeholders, facilitated task forces, or through laboratory staff supporting these efforts.



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DOE OE Energy Storage Systems Safety Roadmap

GOAL

Foster confidence in the safety and reliability of energy storage systems.

BACKGROUND

Energy Storage Systems (ESS) are in increased demand for stationary applications. The aggressive adoption in the U.S. of stationary ESS has raised concerns about the degree of risks they pose, and questions about how to best understand and mitigate such risks. Stationary energy storage can bring with it risk management concerns and increase challenges associated with ensuring public safety. There is no expectation that the rapid evolution of stationary storage associated with energy storage technologies will slow as the costs continue to fall, new applications continue to be discovered, and policy initiatives continue to spur ESS implementation. There has been and continues to be a pressing need for coordinated, industry-wide action to improve the safety and reliability of energy storage systems.

In 2013, with the release of the Grid Energy Storage Strategy, the U.S. Department of Energy's, Office of Electricity Delivery and Energy Reliability (DOE OE) identified the challenges to widespread deployment of energy storage.[1] One of the central challenges identified was a concern about the risks associated with energy storage. This challenge provided the motivation for holding an energy storage safety workshop sponsored by DOE OE in 2014.[2] A wide range of stakeholders attended this workshop, and with their input, the DOE Energy Storage Safety Strategic Plan was developed and released in late 2014. DOE has fostered a number of efforts to address energy storage risk assessment and mitigation, including numerous publications, educational materials, communications and meetings organized under an ESS Safety working group. The working group was comprised of three sub-groups focusing on research and development (R&D), codes and standards, and education and outreach. Through their efforts, research has been facilitated, codes and standards have been updated, and information on risk identification and management has reached those having an impact on the deployment of energy storage systems. With a significant increase in R&D activities and in the number of codes and standards that relate to ESS safety, Sandia National Laboratories held the ESS Safety Forum in early 2017. This brought together the energy storage community to share past efforts and research, as well as helped to identify the most critical needs going forward.

Understanding and mitigating safety risks associated with ESS are receiving greater attention. It has been identified that organizational work and collaborative efforts needed around safety can benefit if they are coordinated by an entity that does not represent any specific ESS development or implementation stakeholder. The DOE OE, through the national labs who support its activities in ESS safety, are shepherding these activities, facilitating efforts to identify and mitigate risks in ESS, and establishing the foundation needed to foster communciation and collaboration amongst all ESS stakeholders.

INTRODUCTION

This document is the result of past efforts as described above and most notably the Energy Storage Safety Forum held in late February 2017 which had over 100 attendees representing a wide range of stakeholders associated with ESS development and adoption.

The primary focus of this roadmap is to establish a goal and then a path toward achieving that goal. The roadmap provides a specific goal and three distinct objectives identified to reach that goal. Each objective has specific tasks identified to enable successful realization of the objective. The tasks outlined under each objective fall naturally into the past activities associated with the ESS Working Group and are in line with other initiatives being undertaken by the wide range of stakeholders. The roadmap objectives fall into the following categories: research/development, codes/standards, and collaborative resources.

The areas of focus throughout the roadmap that are relevant to all three objectives include electrical safety, fire, and smoke hazard detection and mitigation, health and environmental hazards, natural and -man-made disasters, ventilation and thermal management, and system controls. These areas of focus are addressed beginning with system development

[1]Grid Energy Storage, US DOE, December, 2013. http://www.sandia.gov/ess/docs/other/Grid_Energy_Storage_Dec_2013.pdf
[2]Energy Storage Safety-Strategic Plan, US DOE, December, 2014. http://www.sandia.gov/ess/docs/other/DOE_OE_Safety_Strategic_Plan_Dec_2014_final.pdf

