Codes and Standards for ESS Relevance and Importance

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Purpose and Expected Outcome

Purpose

- Reinforce the relevance and continuing importance of ESS safety-related codes and standards (C/S) development and adoption in fostering successful expansion of energy storage technology development and deployment.

Expected Outcome

- An understanding of the value of C/S and the foundation that exists through past and current efforts that will support future efforts.

Energy Storage Safety Goal

Achieving desired growth of ESS in the built environment that is minimally affected by safety-related incidents because of the availability of codes and standards that….

- ✓ support ESS technology
- ✓ form a basis for communication and understanding
- ✓ foster the installation and use of ESS
- ✓ are founded on robust research and field data
- ✓ are supported by all relevant stakeholders
- ✓ are widely adopted and understood
- ✓ can be easily updated as warranted

OR

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Challenges Associated with ESS Development and Deployment

- The ever increasing number of ESS technologies and applications and ability of relevant stakeholders to ‘keep up’
- Codes and standards provide a vehicle to uniformly document and validate ESS safety but can be in need of updating and enhancement
- Research and data to define what is and is not safe are needed to develop appropriate codes and standards
- All interested and affected parties may not recognize the importance of codes and standards or if they do may be reluctant to participate or collaborate with others
- When codes and standards are available they may not be adopted and applied in a timely manner
- Ensuring all stakeholders have the necessary training and resources to document, validate and ensure compliance

Addressing the Challenges - ESS Safety Roadmap

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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.

GOAL

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

OBJECTIVES

R&D | C/S | CR

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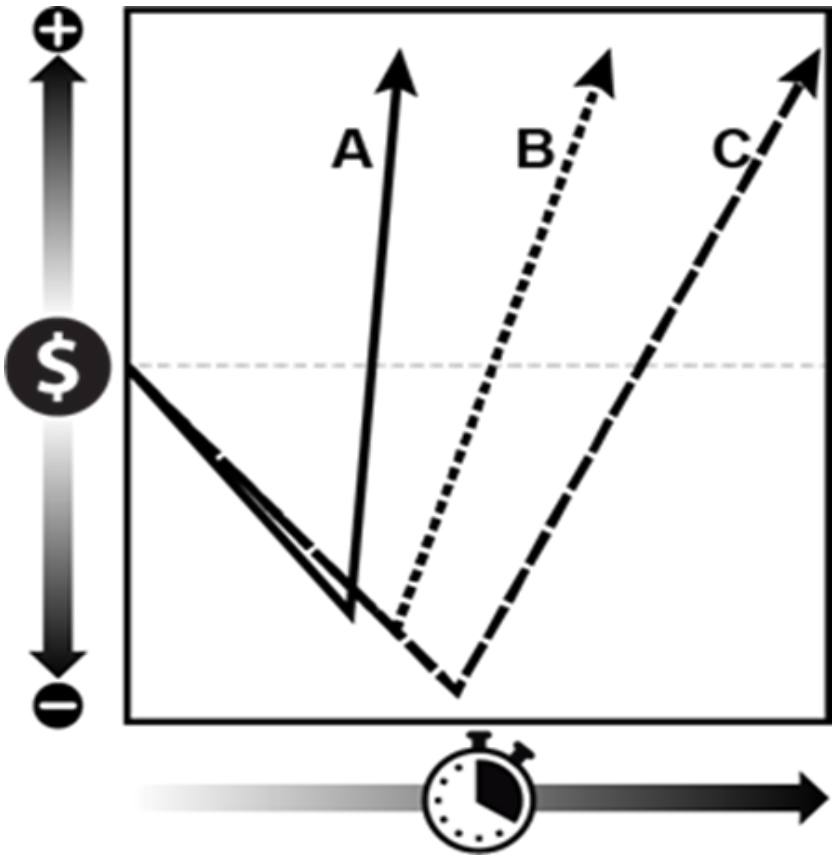
A Value Proposition

- Investment in ESS development and deployment (Y-axis) over time (X-axis)
- Updated/current C/S provide a basis to uniformly document and validate ESS safety in a timely manner
- ESS proponents can make an investment to be involved (or not) with C/S development
  - A – active participation
  - B – track efforts of others
  - C – no involvement



- The choice made will affect how successfully ESS can be deployed which in turn affects the ROI associated with ESS development

