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Overview of Development and Deployment of Codes, Standards and Regulations Affecting Energy Storage System Safety in the United States

August 2014

DR Conover

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the U.S. Department of Energy
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Department of Energy

Washington, DC 20585

Codes, standards and regulations (CSR) provide a critical function in the safe and reliable deployment of energy storage systems. They impact all aspects of energy storage systems, from the fundamental components (wires, relays, etc.) through installation and operation. However, for dynamic and growing technologies like energy storage, CSR activities often lag well behind technical development. During the DOE Office of Electricity Energy Storage Safety Workshop in February of 2014, many developers expressed frustration navigating CSR's, especially during their first introduction. The following document was created in response and is intended to acquaint those working in energy storage with a basic background in how CSR's are defined, developed and implemented. It is our hope that this will help demystify the CSR process and enable accelerated adoption of energy storage systems. This document and the companion compendium of Current Codes and Standards support the DOE-OE Energy Storage Safety Strategic Plan to be published in the near future.

A handwritten signature in blue ink, reading "Imre Gyuk", is positioned above the printed name.

Dr. Imre Gyuk
Program Manager
Energy Storage Research
Office of Electricity
U.S. Dept. of Energy

Summary

Purpose

The purpose of this document is to acquaint stakeholders and interested parties involved in the development and/or deployment of energy storage systems (ESS)¹ with the subject of safety-related² codes, standards and regulations (CSRs).³ It is hoped that users of this document gain a more in depth and uniform understanding of safety-related CSR development and deployment that can foster improved communications among all ESS stakeholders and the collaboration needed to realize more timely acceptance and approval of safe ESS technology through appropriate CSR.

Scope

This document addresses how CSR that provide minimum safety requirements applicable to ESS are developed and deployed⁴ in the United States. It is recognized that the development and deployment of CSR internationally at the national, regional or global level are also of relevance and interest to the ESS industry and stakeholders and interested parties.⁵ The immediate need for this document in supporting the upcoming Strategy for Energy Storage Safety (DOE 2014) suggests that the focus for the first version of this document be on the United States and extended and enhanced in the future to address efforts outside the United States. One exception is the inclusion in this document of U.S. efforts associated with relevant standards development at the global level through the International Electrotechnical Commission (IEC). This document does not address the value of or economics associated with ESS, which will also affect the deployment of ESS. Those and other issues will certainly have an impact on a decision to apply (or not) ESS. On the other hand, CSR will impact if and the manner in which ESS can be deployed.

¹ ESS technology is stationary energy storage technology and does not include vehicular based storage technology, although such vehicular applications could also be used at times to provide energy to address non-vehicular energy needs and as such could be considered under some CSR as a stationary application.

² While focusing on safety, significant portions of this document provide general information needed to understand CSR and therefore applies to CSR covering other topics or non-ESS technology.

³ The scope of CSR includes laws, regulations, rules, model codes, standards, codes, specifications, protocols, acceptance criteria and any other type of document that provides safety related requirements that ESS technology must satisfy in order to be acceptable for installation and use on a continuing basis.

⁴ Development is focused on the processes by which model codes and standards are developed leading up to but not including their adoption, unless the CSR are being developed directly by an adopting authority in which case development and adoption are essentially the same activity. Deployment includes activities associated with the adoption of model codes and standards, unless being developed by an adopting authority, and the activities associated with documenting or verifying compliance with the CSR requirements.

⁵ As used herein, the term “industry” is intended to mean any entity involved in the production of any ESS or ESS components. Stakeholders include any entity directly engaged in the development or deployment of ESS other than the industry (e.g., code officials, first responders, utilities, third-party testing and certification agencies, etc.). Interested parties are those that are not directly engaged in development or deployment (e.g., building owners, elected officials, building designers, etc.).

Acronyms

AHJ	authority having jurisdiction
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
APCO	Association of Public Safety Communications Officials – International
ASME	American Society of Mechanical Engineers
ASQ	American Society for Quality
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
ASSE	American Society of Safety Engineers
ASTM	American Society for Testing and Materials International
AWEA	American Wind Energy Association
CAGI	Compressed Air and Gas Institute
CGA	Compressed Gas Association
CSR	codes, standards and regulations
DOE	U.S. Department of Energy
EASA	Electrical Apparatus Service Association
ESS	energy storage systems
FERC	Federal Energy Regulatory Commission
HVAC	heating, ventilation and air-conditioning
IAPMO	International Association of Plumbing & Mechanical Officials
IBC	International Building Code
ICC	International Code Council
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NERC	North American Electric Reliability Corporation
NESC	National Electric Safety Code
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Laboratory
OE	Office of Electricity Delivery and Energy Reliability
OSHA	Occupational Safety and Health Administration
PEARL	Professional Electrical Apparatus Recyclers League
PGMA	Portable Generator Manufacturers Association
PUC	Public Utility Commission
PV	photovoltaic
RD&D	research, development and demonstration
RIMS	Risk & Insurance Management Society
SDO	standards development organization
UL	Underwriters Laboratories, Inc.

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1.0 Overview

1.1 Overview of ESS Technology and Market Opportunities

There are a myriad of energy storage technologies in terms of design, capacity and function. They include but are not limited to batteries, pumped hydro, electrochemical capacitors, compressed air, flywheels and thermal storage. Anything that can store energy for future use can be considered energy storage. Within battery storage, there are different chemistries such as lithium-ion, lead-acid, nickel metal hydride, alkaline and potassium-ion as well as various flow battery chemistries. Though not described in this document, fuel cells are similar to batteries in that they use a chemical reaction to provide electricity, but they do not store energy and instead create it through reactants containing hydrogen and oxygen that are stored externally. The U.S. Department of Energy (DOE) International Energy Storage Database provides information on the energy storage projects operating or planned in the United States, North America and globally (<http://www.energystorageexchange.org>). Further information on energy storage technologies is available in the “DOE/EPRI Energy Storage Handbook in Collaboration with NRECA.”

Electrical storage today is not fundamentally different than it was in the late 1800s, only altered in the range and type of technologies used, system size, their location and ownership/operational situations (grid or customer side of the meter), interconnection with other systems and existence as pre-packaged systems or on-site systems constructed of mix-matched components. The intended applications for ESS (peak shaving, frequency regulation, islanded microgrids, etc.) are increasing in depth and breadth. Due to factors spurring market demand for energy storage technology as discussed in Section 1.2, North America is expected to see the most growth in energy storage over the next 5 years. Grid-scale storage will increase globally upwards of 10 gigawatts over that same period. This includes not just grid or commercial size systems but residentially focused systems in the 5 to 25 kilowatt range. The projected U.S. market for energy storage in 2015 is estimated at \$10 billion annually. This acceleration in the application and use of ESS in the built environment¹ increases the need to emphasize ESS safety, among others such as reliability, an issue addressed by CSR. The degree to which CSR are updated to fully address ESS safety, which includes among others electrical shock, fire, explosion, egress and protecting an installation from natural or manmade disasters or access by unauthorized persons, and the success in deploying those CSR will have a significant impact on how fast that growth potential can be realized.

1.2 Drivers Accelerating the Demand for ESS

Energy, environmental and economic challenges are spurring activity associated with new energy-related technology. We need electric power to meet those challenges and address growing demand. In addition, there is a need to improve power reliability and flexibility along

¹ The term “built environment” is intended to include anything humanly built. For the purposes of this document, it includes the opportunities for application and use of ESS to address our electrical energy needs whether on the supply (utility) or the demand side (buildings, facilities, industrial manufacturing, etc.).

with reducing costs associated with electric power delivery and an increasing need to be smarter about what we do and how we do it. Electrical storage has a more important and critical role in addressing these challenges beyond its historical role as a backup power source. This information is driving the investment in ESS development and deployment to address many needs for electrical power throughout the built environment. For instance, storage can help address the increasing need for utilities to upgrade their investments in generation, transmission and distribution services to meet these challenges. There is an increased emphasis on power quality, reliability and the ability to time-shift and manage demand charges by those using electric power. In addition, the movement toward a Smart Grid that seeks to improve the grid through automation is heavily dependent on the availability of ESS. Efforts to deploy renewable technologies such as solar photovoltaic (PV) and wind are also driving demand for the ability to store the captured energy for use when PV and wind resources are not available. In addition there are market forces spurring increased ESS application and use. In some states and localities, there are incentive programs and policy directives for specific amounts of ESS use within specific deadlines that are directed at utilities for grid side and building owners/developers for customer side ESS deployment. Policies are also being developed at the Federal Energy Regulatory Commission to foster consideration of ESS.

Energy storage technology today includes predecessor and established storage technologies but also involves the introduction of many new approaches and chemistries to store energy. Codes, standards, regulations and other criteria governing the safety of technology tend to lag technology development because these documents cannot anticipate technology and need relevant safety-related research and documentation upon which to evolve to address new technology. The processes for development and deployment of CSR may require time to realize the needed changes to specifically address the range of energy storage technology available today and ongoing efforts to address future ESS technology. The alternative to not being proactive about conducting the necessary safety-related research and providing continuous updates on CSR that track with ESS development may adversely affect ESS deployment. Inaction means that the needed updates to CSR do not occur, or others outside the industry update the CSR in response to incidents associated with the technology.

1.3 Overview of How CSR are Developed and by Whom

Codes, standards and regulations are the body of criteria or provisions that when adopted, as covered in Section 1.5, must be satisfied to design, construct, commission, rehabilitate, operate, maintain, repair and demolish components of the built environment such as buildings, facilities, products, systems and equipment therein. The provisions in CSR affect the acceptability of energy storage technology on the utility and customer side of the meter² and the time and resources

² The differences in the processes associated with deployment of CSR on either side of the meter is discussed in more detail later in this document. While the utility may be the authority having jurisdiction (AHJ) with respect to utility systems and federal, state or local authorities and Indian Tribes the AHJ for installations on the customer side of the meter (e.g., non-utility systems), safety of ESS is to a large extent “blind” as to which side of the meter the

necessary to bring such technology to market as well as the eventual cost of the technology installation. They create opportunities for the development and use of new technology to address new and emerging issues where proponents of the technology are proactive in conducting needed safety-related research and recommending enhancements to CSR.

An historical review of CSR in the United States indicates that requirements memorialized in CSR have been developed and deployed to address natural or manmade disasters (building fires, hurricanes, seismic events), new and emerging issues (indoor air quality, radon, accessibility for the disabled) and to provide a basis for the application of new technology (plastic pipe, engineered lumber, non-CFC based refrigerants). One historical example is the need for electrical safety codes coincident with the introduction of electrical lighting in the late 1800s. Figure 1.1 provides a high-level general overview of the CSR development and deployment process in the United States.