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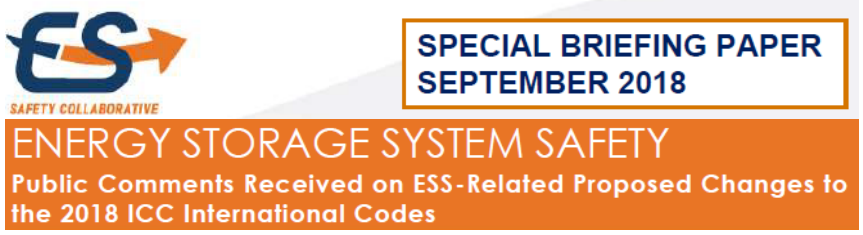
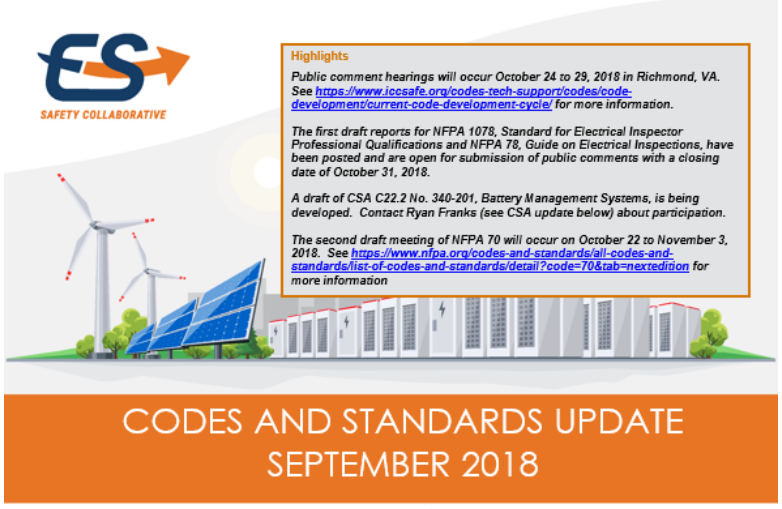
Standards and Model Codes





The goal of the DOE OE Energy Storage System Safety Roadmap[1] is to *foster confidence in the safety and reliability of energy storage systems.* There are three interrelated objectives to support the realization of that goal: research, codes and standards (C/S) and communication/coordination. The objective focused on C/S is *"To apply research and development to support efforts that refocused on ensuring that codes and standards are available to enable the safe implementation of energy storage systems in a comprehensive, non-discriminatory and science-based manner."*

The following activities support that objective and realization of the goal:

a. Review and assess C/S which affect the design, installation, and operation of energy storage systems (ESS).
b. Identify gaps in knowledge that require research and analysis that can serve as a basis for criteria in those C/S.
c. Identify areas in C/S that are potentially in need of revision or enhancement and can benefit from activities conducted under research and development.
d. Develop input for new or revisions to existing C/S through individual stakeholders, facilitated task forces, or through laboratory staff supporting these efforts.

The purpose of this document is to support the above activities by providing information on efforts being conducted by U.S. standards developing organizations (SDOs) and other entities that are focused on ESS safety.

The information is organized relative to the scope of each document and energy storage systems from the "macro to the micro" (e.g., from overarching covering considerable scope, to installation specific, to ES systems and then ES system components). Note also that more macro documents are likely to adopt by reference more micro documents.

Changes in current activity from the prior edition are shown in bold italics. **Time-sensitive items (e.g., those having a schedule/due date) are highlighted in yellow.**

To subscribe to ES Safety Collaborative communications visit https://public.govdelivery.com/accounts/USDOESNLEC/subscriber/new?topic_id=USDOESNLEC_195

[1] DOE OE Energy Storage Systems Safety Roadmap, PNNL-SA-126115 I SAND2017-5140 R https://www.sandia.gov/ess-ssl/publications/EnergyStorage_safetyroadmap_2017.pdf

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DOE OE Energy Storage Systems Safety Roadmap

Accomplishments

- Identification of all ESS relevant C/S development activities (ASME, CSA, DNV GL, ICC, IEEE, FM Global, NECA, NEMA, NFPA and UL)
- Review of C/S activities and communicating all ESS safety-relevant information to all interested parties
  - Monthly C/S Reports
  - Webinars on C/S activities
  - Conference presentations
  - Technical input to a number of standards and model codes
  - Briefs and special publications
  - Ongoing information transfer

