WHITE PAPER

POWERING DOWN RESPONSIBLY: Battery Energy Storage System Decommissioning Requirements

As Battery Energy Storage Systems (BESS) become more prevalent, and the industry matures, developing a strategy for decommissioning, removing and disposing of systems at the end of their life is essential. ***Andres Perez-Doval*** and ***Chad Jones*** look at what goes into safe, reliable and repeatable protocols.

ABOUT RSP

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Lithium-ion batteries are the most widely used energy storage technology in Battery Energy Storage Systems (BESS), offering various chemistries and types. However, at the end of their life cycle, these batteries are classified as hazardous waste, posing significant challenges for industry stakeholders when it comes to safe and compliant removal.

To navigate these challenges, current and prospective BESS owners should implement comprehensive decommissioning plans that adhere to all applicable codes and regulations. Effective plans include developing accurate budget estimates and regularly updating them to reflect evolving regulations and emerging recycling opportunities.

This report provides a detailed overview of BESS technology, focusing on the relevant codes, standards, and regulations governing its installation and decommissioning. Additionally, we present a calculation study demonstrating that 5.9% of a project's CAPEX is typically required to cover future decommissioning costs.

Many states have already enacted decommissioning regulations, and more will be required to as BESS decommissioning requirements are implemented within adopted codes.

> *Decommissioning a BESS ... requires thorough planning and documentation to ensure the process is efficient and safe.*

BACKGROUND

A Battery Energy Storage System (BESS) stores energy in batteries for later use, often in conjunction with renewable energy sources such as solar panels. For instance, a BESS can store excess energy generated by solar panels and release it later when solar energy production is low, or load demand is high. BESS implementations commonly use lead-acid or lithium-ion batteries, which require decommissioning at the end of their lifecycle due to the potential risks the chemicals pose to human health and the environment.

Decommissioning a BESS involves the disassembling of the system to ensure safety and compliance with relevant codes and regulations. This process includes the safe handling and recycling of the batteries, along with the proper disposal of other system components. Decommissioning typically occurs when the batteries reach the end of their lifecycle or when the system is no longer in use. It requires thorough planning and documentation to ensure the process is efficient and safe. Lead-acid batteries generally have a lifecycle of fewer than five years, while lithium-ion batteries can last up to 20 years.

Proper planning assigns clear roles and responsibilities to the workers involved. Additionally, a well-structured decommissioning plan helps recover valuable materials and reduce waste.

Currently, federal regulations require a government bond for the decommissioning of solar panel systems. While there are no federal requirements yet for obtaining a bond specifically for BESS decommissioning, such requirements may be introduced in the future. These bonds typically require a cost estimate for the decommissioning project, enabling landowners to determine the necessary financial allocation. The financial plan should cover costs associated with labor, infrastructure removal, transportation, recycling, and any required site restoration. [1]

CODES AND STANDARDS FOR DECOMMISSIONING

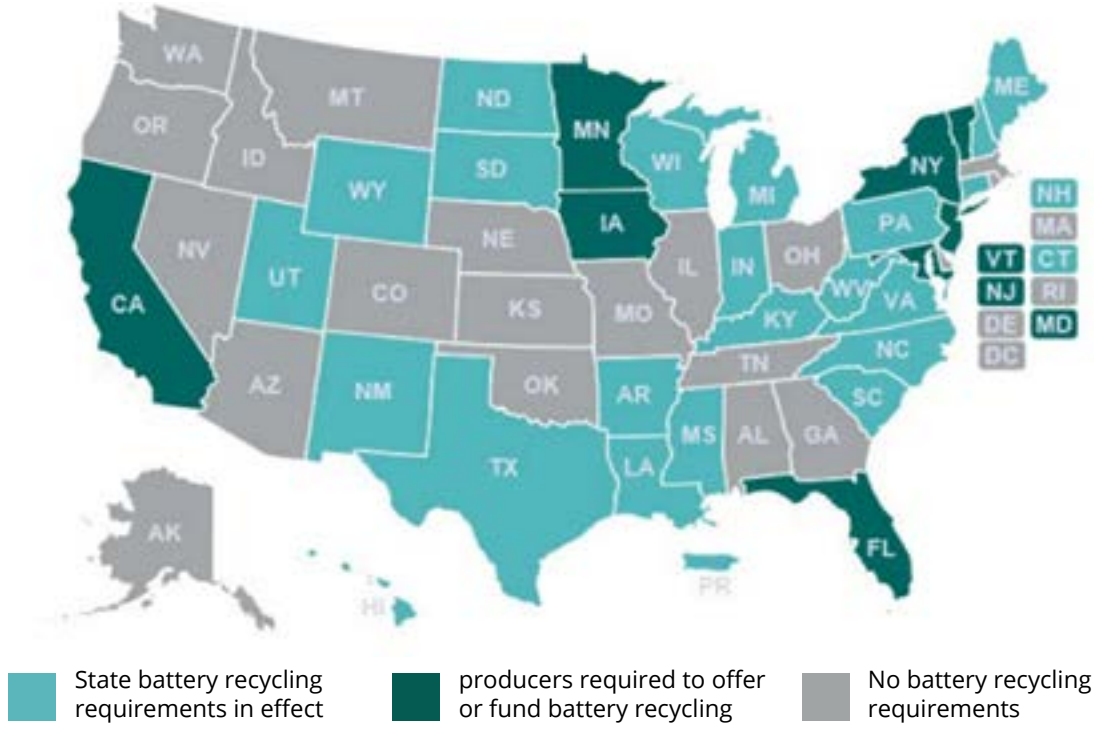
To begin, we define a code and a standard, explain their purposes, and discuss their legal statuses. A standard is a set of technical definitions, specifications, and guidelines created by companies, organizations, or countries. Its purpose is to clarify how something should be done, but it cannot be enforced as law. In contrast, a code is a model that can be adopted into law, often based on a standard. Its purpose is to specify what needs to be done and to serve as a legal framework (Hasa, 2016).

