Decommissioning and Battery End-of-Life Management

COMPLIANCE STEWARDSHIP

WHITE PAPER

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INTRODUCTION

Decommissioning a **Battery Energy Storage System (BESS)** is a complex, multi-phase process that requires careful planning and precise execution. At its core, it involves critical decisions about whether batteries, inverters, and balance of plant equipment should be repurposed for secondary use or recycled. These decisions are affected by a wide range of regulatory frameworks that vary by jurisdiction, making compliance an essential component of proper battery stewardship.

This paper provides an overview of critical regulatory compliance considerations* throughout the decommissioning and end-of-life management process of a large-scale BESS.

01. **Permitting, certifications, and training**
02. **Pre-decommissioning planning**
03. **Battery module removal, packaging, transport, and recycling**
04. **Ancillary systems dismantling and removal**
05. **Site restoration**
06. **Recordkeeping and reporting**
07. **Liability considerations**

* Regulatory requirements, standards, and best practices vary by jurisdiction and may change over time. Renewance makes no representation or warranty that the information contained herein reflects the most current or complete set of obligations. Users should independently verify requirements with the appropriate authorities. Contact **Renewance** for more information at **1-800-233-5038** or **sales@renewance.net**.

Regulatory Compliance and Permitting: What You Need to Know at Battery End-of-Life

At the end of a battery's service life, a structured decommissioning process is essential. This process encompasses compliance with waste handling requirements, securing the necessary permits and certifications, and safely disconnecting and handling equipment.

Effective decommissioning must be carried out in accordance with federal, state, and local regulations, while also adhering to recognized industry best practices. These measures are critical to ensuring the protection of personnel, the public, and the environment throughout the transition from active use to final disposition.

Regulatory requirements may include the following:

01. OSHA Construction and General Industry Standards (29 CFR 1926 and 29 CFR 1910), including provisions for electrical safety, fall protection, and hazardous materials handling.

02. EPA Resource Conservation and Recovery Act (RCRA) standards for handling and transport of universal and hazardous waste.

03. U.S. DOT Hazardous Materials Regulations (49 CFR Parts 171–180), including packaging, labeling, documentation, and personnel training requirements.

04. NFPA 70E for electrical safety in the workplace, including arc flash protection and energy isolation protocols.

05. Local building and fire codes may impose additional state-level requirements.

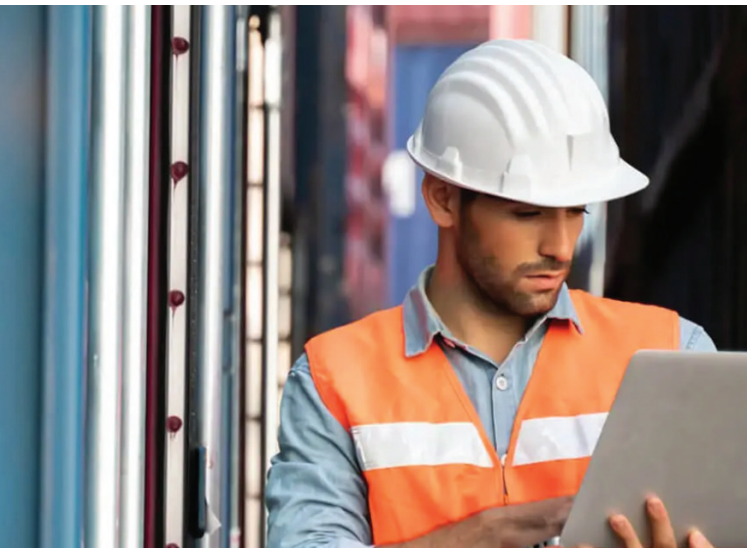
06. Implementation of a site-specific Health and Safety Plan (HASP) that identifies hazards, establishes safety controls, and outlines emergency procedures.

07. Completion of Job Hazard Analyses (JHAs) prior to the start of tasks, and daily tailgate safety meetings to reinforce awareness and accountability.

Decommissioning a **BESS** isn't just about removing batteries; it's a **multi-phase process** involving permitting, safe removal, recycling, site restoration, and compliance documentation.

Pre-Decommissioning Planning: What Does This Process Entail?

Devising a detailed and thorough plan before decommissioning a BESS is critical to ensuring a safe, compliant, and efficient decommissioning process. The first step involves identifying qualified suppliers and contractors with the expertise to manage specialized equipment and materials. A good practice is to document the allocation of roles and obligations among all stakeholders involved in the decommissioning in a Division of Responsibility table, including the asset owner, EPC, decommissioning contractor, recycler, and the transport company you plan to use. This step helps in enforcing owners to follow industry best practices, ensuring accountability, regulatory compliance, and safe handling of material.