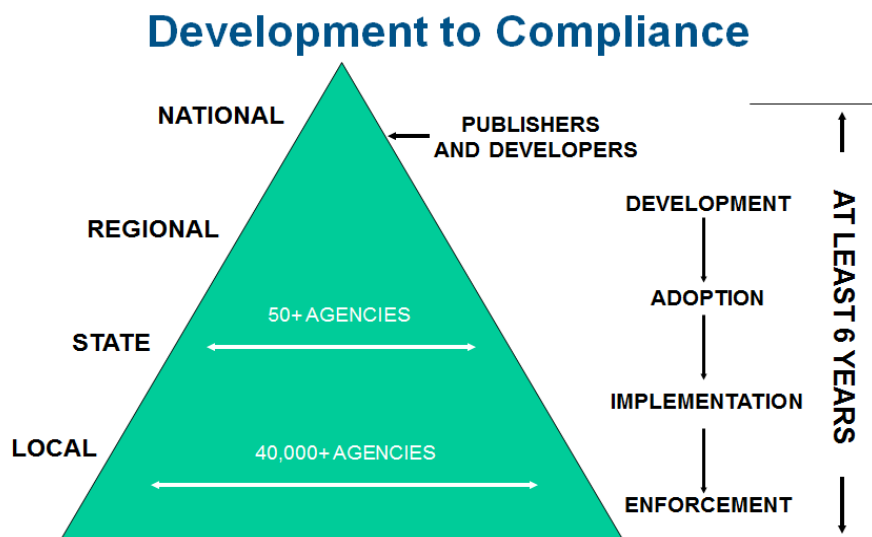


Figure 1.1. Overview of CSR Development and Deployment

The basis for most all CSR requirements in the United States are standards and model codes developed and published by organizations in the private sector.³ These documents exist separately to address a specific purpose and scope provided in each standard or model code. Collectively, they are part of a comprehensive set of laws, rules and regulations covering all aspects of the built environment that are required to be satisfied because, as covered in Section 1.5, they have been adopted. There are a myriad of standards each of which cover building-related issues and properties and the construction and installation of products, materials,

ESS is located. For that reason the development of CSR is generally applicable to all installations, while the adoption and conformity assessment processes associated with those CSR may differ on either side of the meter.

³ Note that while CSR may be considered voluntary when developed in the private sector, they become mandatory when someone adopts them and either requires conformance to them or makes conformance a prerequisite for some other consideration (e.g., ability to secure insurance or a reduced insurance rate premised on a decision to adopt CSR).

components, etc. Beyond standards there are separate building, mechanical, fire, electrical, plumbing, accessibility, energy efficiency and other model codes that reference those standards as appropriate on an individual basis and then collectively those model codes address the built environment (e.g., all buildings and facilities and their component parts).

Considering ESS safety from a ground up perspective, standards will apply to the smallest parts of the system (e.g., wires, relays, switches, etc.) to address their design, construction and safety features to serve their intended purpose.⁴ Subsequently, standards for components of the ESS (cells/modules, inverters, management systems, etc.) that rely on those other standards would be relevant for the resultant assembly of those “parts” to ensure that the components individually as well as collectively also safely serve the intended purpose; safety determined based on how they perform against relevant safety-related metrics. Beyond the assembly of components to yield an ESS the focus evolves to how the ESS is integrated into the built environment, whether at a utility site, connected to a wind farm and the grid or in, on or adjacent to a building or facility on public or private property. In looking at that integration of the ESS with a site and associated buildings and facilities, the standards for the ESS itself and its components will be referenced, but necessary criteria will also be provided to ensure the safety of the ESS in relation to its environment (e.g., fire department access, fire alarms and suppression, clearances to combustibles, ventilation of and egress from spaces where the ESS is located, etc.). This situation (components, systems and then system installations) means that there are a number of different CSR that will apply and will have been developed under the auspices of a number of different entities. Fortunately, the processes for development of standards and model codes are generally the same.

Voluntary sector standards development organizations (SDOs)⁵ exist in the United States as private sector entities with (among others) the mission of developing and publishing standards and model codes⁶ to address specific issues, technologies and design/construction solutions. The documents developed are generally focused on specific areas or issues and impact among others stakeholders who want to deploy technology.⁷ Two important issues to recognize about the process that each SDO employs is that development occurs on a particular schedule and each SDO organizes and manages the process. The provisions in the documents published by the SDO are not developed by the SDO but instead are developed by all interested and affected parties under a process provided and administered by the SDO. Whether acting alone or as the ESS

⁴ Note the focus of this document is on safety. Criteria in CSR can address other issues such as performance from an energy efficiency or emissions standpoint and equally affect the acceptance of technology.

⁵ For the purposes of the discussion on development, standards and model codes are the focus when discussing development in the voluntary sector. Subsequent to their adoption, they are considered regulations as are any “home grown” criteria developed and adopted directly by a legislative body or regulatory agency.

⁶ The terms “standard” and “model code” are covered in Section 1.4. To simplify the presentation on development they can be considered the same.

⁷ Examples include those responsible for verifying the safety of an ESS application that would have to develop their own “home grown” criteria in the absence of what is developed in the voluntary sector. They also include proponents of ESS applications who in the absence of CSR developed at the national level for adoption would face increasing challenges to respond to a possible “crazy quilt” of differing requirements across the United States, affecting energy storage systems, their components and the installation of systems.

“industry,” any revisions to existing CSR will have to account for SDO schedules and deadlines and be initiated by someone other than the staff of the SDO. Those revisions will have to be developed, supported with safety-related research and other documentation and fostered through the process by the proponent of the revision. Ideally that proponent will be the ESS industry taking a proactive role, as opposed to reacting to what others outside the ESS industry may feel is needed to address ESS safety as noted in Section 1.2. In the case of new CSR, the same is true, but the schedule is driven in part by the time it takes to develop a draft document and process it through the SDO process. For new standards or model codes it would be advantageous for the ESS industry to develop a pre-standard, protocol, or guideline that can address any immediate need for safety-related criteria and also serve as a first draft of a standard or model code.⁸

The standards development process in general is depicted in Figure 1.2⁹ and model code development process for the International Code Council is depicted in Figure 1.3; however, each SDO has a unique process. Many of those processes are intended to satisfy the American National Standards Institute’s (ANSI) essential requirements for standards development.¹⁰

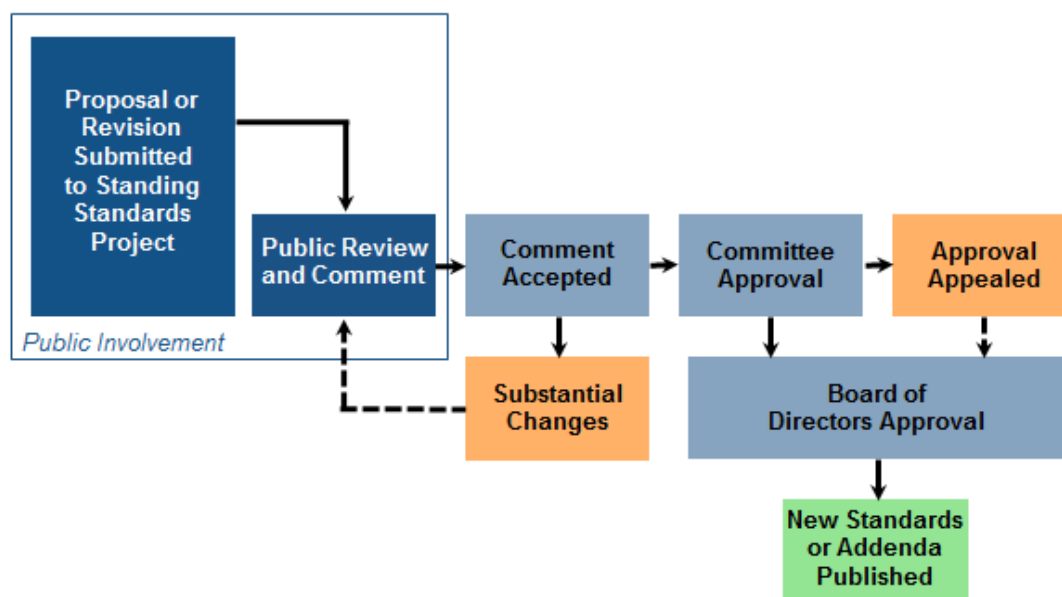


Figure 1.2. General Standards Development Process

⁸ The PNNL/SNL “Protocol for Measuring and Expressing the Performance of Energy Storage Systems” is an example of development of a pre-standard to serve a specific short term need concurrent with becoming the first draft of a more formal standard on the subject developed by SDOs in the United States and internationally.

⁹ ANSI Standards Overview

http://www.ansi.org/news_publications/media_tips/standards_overview_cont.aspx?menuid=7

¹⁰ While many SDOs maintain and apply ANSI approved processes they may not apply them to all documents they develop. Guidelines, protocols, bench standards, pre-standards and other documents may be formatted and read as standards but may have been developed through alternative because the body of information necessary to process a more formal standard may not exist. The processes used by the SDOs in these cases should be available from the SDO and there should be an ability to participate but that process is not as formal as when the goal is to achieve consensus.

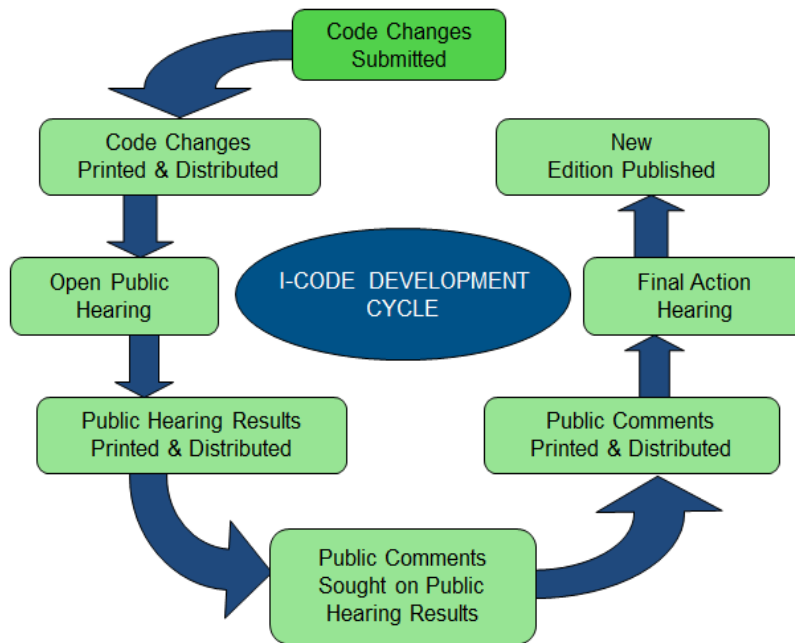


Figure 1.3. ICC Model Code Development Process

When applying a process meeting the ANSI essential requirements, it is important to determine if an applicable standard or model code already exists and can be revised or if a new document is needed because no applicable one was found to exist. In either case, a committee of balanced interests is generally formed to oversee the revision of an existing document or development of a new document. Any interested and affected party can be considered for participation on these development committees and can also submit proposed revisions to any of the existing documents. In the case of a new standard, a new committee will be established to develop a draft document for consideration; however, that process is streamlined if, as previously noted, those requesting the development of the standard have a draft (e.g., guideline, protocol, bench standard or pre-standard) upon which to base their initial standards development work.

All proposed revisions are considered by the committee responsible for revision of the document, and those voted for approval by the committee are made available for public review. Any interested party can submit comments, and they must be considered by the committee. The commenter is advised of the disposition of his/her proposal and has an opportunity to work with the committee to find an acceptable compromise or if an acceptable outcome is not realized then remain unresolved. If this process results in significant changes to the original proposal or draft document that was sent out for public review, those changes or if extensive enough the entire document must be submitted for additional public review and comment. When all or a vast majority of commenters are satisfied the standard can be considered for approval. Any commenters that remain unresolved can appeal a decision to approve the standard. If an appeal is successful, the standard must return for additional revision and public review. In some instances, the proposed changes are heard in open public hearings, where the committee votes a recommended disposition on each change. Those changes are published for public review and comment, and additional comments can be submitted. After changes and additional comments

are considered at a second public hearing, the final vote occurs on each change by federal, state or local government representatives. Regardless of the details associated with each SDO process, all processes designed to apply the ANSI essential requirements that are employed by SDOs are intended to ensure balance, transparency and a consensus on the outcome associated with each document. As noted in Section 1.2, collaboration among proponents of energy storage and affected stakeholders going into and when engaging in this process is advantageous because it will ideally already represent a consensus.