Codes and Standards

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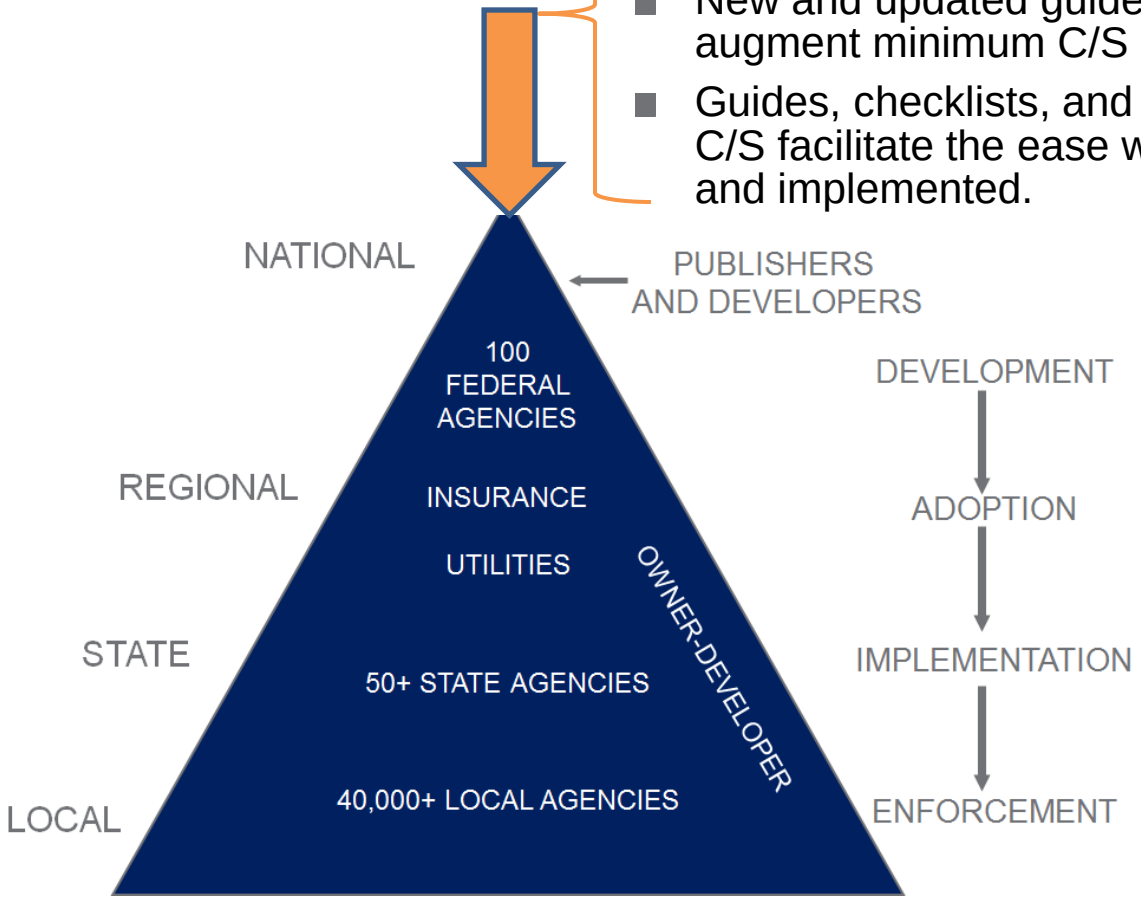
Outcomes

- New and updated C/S are adopted and become the minimum safety metric affecting the timely acceptance of ESS.
- New and updated guidelines, protocols, best practices, etc. augment minimum C/S
- Guides, checklists, and educational materials supporting C/S facilitate the ease with which ESS can be approved and implemented.



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The Big Picture

- Many US and global entities that oversee the development of model codes and standards (C/S)
- C/S collectively form the basis for a cohesive and integrated set of criteria that govern the design, construction, commissioning, operation, maintenance, renovation and demolition of the built environment
- Standards have specific purposes and scopes and are available for adoption directly, in other standards and/or model codes
- Model codes adopt standards and in that adoption provide administrative criteria that will influence application of the standard
- Model codes can be adopted voluntarily, mandated or adopted on a conditional basis as can standards
- Those adopting model codes or standards can and do amend them
- Guides, guidelines, protocols, best practices, recommended practices etc. provide additional guidance and can be pre-cursors to C/S