Other Pre-Decommissioning Activities Include:

- Conducting hazard assessment, safety, and environmental planning.
- Reviewing and complying with all applicable local, state, and federal waste-handling regulations.
- Securing required permits and certifications prior to initiating decommissioning activities.
- Providing necessary training to personnel to ensure safe handling and regulatory compliance.
- Safely disconnecting equipment from all electrical sources to minimize hazards.
- Recovering and properly managing refrigerants and other regulated substances from equipment.
- Developing a reverse logistics plan to minimize handling, maximize recycling or reuse, and optimize cost recovery.
- Conducting an inventory of all components and identifying component weights, chemistries, and conditions.

Equipment Dismantling and Removal

Before a BESS can be dismantled or removed, it needs to be shut down and disconnected from the utility system in accordance with the manufacturer's/integrator's procedures. This will include a final inspection of the system, system shut-down, and physical disconnection of the system's electrical components.

All workers who perform electrical work, including lockout/tagout and electrical disconnection, should be qualified electrical workers as defined by 29 CFR 1910.269(A)(2).

The removal and transportation of battery packs represent some of the most labor and cost-intensive phases of an **Energy Storage System (ESS)** decommissioning project.

Waste Removal Defined

In the U.S., most batteries used in ESS applications are regulated as "Universal Waste," a special category of hazardous waste under the Code of Federal Regulations (40 CFR Part 273), provided they are intact[1], an unbroken battery that still contains its electrolyte. Project owners are required to obtain an EPA Identification (ID) Number before accumulating 5,000 kilograms of Universal Waste, an amount often reached when batteries are removed at end-of-life. The EPA ID number can be obtained at any stage of the project, but must be secured before reaching this threshold. If batteries are destined for refurbishment and reuse, they are not considered 'waste' under RCRA and are handled outside Universal Waste rules.

Additionally, lithium-ion batteries are classified by the U.S. Department of Transportation (DOT) as Class 9 hazardous materials. As such, all packaging, labeling, and transportation must comply with the Code of Federal Regulations, Title 49, Subchapter C, Parts 171–180.

Battery Removal, Packaging, and Reverse Logistics

The removal and transportation of battery packs represent some of the most labor and cost-intensive phases of an Energy Storage System (ESS) decommissioning project. Proper execution at this stage is essential not only for worker safety but also for compliance with federal regulations, OEM guidelines, as well as ensuring minimal environmental impact.

Battery Removal and On-Site Staging

Modules must first be carefully removed from racks and staged in a secure, designated on-site area. This step is essential for maintaining safety and ensuring compliance with Department of Transportation (DOT) and Environmental Protection Agency (EPA) requirements.

Packaging Requirements

All modules must be packaged to prevent short circuits to prevent damage caused by movement within the package, and to prevent accidental activation of the equipment. This includes the use of strong outer packaging along with proper labeling to reflect the battery's chemistry and condition. Heavy batteries (≥12 kg), with strong, impact-resistant cases may be packed on pallets directly. Batteries will be palletized and packaged in accordance with the requirements of 49 CFR 173.24 and 173.24a.

The packages containing the batteries should be marked and labelled in accordance with 49 CFR 172, Subparts D and E.

Other considerations include:

01. A handler of universal waste may only manage broken or damaged hazardous waste batteries as universal waste if the breakage or damage does not constitute a breach in an individual cell casing.

02. Batteries that are damaged, defective, or recalled (i.e., elevated risk of short circuit, heat, or thermal event) require enhanced packaging. Each battery must be packaged individually (unless the packaging carries a Special Permit which authorizes a safe, alternative method that deviates from the standard DDR requirements when an equivalent level of safety is demonstrated) in a non-metallic inner with non-combustible, non-conductive, absorbent cushioning; then place it in an authorized UN specification packaging, certified to Packing Group I level. The outer package must be marked with "Damaged/defective lithium ion battery".

Transportation

The transportation of hazardous materials is governed by the US DOT Hazardous Materials Regulations (HMR) contained in 49 CFR Parts 100-180, and regulations specific to the packaging of lithium-ion batteries are contained in 49 CFR 173.185. The US EPA imposes several additional requirements through the full transportation lifecycle.

These obligations include:

- Training personnel in proper waste management and emergency procedures.
- Complying with accumulation time limits for hazardous/universal waste.
- Maintaining records of waste handling and off-site shipments for at least three years.

Whether shipping a single battery or a palletized load of batteries, the safety of the package and those who handle it in transport depends on compliance with the HMR. Failure to comply with the applicable regulations could result in fines or even criminal prosecution.