As mentioned in footnote 5 above, a regulatory body (federal, state or local government, Public Utility Commission, Indian Tribe, etc.) can also develop their own requirements instead of adopting the output from the SDOs. In this case development and adoption are concurrent as opposed to development in the voluntary sector and the adoption of the results by these same legislative bodies or regulatory agencies. These entities also include utilities that own or operate grid side ESS. Ideally, what is developed in the voluntary sector meets the needs of all adopters from a technical, administrative and time standpoint; eliminating the need for each adopter to develop their own unique criteria. That said, they do retain that authority to develop and adopt what they feel is appropriate for their needs. Federal agencies, however, are strongly encouraged through an Office of Management and Budget Circular A119 to participate in voluntary sector standards development and adopt the resultant standards as opposed to developing their own unique criteria.

1.4 Defining Terms

The terms provided in Table 1.1 are used in this document and have specific meanings that are important to recognize.

Table 1.1. Energy Storage Systems Terminology

Term	Definition
Adoption	The act of adopting a standard or model code or other set of criteria and causing the provisions therein to be satisfied.
Code	A document adopted by federal, state or local government via legal or regulatory means that provides criteria that must be satisfied. A code covering aspects of the built environment is generally based on or references a model code and may reference additional standards where not referenced in the adopted model code.
Conformity assessment	The process by which compliance with what is adopted is documented and verified.
Deployment	What occurs after the development and publication of a standard or model code or other set of criteria, which generally includes adoption and conformity assessment.
Development	The process by which standards and model codes are written, updated, maintained, published and made available for adoption.

Table 1.1. Energy Storage Systems Terminology (**cont.**)

Term	Definition
Model code	A model of a set of requirements that is developed and maintained by an SDO for adoption as a law or regulation which generally includes references to many standards. With additional criteria, the model code provides a complete regulatory package to govern the design, construction, commissioning and operation of buildings and systems.
Regulation	A legal vehicle through which a legally authorized agency or other entity adopts model codes and standards and conducts conformity assessment to validate compliance with what is adopted. Used herein the term regulation is also intended to include laws, codes, and rules (i.e., official legal terms indicating a legal requirement).
Standard	A document establishing a method of testing, criteria or other requirements intended to foster a specific level of quality, achievement, design and performance outcome that is considered acceptable or desirable. A standard can also define criteria for the design and construction of buildings and products, systems, materials, etc. A standard will generally have a limited scope (e.g., method of test for X, installation of Y, etc.).
Voluntary sector	Singularly and collectively those entities that are not affiliated with public sector agencies (e.g., federal, state or local government or Indian Tribes) or legislative bodies.

1.5 Overview of How CSR are Deployed and Who is Involved

Deployment includes what happens after model codes and standards are developed in the voluntary sector and are published, as discussed in Section 1.3. Deployment involves the processes associated with the adoption of model codes and standards as laws, rules or regulations and the entities involved in that process. It also covers how compliance with those documents is documented and verified through conformity assessment.

Adoption can be by any entity including a person, corporation, insurance carrier or utility as well as by federal, state or local legislative bodies or governmental agencies. The act of adoption through a law, rule, regulation, statute, contract specification, tariff or any other vehicle is intended to ensure that what is contained in the model codes and standards developed in the voluntary sector, or as noted above directly developed by the adopting entity, are required to be satisfied and that there is a basis for enforcement to ensure compliance. While federal, state and local government and other adopting entities have the authority to develop CSR, most adopt those developed in the voluntary sector at the national level with amendments, additions and deletions to address any specific needs of theirs that are not addressed in those documents. For instance, while the U.S. Department of Defense adopts the ICC International Building Code (IBC) as a component of its Unified Facility Criteria, they add provisions on blast safety to augment the IBC criteria. Reliance on the output from voluntary sector SDOs was not always the case as many adopting entities developed their own unique provisions. Even into the late 20th century, some states and major cities did not adopt nationally developed model codes to govern

building design and construction but instead maintained their own unique criteria developed through state or local processes.

The federal government does not generally have the authority to mandate the adoption of CSR by state or local governments, although federal agencies can influence what is adopted through other means such as the availability of federal funding. Aside from buildings owned or leased by federal agencies and a few instances where the federal government has preemptive authority,¹ and as a result Congress or federal agencies adopt specific CSR, state and local regulations will apply to the built environment, which would include an ESS installation. For ESS on the grid side of the meter, equipment and buildings owned or operated by the utility are covered by what is adopted by the utility.

When adopted, the model codes and standards are law, and legal authority is granted by legislative bodies or regulatory agencies for their implementation and enforcement (e.g., conformity assessment). When adopted by utilities, insurance or corporate entities through tariffs, policies, specifications, contracts or other legal documents, what is adopted may apply over and above what governmental entities have adopted or will be applied where no laws or regulations have been adopted or the government lacks the authority to adopt. The power to implement and enforce what is adopted rests with the entity that adopts the CSR and requires them to be satisfied. Documenting compliance with what is adopted rests with various private sector entities—manufacturers, builders, designers, product specifiers, contractors, building owners, utilities and others—involved in the design, construction, operation, use and demolition or decommissioning of what is regulated. The responsibility for determining and adjudging compliance rests with those representing the adopting authorities and is performed based on an assessment of the documentation provided, including inspections, against what has been adopted. With respect to ESS, the manufacturer of the system components would be responsible for documenting component compliance, the system manufacturer for documenting system compliance and a builder, engineer or record or contractor responsible for documenting the system installation is compliant. After an ESS installation is approved,² those engaged with its operation and maintenance would also be responsible for compliance with any applicable CSR, including those applicable to the repair, alteration, relocation or renovation of an existing ESS. Those verifying compliance (e.g., AHJs enforcing the adopted CSR) would include governmental agencies, utilities, insurance carriers and others who adopted the CSR and made them applicable to the ESS components, system, system installation and operation and maintenance of the system.

As demonstrating compliance is generally the burden of the building or technology installation owner or developer, those who will document compliance on their behalf include the architect, engineer, builder, contractor and others involved in design and construction. These entities rely on the manufacturer of the products, materials, systems or equipment to be used to provide the

¹ Examples are product labeling (FTC), appliance efficiency (DOE) and manufactured housing construction (HUD).

² Approval is considered verification of compliance by the relevant AHJs with what is adopted.

necessary documentation to verify that what they produce complies with the adopted CSR. All of these activities are included under the broader term conformity assessment. This includes testing, certification, quality assurance, calculations, simulation and other activities, all of which are intended to document the degree to which the applicable CSR are satisfied. In turn, the documentation is presented to the approving authority that will use it to validate compliance with the CSR in the design stage and then will engage in various inspections during the construction stage as well as through commissioning during operation and use and even decommissioning (e.g., retirement and recycling or disposal of the system or system components)

1.6 Impacts of CSR on Realizing ESS Market Opportunities

The DOE/EPRI 2013 Electricity Storage Handbook (2013) indicates that the biggest challenges hindering adoption of energy storage technology are cost, the ability to deploy ESS and lack of standards. Standards (and codes)—or the lack thereof—have a direct impact on the cost of an ESS and its installation, in terms of material and manpower costs. In addition, administrative burdens and time to approval issues affect the ability to deploy the technology and, in turn, cost. The absence of criteria upon which to evaluate technology performance, reliability and safety leaves those seeking to move ESS into the market and those responsible for public safety, with little upon which to base a decision that the system and its installation are “safe.” Until existing CSR are updated and/or new CSR are developed that specifically address the range of ESS technologies and installations and those CSR are adopted, it is difficult to uniformly document what is safe and determine what can be approved in a uniform and timely manner. In some instances, the lack of specifics limits progress until appropriate CSR are available; for others, “outdated” CSR can be conservatively applied to the technology affecting the cost of the installation or limiting its application.

Figure 1.4 provides a view of how CSR can impact technology development and deployment. All scenarios involve investment up front to bring the technology to market (negative slope) and then in going to market the generation of income (positive slope). Where CSR are not addressed (or are addressed after technology development; the blue line), additional investment in technology development and/or generation of research to document technology safety can be required, which increases the time to market. In a worst-case situation, CSR simply prohibit the use of the technology primarily because the technology compromises a basic tenant in CSR that is not likely to be changed. Where CSR are addressed (red line), a small investment in addressing them in parallel to technology development is more than paid back because the necessary CSR are developed and deployed when the technology goes to market. The yellow line is presented for comparative purposes and represents a “typical” research, development and deployment model where there is some awareness to CSR. There are no “show stoppers,” but there is also little recognition of how to participate in CSR development and deployment effectively to realize additional and timelier consideration of the subject technology. Clearly applying what could be a significant financial and time burden associated with the blue line up front to move toward the red line provides a significant return on investment.

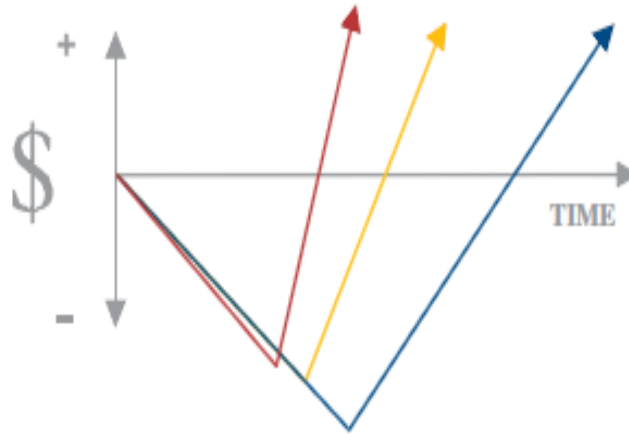


Figure 1.4. The Value in Addressing CSR

Until CSR are specifically updated to address new ESS technology and ESS applications, CSR do provide a path to documenting and validating compliance on the basis that what is proposed is no more hazardous nor less safe and it performs at least as well as other technologies that are specifically covered by existing CSR. While affording approval, this path requires the development of criteria to document and determine “equivalent safety” by each entity that enforces the adopted CSR. This can result in proponents of an ESS installation, having to develop a “custom” documentation package for each jurisdiction (approval authority) where an ESS is desired on the customer side of the meter or each utility when on the grid side.³ In addition, those authorities having jurisdiction (AHJs) may not be inclined to allow this path to compliance because they would have to develop those criteria, spend time assessing the evidence that documents equivalent performance and then actually sign off that the installation is safe on that basis. Clearly having updated and specific CSR to document and validate ESS safety are preferable and as suggested above, is a time-sensitive process.

As a bridge to ESS approval until CSR can be updated, the use of the performance path in documenting and validating compliance can be facilitated at the national level through the development of formal acceptance criteria (pre-standards, protocols or bench standards). When satisfied as documented by an accredited third-party agency or entity, the safety of an ESS can be validated on the basis of equivalent performance to current CSR. In that instance, AHJs can rely on those acceptance criteria and the assessment by an accredited third party in considering whether to approve an ESS installation, as opposed to each having to figure out what to do, as mentioned above. While a good short-term solution and even if facilitated through a nationally recognized AHJ process as an indication of CSR compliance, this scenario requires additional time and resources compared to securing approval based on compliance with CSR that specifically address the range of ESS available now and through continued updating of CSR those that will be developed in the future.

³ Those responsible for ESS approval (whether federal, state or local government, utilities, insurance carriers or others) can be classified as AHJs.

1.7 Challenges and Benefits to Addressing CSR for Various ESS Stakeholders

As suggested in Section 1.6, the benefits to ESS stakeholders for addressing CSR development and deployment are numerous.