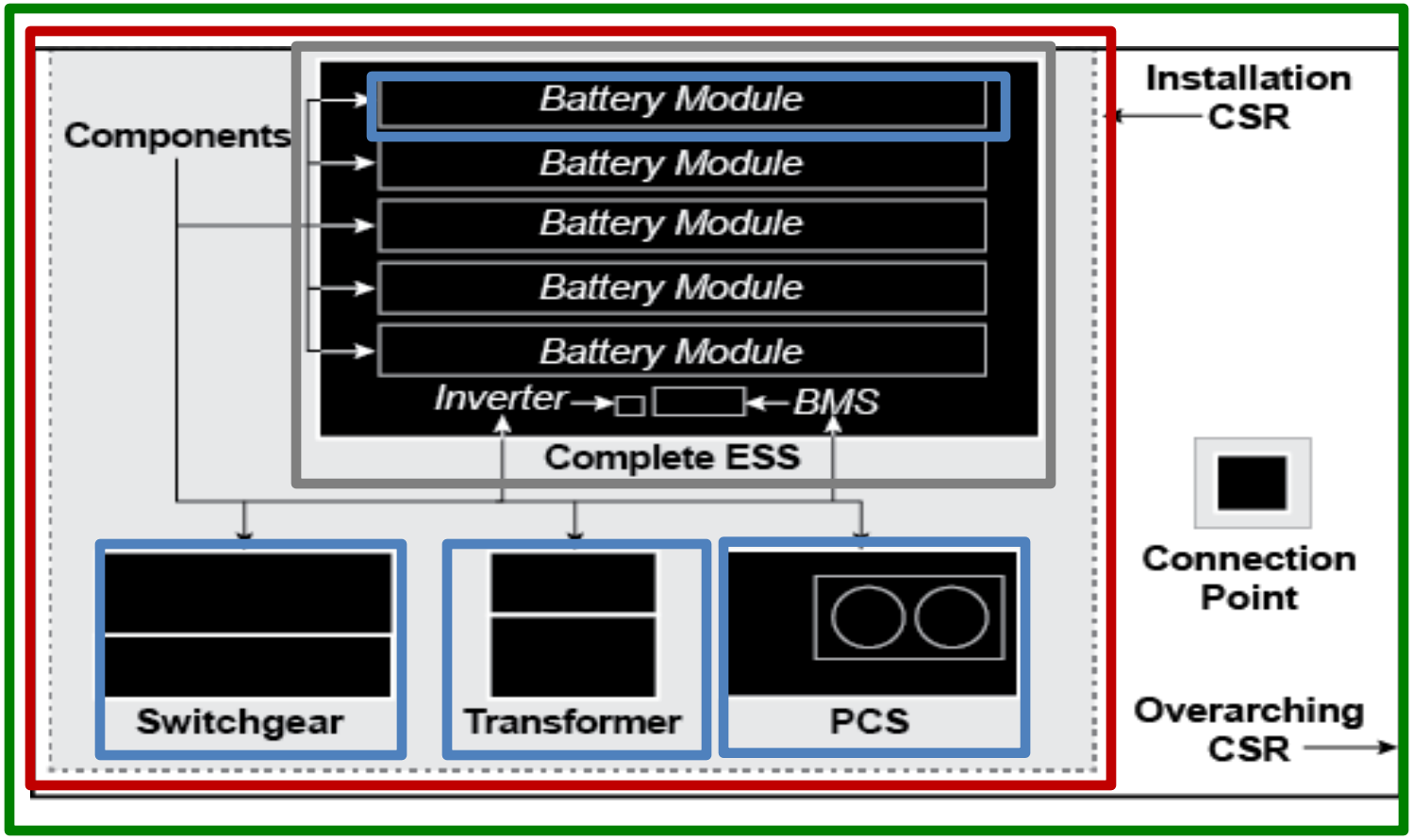
Adoption of Codes and Standards

- Standards
  - Mandatory adoption by Federal, state or local authorities via legislation or regulation
  - Adoption by reference and/or adaptation into model codes
  - Voluntary adoption by non-governmental entities as a component of procurement, insurance, government support/financing, contractor licensing and other reasons
- Model Codes
  - Mandatory adoption by Federal, state or local legislative or regulatory action by reference, within the legislation, automatic or as warranted
  - Applicable in all areas covered by the action
    - Mandatory maximum/minimum
    - Mandatory minimum with amendment allowed
    - Mandatory only if agency elects to adopt a code
    - Mandatory as a required design specification even if an agency elects to adopt
  - Voluntary adoption through insurance, builder, utility, contractor, etc. action
  - Adoption as a component of a professional ethics and licensing

Scope of Codes and Standards vis-a-vis ESS

Overarching CS | CS for ESS Installation | CS for Complete ESS | CS for ESS Components

MACRO → MICRO



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Key Codes and Standards

Overarching CS

- **NFPA 1-2018** (Fire Code)
- **NFPA 70-2017** (National Electrical Code)
- **ICC 2018 IFC**
- **ICC 2018 IRC**
- **IEEE C2-2017** (National Electric Safety Code)
- **DNVGL-RP-0043** (Safety, Operation and Performance of Grid-connected ESS)

CS for ESS Installation

- **NFPA 855-20XX** (Standard for the Installation of Stationary Energy Storage Systems)
- **NECA 416-2016** (Recommended Practice for Installing Stored Energy Systems)
- **FM Global Property Loss Prevention Data Sheet # 5-33 January 2017** (Electrical Energy Storage Systems)

CS for Complete ESS

- **UL 9540** (Energy Storage Systems and Equipment)
- **ASME TES-1** (Safety Standard for Thermal Energy Storage Systems)

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Key Codes and Standards

CS for ESS Components

- **IEEE P1679.1** (Guide for the Characterization and Evaluation of Lithium-Based Batteries in Stationary Applications)
- **IEEE P1679.2** (Guide for the Characterization and Evaluation of Sodium-Beta Batteries in Stationary Applications)
- **UL 1973** (Batteries for Use in Light Electric Rail and Stationary Applications)
- **UL 1974** (Evaluation for Repurposing Batteries)
- **UL 810A** (Electrochemical Capacitors)

Summary and Moving Forward

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DOE OE Energy Storage Systems Safety Roadmap

GOAL

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

OBJECTIVES

R&D | C/S | CR

Secure Adoption

Foster Compliance

Experiences & Data

Additional Research

Update C/S

All stakeholders need to coordinate and collaborate to achieve success

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Q/A and Further Information

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