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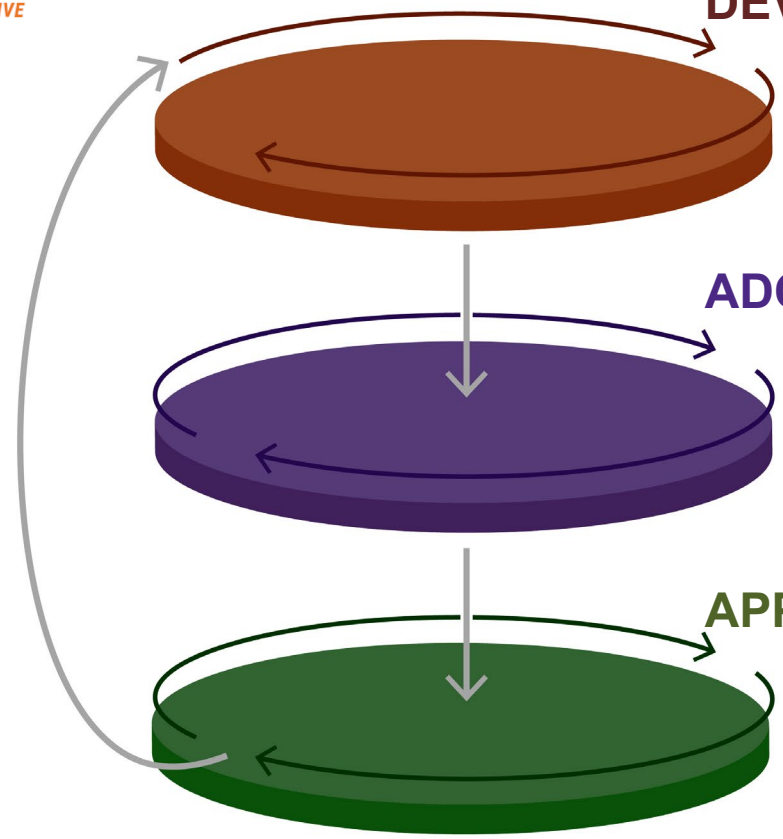
Standards and Model Codes Development, Adoption and Application

ES Safety Roadmap

SAFETY COLLABORATIVE

Stakeholder Participation



DEVELOPMENT

- SDO's
- Assn's
- Orgs
- Utilities
- Homegrown

ADOPTION

- Laws
- Regulations
- Contracts
- Conditional Req's
- Insurance

APPLICATION

ENERGY STORAGE SYSTEM SAFETY
Documenting and Validating Compliance with Codes and Standards

- AHJ's
- Designers
- Manufacturers
- Integrators
- Contractors

Timely deployment of safe ESS

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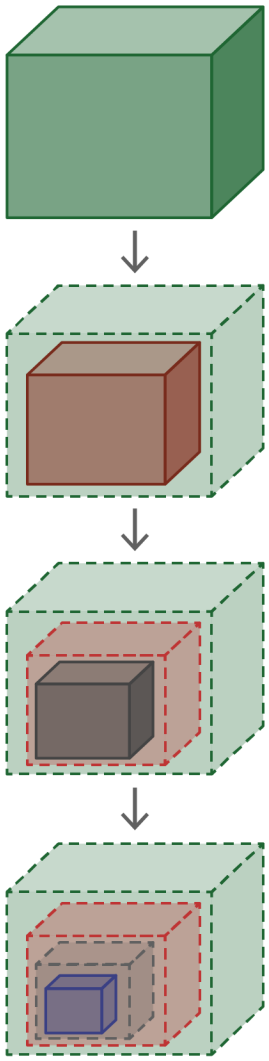
Standards and Model Codes Hierarchy