- ▶ Those seeking to employ ESS have confidence in the safety of what they are proposing and can readily and uniformly document the acceptability of the ESS components, the entire ESS or the planned installation of the ESS to potential users.
- ▶ Those seeking to purchase or specify the technology have a recognized set of acceptable CSR to reference in their procurement documents.
- ▶ Proponents of ESS that are supported by CSR are more likely to have the necessary approval credentials than those who do not, reinforcing confidence by those who procure ESS and, in turn, incentivizing others to secure those credentials if they want to succeed in the market.
- ▶ Specific documentation results in fewer project delays because the necessary information is available and the CSR are clear about what is acceptable.
- ▶ Given the possibility of a project delay in securing approval for a new technology, those who purchase the technology are less likely to avoid the technology to complete their project and generate revenue because it does not pose any CSR related deployment challenges.
- ▶ Specific CSR that address the acceptability of the technology provide a common ground for all technology proponents in securing necessary approvals and offer uniform specifics for safe technology installation.
- ▶ Uniform and acceptable CSR provide a focused foundation for safety-related education and training on and support services for the technology.
- ▶ Technology installers and inspectors know what to expect as the criteria governing all installations are more uniform.
- ▶ Those involved in addressing incidents at installations (e.g., first responders) have fewer problems; if they do have to respond, their ability to address an issue with an ESS is vastly improved.
- ▶ Ongoing operation and maintenance as well as repair or refurbishment of the technology can be undertaken based on clear direction from adopted CSR in a more timely and less burdensome environment.

One additional key point in addressing CSR development and deployment individual ESS proponents who singularly participate in the development of CSR only to benefit their business interests may do so possibly at the expense of others who are offering the same basic ESS technology. This situation can create confusion among CSR developers, most notably AHJs that are involved in the approval and adoption of CSR and can result in delays in creating the CSR needed to support acceptance of safe ESS to yield the above benefits. Collaboration by all ESS proponents on development and deployment of CSR is critical. While collaboration may not yield the benefit to

the one or two that “go it alone,” it does raise the bar for the industry as a whole. Those in the regulatory arena (e.g., AHJs) that participate in CSR development and will be adopting the outcome of SDO development efforts will recognize and consider the existence of industry collaboration (or not) in their activities associated with CSR development and deployment.

1.8 The Importance of Research, Analysis and Documentation to CSR Development and Deployment

Simply stated, if a new CSR or revisions to an existing CSR are desired, the presentation of suggested criteria, requirements or test methods are likely to be considered and eventually approved by an SDO only after some basis for their validity. Without documentation, it is difficult to secure approval to circulate for public review and comment proposed criteria for a CSR or move through the remaining steps in standards and model code development. In most cases, the need for basis and documentation for the criteria will guide the development of the CSR language to be presented for consideration to an SDO, although it is not unusual to find these proposals with “soft” technical justification. Beyond development, if criteria are added that may appear to be controversial or supported with marginal documentation they are likely to be candidates for deletion or significant revision when the CSR is considered for adoption.

Consider an ESS proposed for internal building use. The impact of any chemicals that comprise the system must be considered because building and fire codes limit the amount of chemical storage within buildings. Such limits could outright prohibit or significantly alter the intended installation as to location, separation of the system into smaller modules or change the use group of the associated spaces, thereby imposing additional new requirements for the building. Based on the application of those existing CSR criteria to an ESS installation inside a building, research, analysis and documentation may be required to address their inappropriate application to the system in the short term. In the long term, if changes to the CSR are to be proposed, it will be necessary to document what is and is not considered a safe installation. This would be based on research and experiences from existing ESS installations, and use that body of knowledge to facilitate more appropriate treatment of ESS by updating CSR based on that information. Beyond challenging or countering the applicability of current CSR because they are “outdated,” suggested revisions must be substantiated and proven to yield a safe outcome when implemented. A prepared ESS industry is better able to advocate for designation of their technology being safe and achieve the successful updating of CSR and deployment of ESS with a robust and solid body of research and safety-related documentation. Without that forethought, AHJs, who are integrally involved in CSR development and deployment and whose sole mission is protecting public health and life safety, will be less likely to approve ESS installations because they will lack the needed guidance in the CSR that they will have adopted.

Of particular relevance is the entity (and who that entity represents) that does the research, analysis and documentation. While an ESS manufacturer may conduct testing, analysis and other work to evaluate and document the safety of their system for internal use, an accredited third party should be considered to conduct testing, analysis and other work that is intended to be used

in documenting the safety of and securing approval for the ESS. Ideally, the development of the documentation and supporting materials needed to update CSR will be conducted by recognized third parties on behalf of the ESS industry focused on common goals, objectives and issues, as opposed to supporting one manufacturer or one particular ESS technology. That in turn yields a robust, defensible, uniform and reasonable set of CSR for everyone to work from in documenting and verifying ESS safety. In short, a team approach founded on a common and collective body of research and analysis is generally preferable to separate initiatives that propose different solutions to addressing ESS safety.

1.9 How Success with Respect to CSR is Defined

Success with respect to CSR can be defined simply as the ability readily and uniformly to secure approval for and acceptance of the application and use of an ESS under applicable CSR⁴ related to safety, a track record of safe ESS operations, the ability for first responders to address an ESS related incident and no loss of life and minimal (if any) property damage if an ESS related incident occurs. The information provided in this document is intended to foster the development of strategies and implementation of actions that will help foster the application and use of ESS. The recommendations provided in Section 2.0 are intended to help the industry in developing those strategies and actions. The information in Appendices A, B and C are intended to provide additional detail on development and adoption of CSR and activities associated with documenting and verifying compliance with what is adopted (e.g., conformity assessment).

⁴ On the customer side of the meter, consider the CSR what is adopted at the federal, state and local level to ensure public safety in the built environment as enforced by governmental agencies or their assigns. On the utility side of the meter, consider CSR as the requirements, specifications and other guidelines adopted by the utility as the customer for the ESS technology and through the imposition of those requirements also the AHJ. Regardless of which side of the meter the ESS is located, the need for safety is the same, as is the means by and criteria under which it is realized other than their being a different AHJ.

2.0 Recommendations

2.1 Establish a Common Understanding of the CSR “Terrain”

From development through adoption and on to conformity assessment, CSR are intended to ensure among others a safe ESS installation. As such, they impact energy storage system components and entire systems as well as their installation and integration with the built environment. From the initial inception of a technology idea to and including timeframes years after the installation of an ESS, CSR will have continuing and unique features that will affect the successful deployment of today’s systems and the development of future systems. Understanding the CSR process affords stakeholders (as proponents of ESS) to more effectively assess the impacts of the process on the technology and participate in the process to update CSR to foster more timely and less complicated deployment of ESS. Having a common understanding affords those same individual stakeholders a basis to more effectively communicate and coordinate their activities to benefit the entire industry. As previously noted, if the energy storage industry and stakeholders cannot collaborate to address ESS safety through CSR, it is more likely to result in individual stakeholders taking responsibility. Those individual stakeholders would logically focus their efforts on their objectives and in turn increase the chance of confusion within the development, adoption and conformity assessment communities.

2.2 Be Familiar with the Benefits from Action and Consequences of Inaction

Decision makers associated with the development of ESS need to understand what can happen if their individual corporate strategies do not include recognition and consideration of CSR. Consider this mid 1990s news clip.

Thursday, May 16, 5:30 p.m. Eastern Time
Reuters Company News

BALLARD SAYS IT LEARNED FROM GENERATOR’S DELAYS

BURNABY, British Columbia, May 16 (Reuters)—Ballard Power Systems, Inc.’s chief executive said on Thursday the fuel cell maker has learned lessons from the delay in one of the first consumer products that will use its technology. Ballard used its annual shareholders’ meeting to show off for the first time a fuel cell-powered portable generator built by Sunbeam Corporation’s Coleman Powermate unit, which the companies said they hope to get on the market “very soon.”

Commercial production of the 1,000-watt generators had been expected to begin last year, but the first-of-its-kind product has been snagged by a number of delays, including U.S. regulatory approval of its fuel storage canister.

Firoz Rasul said Ballard knows now that it should have spent more time at the start of the process educating regulators about the basic technology, in which electricity is produced from hydrogen through a chemical process. “They understand the internal combustion engine, but this is something new,” Rasul told reporters.

Clearly, even if CSR are being addressed, one missed item or issue can halt technology deployment and in some cases cause funding designated for technology deployment to be redirected to product redesign and additional testing. In this instance, efforts to move the yellow line to the red in Figure 1.4 changed to yield a blue line outcome.

Conversely, other technologies have been more successful in addressing CSR early on and during technology research, development and demonstration (RD&D). One example involves the application of fiber optic cable in above ceiling spaces in commercial buildings used as plenums. The nature of the use of the space necessitates limits on the combustibles that can be placed in the space (e.g., insulation, wiring, etc.) specifically by material or the performance of materials with respect to flame spread and smoke development. One manufacturer of fiber optic cable conducted the necessary research and documentation and pursued changes to the National Electrical Code (NEC) to address fiber optic cable in these spaces because the NEC was silent on this type of product. Those changes were approved for the next edition of the NEC. Most interestingly, the only NEC-compliant fiber optic cable was made by that manufacturer. Other manufacturers eventually caught up and luckily, there were no issues or incidents associated with the products provided by the “front runner.”

There are a number of other examples that cover the range of possibilities in addressing (or not) CSR in technology development and deployment. Insulated concrete forms, engineered lumber and the development and application of alternative refrigerants in heating, ventilation and air-conditioning (HVAC) systems represent some of the more positive examples. Addressing CSR early on and throughout RD&D is important to fostering the timely and less complicated application of new technology. The issues affecting the technology can then be more effectively identified and addressed early and as an industry, whether focused on modifying the technology or conducting research to validate it is safe as presented. There is strength in working together and in sharing valuable resources, and the outcomes are likely to be more timely and favorable to everyone. After collectively addressing the safety issue, ESS proponents can then compete in a more open market on the basis of price, performance, user friendly attributes, color or any other non-safety issues that are important to potential ESS customers and users.

2.3 Identify and Conduct Needed Research, Analysis and Documentation

The status quo is represented by current CSR, the current energy storage technologies, the experiences to date associated with their application and operation and the outcomes of any relevant incidents. To change the status quo, the energy storage industry will have to convince utilities, fire officials, legislative or regulatory agencies, electrical inspectors, insurance carriers, labor unions and others what changes are needed to CSR, which will require testing, research, analysis, documentation and other information that supports why what is proposed is safe and how CSR can be updated to appropriately address ESS safety.

2.4 Apply the Results to Foster More Timely and Streamlined ESS Acceptance

The conduct of testing, research and analysis and development of documentation addressing ESS safety and use of that information in updating and revising CSR is a dynamic process. The technology is constantly changing, model codes and standards are continually under development, updated CSR are regularly being adopted and conformity assessment activities are constantly underway. There will never be a period in time when all of these activities stand still. This strongly suggests that the industry actively engage third-party agencies, insurance carriers, utilities, first responders and building regulatory agencies in the activities recommended in Section 2.3 and then its application in updating CSR. Their involvement will ensure that what is produced will address their needs and can be readily used as it becomes available. In short, consider those involved in the approval chain as partners in the process and establish a collaborative effort that is transparent, dynamic in sharing and evolving information and engage them early and throughout the process. Until CSR are revised such acceptance may be, as discussed in Section 1.6, based on equivalent performance with current CSR. Note that while pursuing short-term approvals under the equivalent performance criteria in CSR the documentation used in those pursuits is available to address the needs of those approving system installations now while concurrently feeding into longer-term efforts to revise and update CSR.

2.5 Track Success with Respect to CSR

In conducting the activities suggested in Sections 2.3 and 2.4, it will be important to keep an eye on the goals, consistently monitor success against those goals and make adjustments to those activities. The ideal situation to facilitate the timely deployment of safe ESS in relation to CSR and securing more uniform and unburdened approvals for system installations is summarized below and graphically in Figure 2.1 and can be used as a metric in tracking success and making needed course corrections.