Figure 1 illustrates those states that have battery recycling regulations. A helpful state-by-state inactive is available on the Battery Council International website.

[1] *A Survey of Federal and State-Level Solar System Decommissioning Policies in the United States (nrel.gov)*

Figure 1

Map of US Battery Recycling Regulations



SOURCE: *Battery Council*

Table 1 on the following page summarizes a few key requirements currently in place for BESS decommissioning.

The New York State Energy Research and Development Authority (NYSERDA) created the New York Battery Energy Storage System Guidebook to assist local governments in adopting decommissioning plans. Among its requirements, applicants must submit a decommissioning plan before commissioning a BESS.

The guidebook references the International Fire Code (IFC) and the National Fire Protection Association (NFPA 1), which require a decommissioning plan to be submitted to the Authority Having Jurisdiction (AHJ) (McDowall, 2023). The plan should outline specific activities involved in the decommissioning process, designate responsible parties, and ensure that the disposal of hazardous materials complies with local and federal regulations.

Additionally, the plan must include an estimate of the battery lifespan and a projected decommissioning cost. BESS owners are also required to establish a fund or bond with their respective village, town, or city to cover decommissioning expenses.

Lithium-ion batteries are considered hazardous materials and must be regulated accordingly during transportation (Transporting Lithium Batteries, 2025). To transport these battery systems effectively, they should be discharged to a 30% state of charge, as required by NFPA

Guidelines are being developed to raise awareness and establish BESS end-of-life management strategies.

855 (McDowall, 2023). Typically, most guidelines are aligned with the U.S. Department of Transportation's Hazardous Materials Regulations (HMR) and the Resource Conservation and Recovery Act (RCRA).

For general decommissioning, companies follow steps such as breaking apart the battery's outer casing and melting, crushing, or dismantling internal components. Upon completing the decommissioning process, a Recycling Certificate is issued to confirm compliance with U.S. EPA regulations. These certificates, provided by the decommissioning company, remain on file and can be requested at any time.

Table 1

Map of US Battery Recycling Regulations

Codes	Standards
• International Fire Code • NFPA1 • NFPA 855 • Title 49, QCode of Federal Regulations, Subchapter C • Title 40, Code of Federal Regulations, Parts 262–273	NY State Energy Research & Development Authority NYSERDA Battery Energy Storage Sytem Guidebook: 1. De-energize 2. Disconnect 3. Remove 4. Disposition 5. Demolition

Guidelines are being developed to raise awareness and establish BESS end-of-life management strategies. One example is the non-profit Energy Storage Association (ESA), which has created a corporate responsibility initiative focused on the end-of-life and recycling of lithium-ion BESSs. Some organizations also offer recycling certifications that facilitate the decommissioning process. In certain states, certification for compliance with RCRA hazardous waste regulations is mandatory.

The EPA provides certifications for electronic waste recycling. These certifications offer numerous benefits, including enhanced information on proper recycling practices, improved access to high-quality reusable and refurbished equipment, and a reduced environmental and energy impact associated with mining and processing raw materials.

FINANCIAL VIABILITY

Future planning for Battery Energy Storage System (BESS) installations must account for the costs and complexities of decommissioning. These expenses can significantly impact a project's financial outlook, particularly if funding or bonds are required. To mitigate unexpected costs, project budgets should incorporate labor expenses for system removal and battery recycling. Additionally, any financial instruments obtained to support decommissioning should be factored into the overall budget.

In our analysis, we calculated the asset retirement obligation (ARO), representing the amount an asset owner would need to set aside today to cover future decommissioning expenses. This calculation was based on a sample 1MW/1MWh system, using variables including CAPEX estimates (www.nrel.gov, 2024), BESS lifetime (www.nrel.gov, 2024), inflation

rate (YCharts, n.d.), investment interest rate (YCharts, n.d.), and an estimated decommissioning rate (Westlake, Investigation of Battery Energy Storage System Recycling and Disposal, 2022).

Our findings suggest that the ARO can reach up to 5.9% of the system's CAPEX, depending on the system's size and other factors. As jurisdictions introduce decommissioning requirements into their codes, determining and integrating this ARO value into the project's total cost will become increasingly essential.

REFERENCES

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