BUILT ENVIRONMENT

- ICC IFC, ICC IRC, ICC IBC
- NFPA 5000
- NFPA 1

INSTALLATION / APPLICATION

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

ENERGY STORAGE SYSTEMS

- UL 9540
- ASME TES-1
- NFPA 791

SYSTEM COMPONENTS

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

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Standards and Model Codes

- Involvement in C/S development (committee or task force member and/or participation in the development of proposed changes/public comments)
  - ASME TES-1 Safety Standard for Thermal (molten salt) ESS
  - NECA 416 Recommended Practice for Installing Stored Energy Systems
  - NECA 417 Recommended Practice for Designing, Installing, Maintaining, and Operating Micro-grids
  - NFPA 70 National Electrical Code
  - NFPA 791 Recommended Practice and Procedures for Unlabeled Electrical Equipment
  - NFPA 855 Standard for the Installation of ESS
  - ICC International Residential Code and International Fire Code
  - UL 9540 Energy Storage Systems and Equipment
  - UL 9540A Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
  - UL 1974 Evaluation for Repurposing Batteries
- Facilitating adoption and application
  - Support documents, fact sheets and briefs
  - Education and training
  - One-on-one assistance as requested

Stakeholder Comments

- *"The DOE OE's support in codes and standards expertise for the Massachusetts' Advancing Commonwealth Energy Storage (ACES) program has been invaluable. With this support, we feel more confident that the 26 projects (for $20 million) will be safer and exemplify best practices for energy storage in the Commonwealth."*

  - Kavita Ravi, Director of Emerging Markets, MA Clean Energy Center

- *"It is my opinion that the work undertaken by the DOE in the safety area has been beneficial to the industry as a whole. By attending the ESS Safety and Reliability Forum, I gained valuable insight into the work other SDOs are undertaking, as well as the direction of the industry."*

  - Nicole Gomez, S&C Engineer, Safety ASME

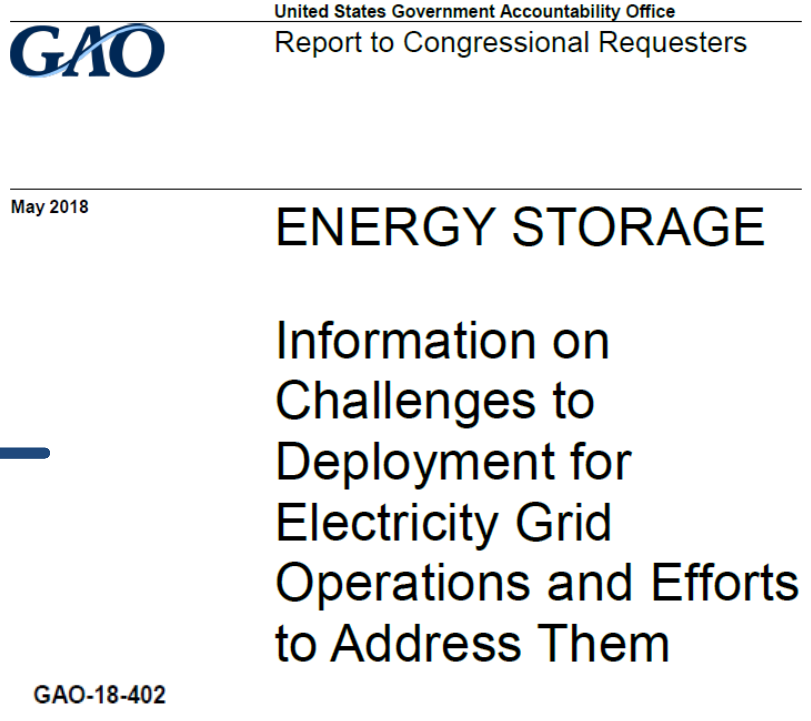
- *"The information the DOE OE ES Safety Program provides on codes and standards developments related to energy storage provides an excellent overview of the current voluntary sector standards and model codes environment. It is very informative to hear about the progress of various ESS related initiatives. There is so much going on in this arena that it helps to have one source of information to keep up-to-date."*

  - Howard Hopper, FPE, Program Manager, Codes and Advisory Services, UL LLC

Recognition

DOE has undertaken various efforts to address challenges affecting energy storage technology deployment

- Efforts to address safety
  - Safety roadmap
  - Supporting the development and deployment of safety codes with industry groups
  - Collaboration with stakeholders
  - Monitoring of codes, standards and regulations
  - Coordination with entities such as NFPA and the ICC
  - Development of resources supporting application of codes/standards



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Acknowledgment

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Q/A and Further Information

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http://www.sandia.gov/energystoragesafety/

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