- ▶ Standards are available as a basis for testing and listing ESS components or entire systems as to the acceptability of their design and construction with respect to safety.
- ▶ Accredited and recognized third-party testing and listing are available to perform the relevant conformity assessment activities to document that components and entire systems comply with those standards.
- ▶ Provisions that address the installation of an ESS appropriately and specifically whether in, on or adjacent to buildings or located remotely in an open environment are contained in CSR.
- ▶ All entities involved in the application and use of ESS are familiar with the CSR and ESS approvals and have the information at hand to readily document compliance with CSR and implement complying ESS installations.

- ▶ All entities involved in the review and approval of ESS are familiar with the CSR and ESS approvals and have the information at hand to readily approve the plans for proposed ESS installations and inspect and approve them during and at the completion of construction.
- ▶ All entities that will be involved in responding to any incidents associated with an ESS have the necessary access to the ESS and tools and training to address possible incidents.



Figure 2.1. Securing ESS Safety Success

2.6 Collaborate

All ESS stakeholders and interested parties should collaborate on the development and implementation of actions needed to realize the successful deployment of safe ESS as presented in Section 1.9. Considering the depth and breadth of the information presented in this document such collaboration is necessary for the following reasons.

- ▶ It will take considerable manpower and financial resources to ensure that CSR appropriately address the timely and less complicated acceptance of safe ESS.
- ▶ The range of ESS technologies and potential applications means that no one singular set of CSR is likely to address all the needs associated with getting safe ESS deployed.
- ▶ The level of effort in terms of manpower and financial resources necessary to realize that needed support given the urgency by which research needs to be done and CSR need to be updated and then deployed is beyond the likely capabilities of any one ESS proponent.
- ▶ ESS proponents will have to take the lead on the majority of work because other stakeholders may not have the resources or incentive to perform the needed activities.
- ▶ Those other stakeholders will impact the outcome of CSR activities and the deployment of ESS and will have to be “sold” on and kept apprised of activities in support of ESS safety undertaken by ESS proponents.
- ▶ It will be difficult for any one ESS proponent to accomplish what is needed considering the items above and that safety is universal and does not have varying degrees of being ensured through CSR (e.g., either something is safe or it is not).
- ▶ If individual ESS proponents undertake work related to CSR that is specific to their ESS outside any collaborative effort those stakeholders that are involved in development, adoption and enforcement of CSR will observe the “competition” and be less inclined to “choose sides,” thereby delaying development and deployment of needed CSR.

The above make a strong case for the ESS “industry” (e.g., ESS proponents) to collaborate on safety-related research and CSR development and all the activities associated with their deployment including information needed to enhance the support infrastructure associated with those CSR. Such collaboration should engage all relevant stakeholders on regular and ongoing basis as they will be the entities making the decisions on the CSR criteria and their adoption as well as the specification and approval of ESS technology. That collaboration should be facilitated through the establishment of an ESS CSR forum or collaborative in which all ESS proponents and stakeholders activity and regularly engage in the activities needed to successfully address the items in Section 2.5 and achieve the goal provided in Section 1.9.

Appendix A

Development of Codes, Standards and Regulations

Appendix A

Development of Codes, Standards and Regulations

A.1 The Developers

Model codes and standards are generally developed in the United States under the auspices of accredited voluntary sector SDOs who maintain a process meeting the ANSI essential requirements as discussed in Section 1.3. ANSI facilitates this process and performs accreditation of the United States. SDOs ensure that it follows appropriate criteria associated with transparency, due process and “fair play.” ANSI-accredited SDOs that develop model codes and standards likely to have a direct impact in addressing ESS safety include the following organizations:¹

- American Society of Mechanical Engineers (ASME) www.asme.org
- American Society of Safety Engineers (ASSE) www.asse.org
- American Society for Testing and Materials International (ASTM) www.astm.org
- FM Approvals (FM) www.fmglobal.com
- International Code Council (ICC) www.iccsafe.org
- InterNational Electrical Testing Association (NETA) www.netaworld.org
- Institute of Electrical and Electronics Engineers (IEEE) www.ieee.org
- National Electrical Contractors Association (NECA) www.necanet.org
- National Electrical Manufacturers Association (NEMA) www.nema.org
- National Fire Protection Association (NFPA) www.nfpa.org
- North American Electric Reliability Corporation (NERC) www.nerc.com
- Underwriters Laboratories, Inc. (UL) www.ul.com

The SDOs that could develop model codes and standards likely to have an indirect impact on ESS installations or that could support development of future ESS model CSRs are listed below.²

- Air Movement and Control Association (AMCA) www.amca.org
- American Society for Quality (ASQ) www.asq.org
- American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) www.ashrae.org
- American Wind Energy Association (AWEA) www.awea.org
- Association of Public Safety Communications Officials – International (APCO) www.apcoIntl.org

¹ As noted in Section 1.3 of the main text, not all SDOs may be ANSI accredited (because there is no specific mandate to become ANSI accredited) but they can still develop standards, model codes, pre-standards, protocols, guidelines and other documents outside an ANSI approved processes, as can ANSI accredited SDOs. The application and use of the resultant documents, however, may be limited to situations where the adopting authority is able to adopt documents that have not been developed pursuant to an ANSI approved process.

² An inventory of CSR that are or could apply to ESS or serve as models for new CSR and assessment of those documents from these and other SDOs provides much further refinement to organizing SDOs and the various documents they develop. The suggested classification of SDOs here is very high level and considered appropriate for the scope and purpose of this document.

- Compressed Air and Gas Institute (CAGI) www.cagi.org/welcome.htm
- Compressed Gas Association (CGA) www.cganet.com
- Electrical Apparatus Service Association (EASA)
- International Association of Plumbing & Mechanical Officials (IAPMO) www.iapmo.org
- National Board of Boiler and Pressure Vessel Inspectors (NBBPVI) www.nationalboard.org
- Portable Generator Manufacturers Association (PGMA) www.pgmaonline.com
- Professional Electrical Apparatus Recyclers League (PEARL) www.pearl1.org
- Risk & Insurance Management Society (RIMS) www.rims.org

As voluntary sector activities, the documents released by these SDOs are not required to be used or satisfied until adopted, even if adoption is simply through an individual or entity that makes a decision to adopt them for their own internal purposes (e.g., a national chain decides to adopt a policy on some topic and references a model code or standard in helping them define and implement that policy). As defined for the purpose of this document, regulations are law; as such, they are not developed in the voluntary sector, although they may reference or adopt model codes and standards but directly by the law, rule and policy promulgated by some relevant authority as discussed in Appendix B.

Where a model code or standard is not adopted but instead the adopting entity chooses to develop its own “home grown” criteria, the entity can be considered a developer. Due to the significant reliance on model codes and standards as a basis for what is adopted in the United States, there are few adoption entities that develop their own provisions. That said, the inability of SDOs to respond to and address new technology as influenced by proponents of the new technology has an impact on the degree to which individual criteria are developed by adopting entities. Where model codes or standards are not available, those having the need are more apt to undertake development independently possibly creating multiple, duplicative and conflicting criteria across the United States.

A.2 How CSR are Developed

Voluntary sector model codes and standards are developed by one SDO or through co-sponsorship agreement of multiple SDOs. It is important to stress that the SDO does not develop the model code or standard, but rather the SDO establishes and oversees a process whereby all interested and affected parties, stakeholders or any interested entity can participate. The SDOs listed above subscribe to the ANSI essential requirements, which are intended to ensure the SDO provides fair and due process to all interested and affected parties. Section 1.0 of that document covers this issue as follows:

Due process means that any person (organization, company, government agency, individual, etc.) with a direct and material interest has a right to participate by:

- a) expressing a position and its basis, b) having that position considered, and c) having the right to appeal. Due process allows for equity and fair play.

Acceptable due process includes criteria for openness, lack of dominance, balance, coordination and harmonization, notification of development, consideration of views and objections, a consensus vote on then requirements, the ability to submit appeals and have them considered and the availability of written procedures. These essential requirements are general rather than specific such that each SDO has the ability to write specific development procedures that are unique to them and are responsive to their needs. It is also important to note that those procedures are developed and the process controlled by stakeholders and interested parties. As previously emphasized, proponents of new technology must take the initiative in participating not only in the updating of existing and development of new CSR but also in the development and administration of the processes by which those CSR are developed. Each SDO has staff assigned to assist the participants, but the final decision on “content and processes” rests with those participating stakeholders and interested parties.

As noted above and in Section 1.3, not all SDOs may be accredited by ANSI and those that are may develop documents outside their ANSI-accredited process. Such documents may include model codes and standards but are more likely to be designated as pre-standards, guidelines, acceptance criteria, protocols or bench standards and are intended to bridge the gap because the information and documentation necessary upon which to formulate and secure approval of a more official model code or standard through a rigorous consensus process may not exist. Such documents can serve as a basis for acceptance on a short-term basis until model codes and standards can be developed through the more traditional model code or standard development process overseen by an SDO.

The process by which each SDO develops model codes and/or standards is available from each SDO. In general, a process meeting the ANSI essential requirements can be summarized as follows:

The need for a new model code or standard is identified (e.g., one does not exist) by a committee associated with the SDO, an interested and affected party, stakeholder or any entity with an interest in seeing a model code or standard developed.

The proponents of the new model code or standard prepare relevant documentation for submittal to the SDO for consideration.

The SDO processes the request through their codes and standards development procedures and either approves, disapproves or requests additional information.

When approved, the SDO will provide notification of their intent to establish a new model code or standard so that the public can comment on the intended action. If no adverse comments are received, the SDO will initiate development of the new model code or standard starting with a call for committee members that will be responsible for the development of an initial draft of the model code or standard.

At this point, the process associated with development of new model codes and standards or revisions to existing model codes and standards is essentially the same.

- ▶ The initial draft of a new model code or standard is circulated for public review, and existing model codes and standards are available for submission of suggested revisions, typically on a deadline-oriented schedule of 3 to 4 years.³
- ▶ Revisions to the model code or standard are invited according to SDO procedures but generally must show redline changes (e.g., existing deleted in strikethrough and new text to be added in underline) and be accompanied by analysis and documentation that describes the rationale to support the validity of and need for the change.
- ▶ All proposed revisions and documentation are made available to the SDO committee responsible for the subject model code or standard for consideration.
- ▶ The responsible committee undertakes a review of the submitted materials and determines which ones will comprise the revisions to the model code or standard.⁴
- ▶ All proposed changes, either from an SDO committee or as submitted by the public, are made available for public review and comment.
- ▶ Public comments and recommended revisions to the proposed changes are accepted by the SDO and considered by the responsible committee.
- ▶ The committee will communicate with those submitting proposed changes as to the disposition of the change. The submitters are given an opportunity for further dialogue and revision to the proposed change to achieve agreement on the outcome of and final language associated with the change.
- ▶ Revisions to the proposed changes may be made available for additional public comment to find a common ground for criteria in the model code or standard.
- ▶ Based on any additional public input, the committee or SDO membership will consider the changes and public input and vote a disposition on each change.
- ▶ Proposed changes voted for approval, along with the existing unchanged text of the model code or standard, would comprise the next edition of the model code or standard or, in the case of new model codes or standards, the first edition.
- ▶ Stakeholders who participated in the process have the right of appeal to the SDO if they feel the outcome is incorrect because procedures were not followed. If the appeal is upheld, the

³ Some SDOs have set schedules or “cycles” for updating their existing documents with deadlines that, if missed, result in waiting until the next cycle. Submitting before the deadline does not result in a timelier outcome, but it can allow more time for review and consideration by the committee responsible for reviewing proposed changes. In some instances, SDOs employ a continuous maintenance process in which there is no deadline for submittals and changes are considered separately under different timelines and those approved published as addenda. Publication of an updated standard would still follow a set cycle, with the updated standard simply being an aggregation of all approved addenda since publication of the standard’s last version.

⁴ Note that in some instances, the changes developed for public comment must go through an SDO committee; at other times, all suggested changes to a model code or standard may be accepted, discussed at public hearings and subsequently receive recommendation from the responsible committee on the disposition of the change subject to additional public comment.

revision is sent back to the responsible committee for additional work instead of being included in the model code or standard.

A.3 The Need for and Value of Research, Analysis and Documentation

When initiating a new or proposing revision to an existing model code or standard, a reason for what is proposed is required.⁵ In the case of a new model code or standard, the process includes making the case that the document is needed, the value of the criteria in the document and, if possible, should include a first draft of the suggested document.

Consider two widely varying options focusing on the development of a standard for measuring and expressing the performance of ESS. The need and value of such a document can be presented as fostering uniformity and accuracy in assessing the value of ESS and making more informed decisions on which one might work better in a particular application. While the need for a standard would have to be justified to an SDO for them to approve a project to develop a standard, form a committee and oversee the process of standards development (a formidable business consideration because there is a cost borne by the SDO to organize and oversee these activities and then publish, disseminate and support the resultant standard), consider how they would be likely to react with or without research, analysis, documentation and a draft upon which to start work. With nothing but the “ask,” there is likely to be ongoing and continued questioning of the value of starting the effort simply because it is more challenging to visualize the request and desired outcome. This process takes time and will likely postpone any decision on approving the activity to develop a new model code or standard, time that is critical to creating the model code or standard needed to support the technology. With little more than a general description of the title, purpose and scope of the document, the absence of additional information is more able to generate both technical and policy level questions and concerns. In a way, the absence of information is more likely to generate mis-information, confusion and conflict while valuable time continues to pass.

With a complete rationale for the model code or standard, supporting research, analysis and documentation, the project is much more likely to be approved upon initial SDO consideration. In addition, the availability of a draft (pre-standard or protocol) further ensures project approval and timely completion. It is not unusual for projects associated with the development of new model codes or standards to take over 5 years to begin when not accompanied by any of these suggested items. Conversely, when they are provided along with a first draft of the model code

⁵ While the focus is voluntary sector model codes and standards, the need for and value of this information is equally relevant when seeking adoption of these documents, proposing amendments to them when being adopted or working directly with adopting entities who may be developing and adopting “home grown” criteria.

or standard, it is possible for an SDO to initiate a project and approve a model code or standard in as little as a year.⁶

The same holds true in proposing revisions to existing model codes or standards, noting (as mentioned above) that there is a specific cycle associated with revision to existing documents that if missed will delay consideration of the revisions until the next cycle. Without research, analysis and documentation to support the desired revision, it is less likely to be approved for public review or complete the SDO process without some adverse comment.

Consider one suggested revision to “make the document easier to read and be more rigorous in how safety should be addressed,” with the supporting statement being that an easier to read document does a better job in meeting the intent of providing better public safety. Consider another suggested revision that has the same goal, is accompanied by specific language changes desired in the model code or standard and has a robust set of analysis, documentation and rationale to document the validity of the change and promote its acceptance. The latter will clearly have an advantage over the former in being considered and accepted. In addition, the more general the comment the increased likelihood that in trying to address it the committee may develop criteria that does satisfy the proponent of the comment.

Given the opportunity provided by SDOs in their cycle to revise existing model codes and standards, having an incomplete proposal increases the probability that the proposal will not be accepted. This situation could mean years until the next opportunity; time that may not be available if one is attempting to secure the basis for acceptance of safe technology applications in a timely, unencumbered manner through model codes and standards. As noted above, if the technology is being applied in the market and model codes and standards are not available to address the technology specifically, it is more likely the technology will not be approved, or that approval would be considered on a case-by-case basis under alternative materials and methods provisions (equivalent performance to what is already approved). In addition, there is an increased probability that those adopting model codes and standards and faced with ensuring the acceptability of a technology such as ESS will develop their own unique “home grown” revisions to their existing requirements.

A.4 Publication of CSR

Once a new or revised model code or standard is completed and approved, the model code or standard is published by the SDO. Model codes and standards that are published are generally available from the SDO, but there are also a number of entities that provide comprehensive assistance for many of these publications. The publication can be a complete new edition of a model code or standard or can be addenda or supplements to the latest edition that overlay the

⁶ This timeframe is the optimum for a simple standard that has no controversy during public review. Increased document complexity and volatility in terms of controversial issues in the document can increase the longevity of this process by a few years.

edition until a future time when they are included in a re-publication of a new edition of the model code or standard with all addenda, revisions or supplements.

A.5 Updating and Revising CSR

The process of updating and revising model codes and standards has been presented. The manner in which the ESS industry and technology proponents should consider updating those documents is also relevant.

- ▶ Know which model codes and standards impact ESS and in what manner.⁷
- ▶ Determine what changes are required to foster acceptance of safe and effective energy storage system installations and what research and analysis may be needed.
- ▶ Conduct the research, analysis and prepare the documentation needed to support the changes and counter any likely arguments against acceptance of the changes.
- ▶ Submit the proposed changes and supporting documentation to the SDO before any deadlines.
- ▶ Engage individuals involved with the SDO process in early consideration of the proposed changes, including entities who will be adopting the updated model code or standard who may be early adopters of the proposed changes and/or can provide valuable insight into enhancing what is proposed to the SDO.
- ▶ Follow the SDO process and engage at appropriate times to support the proposed changes, counter any arguments against the changes and conduct additional research and analysis deemed necessary to ensure success.
- ▶ Communicate throughout this process with all stakeholders and interested and affected parties so that they are aware of the effort, can provide input and can become advocates for what is being proposed.

In short, there are tasks and timelines associated with the processes of each SDO. Coupled with them is the manner in which what is proposed is crafted and processes used to advocate for its approval by the SDO. In short, thorough preparation is critical and, in this instance, an industry team approach is preferable to different entities associated with the industry working individually and at possible cross purposes.

A.6 Educational and Technical Support Available from Developers

Many SDOs provide education, training, commentary documents, technical support and other products and services to augment the implementation of their documents, enhance their value to

⁷ See “Inventory of Safety-related Codes and Standards Requirements for Energy Storage Systems” (Conover 2014).

their members⁸ and users of their documents and to support their business model. These materials may be developed by SDO staff, consultants to the SDO and/or volunteers involved in the development of the subject model code or standard. It is important to understand that the language in model codes and standards must be presented as mandatory and enforceable. As such, commentary, background, informative language and examples typically found in educational materials, training programs and other supporting products are not appropriate for inclusion in the model code or standard. Nevertheless, these supporting materials and programs are vital to model code and standard development, adoption and use. Ideally, they should be developed in parallel to the development of model code or standard.

In the case of criteria covering energy storage, the industry would want to develop these materials so they are available when the CSR are developed where they can be used to reinforce the rationale for what is being proposed in model codes and standards. This is best addressed when considering needed research, analysis and documentation to ensure that it serves multiple purposes – criteria validity, acceptance and interpretation and application. Development of these support materials in parallel with developing the criteria for the model code or standard also increases the probability that problems with the criteria can be identified and addressed early on.⁹

A.7 How ESS Stakeholders Can Most Effectively Participate in Development

The availability of model codes and standards that appropriately address the design, construction, installation, commissioning and operation of ESS is important to their timely, cost effective and safe application and use. Whether new or revisions to existing model codes and standards are needed, the following should be considered in pursuing those activities.

1. The “industry” should collaborate and show a united front in these processes. Where different segments of the industry or competitors use model codes and standards to gain an advantage at the expense of others, it is more likely that decision makers will not progress and instead postpone action until there is a more obvious consensus from those advocating for change.
2. Determine which model codes or standards need revision (or where new ones are needed) and become familiar with the processes used by the SDO.¹⁰

⁸ Note most SDOs are membership driven 501c organizations. Those same members are most likely participating in the development of model codes and standards and/or managing and overseeing the SDO processes.

⁹ In developing criteria and then authoring commentary and educational materials to explain the criteria the amount of effort associated with the latter provides valuable information on the clarity, simplicity and acceptability of the former.

¹⁰ Addressed in part in “Inventory of Safety-related Codes and Standards for Energy Storage Systems” (Conover 2014).

3. Get engaged early in the process with those committees responsible for approving requests for new model codes or standards or considering proposed revisions to existing model codes or standards.
4. Engage all stakeholders in the development of provisions for new or revisions to existing model codes or standards. Advising all stakeholders of the planned activities and inviting them to participate is critical to a successful outcome.
5. Collaboration in development of proposals should also include collaboration in the development of the supporting documentation, analysis and rationale for what is being developed. These efforts can be significant in terms of time and resources and are much easier to accomplish and more effective and robust when developed collectively by storage system proponents.
6. Engage contractors, code officials, inspectors and others that will have some interaction with an ESS in these activities. They will be using these documents to guide ESS deployment and approving ESS installations. Having their input early is important and will further ensure that these key players are proponents during the development and deployment of model codes and standards and in their actions associated with ESS approval, installation and use.
7. Engage in activities that can further educate decision makers associated with the development process on what is proposed. When they have questions or need additional information, the responses should be based on input from all those involved in developing the initial proposal(s).
8. For longer-term updating and enhancement, remain engaged. Just as energy storage technology development and deployment are dynamic, so too are model codes or standards. Being connected to the appropriate organizations and their processes through committee participation, ongoing educational support and communication will ensure that as their processes evolve and documents are available for updating that those efforts remain synchronized with advances in energy storage technology.

Appendix B

Adoption of Model Codes and Standards

Appendix B

Adoption of Model Codes and Standards

B.1 Defining Adoption

After model codes or standards are developed in the voluntary sector, they are available for adoption. Adoption is simply a decision by any decision making entity that a model code or standard will be used, implemented, complied with and satisfied. Adoption makes compliance with the model codes or standards that are adopted mandatory and, as such, makes the document much more relevant than if it were advisory but not required.

B.2 Who Adopts CSR and How

Adoption can occur in many ways that include the following:

- ▶ Legislative or regulatory action by a governmental entity (federal, state, local, Indian Tribe) as a mandatory requirement in all cases or as a condition for program participation or funding.¹
- ▶ Action by a utility under its operation as controlled by a Public Utility Commission (PUC) and acting as the AHJ for systems on the grid side of the meter or simply as the entity connecting to an ESS on the customer side of the meter.
- ▶ A requirement by an insurance carrier as a condition for insurance coverage.
- ▶ As a condition for licensing (e.g., a state contractor licensing board that adopts and applies particular technical requirements and compliance with those as a condition for licensure).
- ▶ By reference in building specifications issued by a building owner/developer or financial institution backing a project.
- ▶ By anyone considering the application and use of energy storage that in the absence of any other means of adoption elects to apply model codes or standards to their project (e.g., self-adoption).

When legally adopted through legislative or regulatory action, model codes or standards are considered regulations. Their adoption through other means is more likely to be considered as rules, specifications or some other term that distinguishes the adoption from a legislative or regulatory action by government (e.g., law).

The federal government has traditionally undertaken the adoption of model codes or standards as regulations governing certain federal buildings and facilities. This situation includes those owned

¹ Mandatory requirements would generally be considered building regulations. Conditional requirements would be for instance compliance as a condition for a facility securing approval under a specific financing program or accreditation to participate in a federal program such as Medicare or Medicaid.

by the federal government as well as private sector construction leased to a federal government agency and can also include programs where federal funding or support is involved (e.g., health care facilities as a condition for Medicare participation). Some states have authority to adopt model codes or standards as regulations that apply throughout the state. In the majority of cases in which there is a state-mandated preemptive regulation, the adoption process is legislatively granted to one or more agencies instead of being addressed directly by the legislature.² In turn, those agencies will use a specific and unique state regulatory process to adopt and administer their regulations. In states without such authority, the authority is delegated to the local government, who then use their own specific and unique local legislative or regulatory process. Indian tribes are autonomous and not under the jurisdiction of any federal, state or local legislative or regulatory action and as such control what regulations they adopt. It is important also to recognize that the authority (or not) of federal, state and local government is likely to vary by subject, scope and many other factors. For instance, there may be a statewide set of requirements for only public buildings or only a statewide electrical code; the remainder of what is not covered by the state is then subject to whatever local government chooses to regulate (or not).

In the case of governmental regulation, it is important to be active in the adoption process because the adopting entities (legislative or regulatory) may not necessarily adopt the most recent model codes or standards or upon adoption may include amendments that can either strengthen or update the requirements or weaken them. Engagement in this process can foster the more timely adoption of current model codes or standards and also can minimize the approval of amendments that would adversely impact ESS. In addition, where older versions of model codes or standards have been adopted, amendments can be submitted to at least update what has been adopted to more appropriately address energy storage system safety. Because state and local governmental adoptions generally occur on a 3-year or more cycle (similar to that with model codes or standards development), it is equally important to recognize state and local schedules associated with and opportunities for adoption. Adoptions by a contractor licensing board could also be considered regulatory, the mechanism for ensuring compliance being licensing of contractors doing electrical work as opposed to not approving an ESS installation through a more traditional plan review and construction inspection process.

Outside legislation or regulation there are other adoption mechanisms whose timing is not as structured but should still be addressed. Utilities would adopt standards and possibly model codes to govern the acceptability of an ESS and its installation on the grid side of the meter or possibly for an ESS they own and operate on public or private property on the customer side of the meter. Those would not likely be considered regulations but instead specifications and guidelines as to what those providing an ESS to the utility must satisfy as a condition for doing what is contracted for. The utility would be able to undertake adoption at any time. This is also

² Typically, the involvement of an elected body in essentially writing construction requirements is not encountered for many reasons, one being every time a revision is desired it must go through the legislative process. For this reason, legislative bodies will generally direct what they want (e.g., a statewide code) and then authorize and empower governmental agencies to develop and adopt the requirements. In some instances, however, the legislature does retain oversight and votes to confirm what the regulatory agency(s) have adopted.

the case with insurance carriers and owners/developers who would be looking to update specifications or other criteria they place on those they insure or who do design and construction work for them. Note also model codes and standards may be adopted by multiple agencies and concurrently apply to a project. For instance, a federal agency can officially adopt specific model codes and standards for their projects, but a set of state regulations such as a state building and fire code covering the same subject might also apply but could differ with what the federal agency has adopted.

B.3 The Need for and Value of Research, Analysis and Documentation

As covered in Section A.3, it is virtually impossible to secure a change to a model code or standard without a reason and some substantiating data, analysis or documentation unless the change is editorial. The same guidance provided above on development applies equally to adoption, especially where the adopting entity is developing “home grown” provisions³ instead of adopting model codes or standards. Ideally, they can be influenced to adopt model codes or standards to address ESS installations, but when that is not possible maybe because those documents are not completed or the adopting entity feels the need to go “above and beyond,” the ESS industry will need to work more closely on criteria with those adopters. As such research, analysis and documentation will be needed. Due to the nature of adoption and the entities that will be making the final approval decisions for each ESS installation the need for this information to support criteria proposed by proponents of ESS may be even more acute.

B.4 Publication of What is Adopted

A crucial part of involvement with model codes or standards development is obtaining a copy of the final documents or securing them from the SDO. To determine what has been adopted, it is necessary to consult the federal, state or local statutes, utility rules or specifications, licensing board rules, owner/developer specifications, insurance companies or other adopting entities. Consult the source (i.e., the adopting entity), many of which have websites and relevant information.⁴ In reviewing what is adopted, it is important not only to confirm the edition of any model codes or standards that have been adopted by reference, but also to be aware of any amendments to what is adopted by reference. If not so adopted, it will be necessary to secure any “home grown” criteria and then compare those provisions to the model codes or standards that are preferred and being advocated for adoption.

Particular attention should be paid to any administrative criteria that address scope or processes associated with reviewing and approving what is proposed and subject to what has been adopted.

³ When an adopting agency does this the actions associated with development and adoption essentially occur at the same time and are one larger initiative as opposed to two separate efforts.

⁴ In supporting development and adoption, the ESS industry can also foster safe ESS installations by providing relevant information on the Internet and helping those adopting entities “populate” their websites with the same information.

While most looking to adopt requirements to address the safety of ESS installations will rely on model codes or standards for the technical details, many will replace the administrative requirements in those documents with their own unique administrative requirements. For example, while ideally all state and local governmental agencies and utilities could refer to one uniform combination of model codes or standards to address the technical details of ESS installations, they could have different requirements as to submittal of plans, acceptability of third-party testing agencies and the inspection and approval processes that will impact deployment of an ESS installation. Beyond that, there could also be operational and commissioning issues not addressed in the model codes or standards that would focus on the qualifications of personnel operating the system and the frequency at which they are to be overseeing and reporting on the operation of the system.

B.5 Updating and Revision of What is Adopted

Federal agencies that adopt model codes or standards to cover their facilities each generally have their own process and cycle for adoption. This could be through the Code of Federal Regulations and may or may not be directly correlated to the revision cycle of the SDOs. State and local government are generally tied into a particular cycle that is based on the revision cycle of the SDOs. For instance some states with statewide building regulations are required to update those regulations within a set time from the publication of the next edition of a model code. As suggested above utilities, insurance carriers, contractor licensing boards, owners/developers and others who would adopt model codes or standards outside the legislative or regulatory process are likely not tied to any specific adoption schedule and as such are candidates for updating anytime. In addition they are more likely to have a simpler process associated with such updating or revision. That said, especially with respect to a new technology, it is important to be proactive in securing the desired updates and revisions. Naturally, the cycle associated with model codes or standards will drive some of this activity, but the cycle should not preclude contacting all other entities who would adopt those documents, engaging them in work to develop new or revisions to existing model codes or standards and working with them to adopt criteria that will ensure safe ESS installations. Any lack of such communication and interaction is likely to result in their not actively seeking information but instead maintenance of the status quo until such time they are faced with taking action.⁵

B.6 Educational and Technical Support Available for Adopters

To facilitate the adoption process, the availability of educational and technical support for the model codes or standards bolsters the probability that they will be adopted. Without these

⁵ An example of this can occur where model codes or standards may not have been updated to address ESS installations and policy has been put in place to hasten the application and use of ESS. There is a need for the industry to work with such adoption entities such as local government, but if those entities are not aware of the resources available to support safe ESS installations they will take action on their own that may not be appropriate or favorable to ESS as viewed by the ESS industry and after the effort and time spent doing that may not be inclined to want to make changes late in or after the adoption process has been completed.

materials those adopting the model codes or standards would then have to develop their own or simply adopt something that is not fully supported. As discussed in Appendix C, a lack of educational and technical support for what is adopted is likely to have an impact on the degree to which compliance with what is adopted is realized and the time it takes to assess compliance and approve ESS installations. This provides another reason to focus on model codes or standards in a timely manner because the number of “home grown” provisions directly impacts the degree to which educational and technical support materials and programs must be customized and maintained.

B.7 How ESS Stakeholders Can Most Effectively Participate in Adoption

The same recommendations on this topic presented in Appendix A generally apply to adoption. Securing revisions to a model code or standard to some degree constitutes adoption, but only by the SDO. In the case of adopting those model codes or standards, the primary difference is the target audience. Under development, it was primarily those involved in the development process (i.e., the stakeholders involved in the SDO process and those who can influence the development process). The target audience associated with adoption in a governmental process are the legislative (elected officials) or regulatory (appointed and/or agency staff) who make the decisions, the stakeholders appointed to decision making committees or councils, stakeholders and interested and affected parties. With respect to utilities, it could involve PUC developed provisions or simply utility management determining what should be adopted. Note that while representatives of some of those stakeholder and interested and affected party groups may have been involved in development through the SDOs, it is not likely the same individuals involved at the SDO level are involved in the adoption process. This strongly supports identifying those adopting entities and initiating and maintaining communications with them even during development activities covered in Appendix A. Among others this helps the ESS industry to be recognized as the source for safety information on ESS.

The most effective way to participate in the adoption process is through a single industry voice that can support a position for the adoption of current and unamended model codes or standards that appropriately address ESS safety. The success of this activity can be bolstered by getting to know the adoption decision makers and the other entities that participate in the process. Adoption tends to be more political and is more dependent on relationships. Establishing those relationships through a singular point of contact with the energy storage industry that represents but can also call on the many varied industry voices is important to ensuring that the effort invested in development is actually implemented through adoption.

Appendix C

Conformity Assessment

Appendix C

Conformity Assessment

C.1 Defining and Understanding

Conformity assessment is the process associated with verifying that certain things that are required to be done are done and done correctly so that the expected outcomes are achieved and results can be trusted. It involves determining what information is required, metrics associated with that information, the basis for measuring and reporting outcomes, inspection and review by qualified entities and quality control. Unless adopting entities that enforce CSR absorb these responsibilities,¹ they will rely on the work of others to verify that what is supposed to happen actually does.

Consider the myriad of events encountered daily such as purchasing of food, gasoline, consumer products and services. There are test procedures or other criteria by which these can be evaluated, metrics considered relevant to the evaluation and possibly minimum requirements associated with those metrics. For prepared food, this would include storage temperature before or after cooking, octane rating for gasoline, testing of a water heater against the criteria in a safety standard or assessment of an insurance salesperson as to their knowledge of their profession and applicable rules and regulations. Conformity assessment embodies how the attributes of something are determined; comparing them to any requirements and then the conduct of an ongoing process to ensure that compliance is ensured over time.² For gasoline, this would include testing standards for octane, setting octane metrics for certain classes of gasoline and an ongoing inspection process from the producer of the gasoline to delivery to the consumer that what is purchased is as advertised. For an ESS, this means that compliance with any standards for the ESS and its components is documented and verified, that the application of the ESS within the built environment is also documented and verified against adopted CSR and that the resultant installation is commissioned, operated, maintained, repaired, refurbished and eventually decommissioned in a safe manner as per adopted CSR. In addition, the CSR provide the requirements or metrics relating to safety, and conformity assessment ensures that they are satisfied and in turn safety is achieved. For example, consideration of first responders is included in case there is an incident associated with an installation to ensure that the issue can be effectively addressed and safety maintained.

¹ While more prevalent in the past, some local government agencies continue to operate their own testing laboratories as part of the conformity assessment (compliance verification) process as opposed to recognizing test results from accredited testing labs.

² This would be done for ESS components and systems production by verifying that continued production as to the parts and the process of assembly are such that the continued production is identical to the component or system that had been tested and found to comply with a particular standard.

C.2 Who is Involved

The short answer is that anyone involved in the design, construction, installation, sale, purchase or use of a product or service can be involved. Those on the supply side may have to meet certain requirements (e.g., codes, standards, regulations, protocols, etc. – basically what is adopted) and those on the demand side have an interest in knowing what was supposed to be satisfied actually happens.³ For ESS, the following entities would likely be involved in conformity assessment when focused on the safety and performance aspects of the system.

- ▶ Manufacturers of systems or components associated with the system (testing⁴ to make sure they comply with standards for safety, testing⁵ to determine performance and quality control of production).
- ▶ Accredited third-party testing laboratories (nationally recognized testing laboratories) that conduct testing and issue reports of findings (e.g., pass/fail or results for specific metrics).⁶
- ▶ Entities that accredit third-party testing laboratories to applicable standards.
- ▶ Accredited third-party certification⁷ agencies that conduct factory inspections to validate that continued production of the system or system components conforms to the details and specifications of the system or system component that was tested and upon which compliance with the standard or the presentation of specific metrics is based.
- ▶ Entities that accredit third-party certification agencies to applicable standards.
- ▶ Designers, installers, contractors, utilities, building owners/developers and others involved in the planning and execution of the installation of an ESS that in their particular activities associated with the installation are required in some way to comply with CSRs associated with the installation.
- ▶ Insurance carriers, accredited third-party inspection agencies, registered design professionals, code officials, fire officials, electrical inspectors, utilities and others involved in assessing the planned installation satisfies CSRs associated with the installation and assessing the actual installation and any required commissioning to validate that what was constructed satisfies the approved plans and specifications.

³ Consider the myriad of possible requirements that those regulated might have to satisfy across the United States and the myriad of different entities involved in conformity assessment and how they might conduct their activities to validate safety the value of a singular set of model codes and standards that cover ESS and a uniform way to verify compliance becomes evident. With 44,000 entities in the United States that issue building construction permits, the number of utilities and others who would be engaged beyond or where state or local government is not the AHJ it is not unrealistic to say there could be thousands of different scenarios to address.

⁴ Testing focused on determining results so changes can be made before testing by a third party (e.g., practice before it really counts).

⁵ Ibid.

⁶ Contrasting with the above mentioned testing, this is the testing “that counts” in validating compliance.

⁷ Sometimes communicated as or referred to as “listed and labeled.”

C.3 Compliance Processes and Associated Documentation and Verification

Using the summary in Section C.2 as a starting point, the following information summarizes the manner in which conformity assessment is conducted and when. It is important to note that this activity is premised on the availability of codes, standards, regulations, protocols and other criteria upon which to assess compliance. In the absence of such documents, there is no universally acceptable basis for safety and performance assessment. Until codes, standards, regulations, protocols or other criteria are available, it is likely that each installation will have to be assessed on its own based on how it performs in comparison to similar technologies already addressed in CSR. This process can involve on-site in-situ testing of each installation and/or submission of documentation validating equivalency with the intent of existing CSR criteria (e.g., what is proposed is no more hazardous nor less safe than a similar technology already addressed in those documents).

In addition, there are provisions in model codes and standards that would also cover untested or unlisted ESS that would impose additional constraints compared to the availability of standards upon which to base safety testing. As previously noted, those responsible for verifying compliance with their adopted CSR may be uncomfortable performing that function without specific criteria on which to base their assessment of ESS safety. In those cases, it is probable that the project will be delayed until such time those criteria are available.

- ▶ System components will be tested during development to determine if they comply with applicable safety standards and, where relevant, the value of required metrics will be determined.
- ▶ As development continues, the components will be re-tested to ensure that they comply and the desired outcomes for any relevant metrics secured.
- ▶ An accredited third party (nationally recognized testing laboratory) will then test the component and issue a report of findings (ideally, they indicate that the component passes the requirements in applicable standards and where applicable values of required metrics will be provided).
- ▶ If the findings are non-compliance or values are not as desired, the system components may be re-evaluated or re-designed and re-tested.
- ▶ An energy storage system manufacturer or entity assembling components into a system will secure components for their system that have been tested and found to comply with relevant safety standards and possess values for metrics they deem acceptable.⁸

⁸ The common description of this would be that the manufacturer secures tested and listed components for their system, testing indicating that the component was tested and found to meet requirements in a particular standard or standards and listing indicating that continued production of the component has been evaluated by a third-party certification agency and was found to be acceptable based on a comparison of what is being produced to the tested component.

- ▶ Depending on the availability of a standard covering an entire energy storage system and the size of the system, there may be a system manufacturer that provides a packaged system, in which case some of the above component testing may not be necessary because the system standard could be applied to the entire system.
- ▶ Where there is no system standard, or the size of the system makes it impossible to apply such a standard, the assembly of components into a system is likely to be addressed through a CSR covering the ESS installation.⁹
- ▶ Those specifying and wanting to install a system will supply documentation the AHJ, who will determine the acceptability of the system on the basis of the plans, specifications, test data and product listings provided compared to the CSR adopted.
- ▶ Those having jurisdiction over the installation will conduct necessary inspections to determine that the approved plans and specifications are being satisfied and where required by the CSR adopted may oversee the commissioning of the system or even conduct periodic inspections during the life of the ESS.

In the simplest situation of a small unitary (e.g., pre-packaged energy storage system that has been tested and listed to a standard covering the safety of the system), the process may entail simply constructing the system in a factory, having it tested and listed, having requirements reference the standard applicable to the system, submitting a permit application or other documentation to the AHJ with an indication that the system is tested, listed and is to be installed in accordance with the manufacturer's installation instructions, the conditions of the listing and adopted regulations. Next, the AHJ would conduct or arrange for an accredited third party to conduct, an inspection of the installation to verify compliance with installation-related items. Ideally, this situation eventually can be no more challenging than securing approvals for any other type of unitary electrical equipment or system.

In a more complex situation where the energy storage system is not unitary, testing and listing of the individual components will be necessary. The assembly of components on site to comprise the energy storage system is more likely to be addressed by CSRs covering the installation and under the auspices of those adopting and enforcing those documents. Where those components are formally matched (e.g., they have been tested and are listed for site assembly), then the assembly and installation instructions supplied with the components and provided by the energy storage system manufacturer will be very helpful in securing an "approved" installation. Where the components are not (e.g., they are not matched and have not been tested together) and the energy storage system "manufacturer" is creating the system on site, CSRs providing criteria covering system installations will tend to "drive" the acceptability of the installation.

⁹ An example of this situation in the HVAC industry is the installation of a large HVAC system in a building where the components are tested to particular standards, possibly come from different manufacturers and the size of the assembled system precludes laboratory testing so the acceptance of the system is based on CSR that govern the assembly of the components at the building site within, on or around the building.

C.3.1 Supporting Infrastructure

Where testing and listing is relevant for system components or an assembled system, the following entities¹⁰ are relevant to determining and documenting compliance with CSR.

- ▶ Accreditation bodies that verify the continued competency of testing laboratories and certification agencies.
- ▶ Testing laboratories.
- ▶ Certification agencies.
- ▶ Registered design professionals, engineers and other duly licensed and qualified individuals who can conduct analysis and prepare relevant documentation for consideration by those associated with the approval of systems and their installation.
- ▶ Those entities engaged in approving what is proposed in relation to the CSRs applicable to the plans and specifications associated with the system and its installation including but not limited to building and fire officials, utilities and insurance carriers.
- ▶ Those entities engaged in the inspection of the system installation and its commissioning conduct the tasks necessary to ensure that the system is installed per the approved plans and specifications and has been commissioned and is operating properly.

Whether documenting compliance or verifying compliance, the focus of this effort is on the criteria adopted and made applicable to the system components, the system, its installation and its operation as well as any repairs, additions, renovations to the ESS. Again, the value of a singular and uniform set of CSR, necessary support infrastructure (products and services to support deployment), and uniformity in conformity assessment (documentation of compliance and verification of compliance) cannot be overstated.

C.3.2 How ESS Stakeholders Can Most Effectively Use Conformity Assessment

Those interested in deploying energy storage in the built environment (whether on the utility or customer side of the meter) can most effectively secure approval for the technology by conducting conformity assessment efforts associated with the system and its components as few times as possible. If using accredited agencies, the acceptability of the system and its component parts should be readily documented and verified at the national or even international level. The other component of this activity is the CSR that form the benchmark for those conformity assessment efforts as discussed above in Appendices A and B. The conformity assessment portion of the effort fosters the vision of a singular and universally accepted activity associated with documenting and verifying the acceptability of the ESS and its component parts (e.g., the “product” or “box”).

¹⁰ http://www.standardsportal.org/usa_en/resources/cab.aspx provides additional information on the conformity assessment bodies (CABs) that offer third-party conformity assessment services in the United States.

The remaining issue is then the acceptability of the installation of the ESS, noting many installations will be unique due to the manner in which they interact with the built environment. The availability of CSR to address system installations will be advantageous as they provide a singular target on which to focus as opposed to multiple “home grown” criteria developed by various adopting entities to fill the gap created because no model codes or standards exist that can be adopted to address ESS installations. Whether evaluating the intended installation against CSR written to specifically cover the intended installation or interim protocols or acceptance criteria or simply making a case for the safety and acceptability of the installation based on equivalency with other accepted technology, conformity assessment can be enhanced the more uniform and robust the associated documentation. Clearly, the ability to produce that documentation is directly influenced by a myriad of different criteria it must address and the lack of uniformity associated with the compliance verification process. As an example, some national chains develop a handful of different building configurations intended for application throughout the United States and document compliance through third parties with model codes and standards applicable to their buildings. Those documents not only facilitate the review and approval of their projects at all levels of government but allow them to benefit from economies of scale in construction that are not possible if each facility is viewed independently.

C.4 Benefits Associated with Conformity Assessment

As defined, conformity assessment involves the processes necessary to ensure that what is intended or desired is actually delivered. The primary benefit of pursuing conformity assessment is that without it compliance with standards, codes or regulations covering safety is undetermined and as a consequence that likely leads to “no installation and no sale.” Conformity assessment allows a transaction to take place whether that is the assembly of components as a system, the installation of a system or the continued operation of a system. A key to success is to engage in conformity assessment activities as few times as possible and in a manner that saves time and money. The concept of one test, one certification, pre-approved installation plans and specifications, a uniform approach to commissioning and uniform operations and maintenance criteria enhance the benefits associated with conformity assessment. Not addressing conformity assessment is a non-starter. After committing to address conformity assessment, the benefits accrue in terms of time, resources, technology deployment and use of the technology when the activities associated with conformity assessment are as uniform and widely accepted as possible.¹¹

¹¹ Given the myriad of utilities, federal, state and local government agencies, insurance carriers and others who are invested in ensuring system safety, the intent is that through uniform and coordinated standards and uniform acceptance of documentation, compliance is realized. Those wishing to deploy the technology have a higher probability that the technology and its intended installation will be readily accepted on the basis that the mechanisms they have used to document compliance are readily and uniformly accepted.

C.5 Using Conformity Assessment Experiences as a Basis for Further CSR Revision

The application of current CSR to some ESS would likely indicate that those CSR do not readily and specifically apply to the ESS. As such the ESS is less likely to be as readily approved as if standards existed, the ESS was tested and listed and CSR were available that provided specifics as to the installation of the ESS. More than likely, as previously mentioned, it could be approved as “unlisted” electrical equipment and the installation assessed based on the provisions in CSR allowing for “alternative materials and methods.” Unlisted simply means there is either no safety standard for the technology or if there is one the ESS has not been tested and listed by an accredited third-party agency. Alternative materials and methods simply means because the CSR does not provide a specific basis for acceptance that approval can be granted on the basis that what is proposed is no more hazardous or less safe than what is allowed by the CSR.

In the absence of specific CSR these vehicles for approval, while time consuming and requiring documentation, may be the only way to secure approval for an ESS installation. When pursuing these vehicles for approval, the required activities, test data, analysis, documentation and other information are all relevant to the development of new or revisions to existing CSR. In pursuing conformity assessment to secure approval from any AHJ for the design of a component, assembly of components as a system and installation of the system, all information generated as part of the approval process is relevant to creating future CSR that more specifically and appropriately address the technology. Over time, new activities will inform past activities and outcomes and the situation with respect to ESS deployment will evolve toward the uniform and widespread acceptance of ESS noted above because the CSR specifically address the technology. It is also important to note that as energy storage technology evolves this process is dynamic: while some more seasoned technologies will achieve that desired outcome, newer ones will have to begin where those seasoned technologies once begun.

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