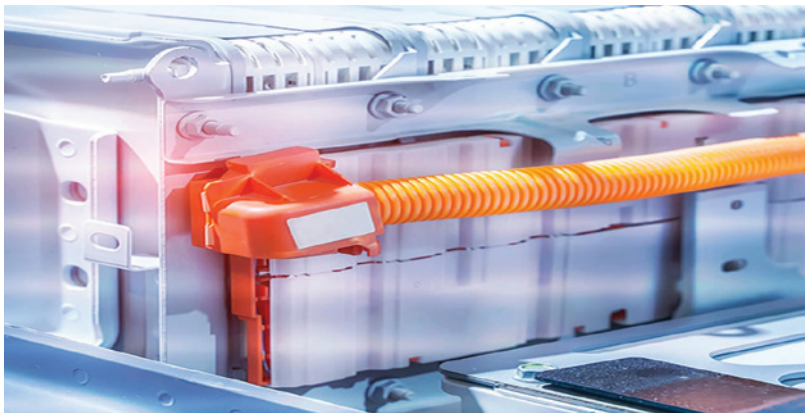
End-of-life planning for battery systems is a complex, resource-intensive process that many organizations are not equipped to manage on their own. Let Renewance help!

Integration of Advanced Logistics Platforms

To ensure each stage in a decommissioning process is completed with care, many companies will integrate an advanced logistics platform, a digital technology platform used to coordinate, track, and optimize the entire end-of-life process

At Renewance, our mission is to help our clients repurpose or recycle in an environmentally appropriate and cost-effective manner. To reduce costs and warrant compliance, companies can benefit from Renewance's DOE Recycling Prize–winning stewardship platform, which integrates:

- Aggregation of volume, optimized reverse logistics routing, and competitive bidding by qualified logistics service providers to reduce transportation costs.
- Aggregation of volume and competitive bidding by qualified recyclers.
- Compliance guidance and record keeping.



By addressing packaging, transportation, and recycling holistically, incorporating advanced logistics and compliance tools, and leveraging its in-house technicians, Renewance can deliver safe, cost-effective, and environmentally responsible BESS decommissioning.

Environmental Effects

Decommissioning activities have a similar risk of environmental impacts as those associated with construction. For example, decommissioning activities will result in the disturbance of soil. As a result, erosion prevention measures will be put in place so that nearby watercourses or other natural features are not impacted. A sediment and erosion control plan, often used during construction, should be employed. The sediment and erosion control measures should remain in place until the site is stabilized to mitigate stormwater runoff and soil erosion.

Further, temporary impact to roadway traffic similar to that during construction will accompany the decommissioning process. Noise levels similar to those during construction may be heard in the surrounding area as well while decommissioning is taking place. The following precautions can help prevent this:

- Remove battery containers, inverters, transformers, and switchgear.
- Remove equipment pads, foundations, structural supports, and underground conduits.
- Restore site per landowner agreement or lease terms.
- Address any environmental remediation requirements.

Ancillary Systems and Site Restoration

Battery removal and transportation can be a damaging and strenuous process. Upon removal of foundations, fencing, roadways, and related civil improvements, the site must be restored to conditions as close as possible to the pre-construction state, unless otherwise directed by the property owner or permitting authority. Final grading will restore original topography where feasible, promoting positive drainage and avoiding the creation of water pooling or erosion-prone conditions.

Following grading and backfilling, topsoil should be redistributed across disturbed areas to a minimum depth consistent with local standards or original conditions. Areas previously vegetated should be reseeded with a native or site-appropriate seed mix to encourage reestablishment of local flora. Temporary erosion control measures will remain in place until vegetation is fully established.

Recordkeeping and Documentation

A large quantity handler of Universal Waste must keep a record of each shipment of Universal Waste sent from the handler to other facilities. The record may take the form of a log, invoice, manifest, bill of lading, movement document, or other shipping document. The record for each shipment of Universal Waste sent must include the following information:

01. The name and address of the Universal Waste handler, destination facility, or foreign destination to whom the Universal Waste was sent.

02. The quantity of each type of Universal Waste sent (e.g., batteries, pesticides, thermostats).

03. The date the shipment of Universal Waste left the facility. A large quantity handler of Universal Waste must retain the records for at least three years from the date a shipment of Universal Waste left the facility.

A large quantity handler of Universal Waste must retain the records or at least three years from the date a shipment of Universal Waste left the facility. For ESS hardware, all associated operational controls, and safety systems not classified as hazardous waste, daily activity reporting, bill of ladings (BOL), recycling or disposal records, or certificates of destruction, as applicable, shall record identifying data or a description of decommissioned items.

Liability Considerations

Managing end-of-life industrial batteries involves significant liability considerations involving labor, transportation, recycling, and recordkeeping.

Non-compliance with federal, state, or local regulations carries additional risk, including fines, penalties, cleanup liabilities, reputational damage, and even insurance claim rejections. Finally, large quantity handlers of Universal Waste must maintain detailed shipment records, including destinations, quantities, and dates, for at least three years, underscoring both regulatory and financial responsibilities.

How Renewance Can Help

Renewance is leading the transition to a sustainable, decarbonized economy by delivering comprehensive lifecycle management solutions for industrial batteries. End-of-life planning for battery systems is a complex, resource-intensive process that many organizations are not equipped to manage on their own. It requires deep knowledge of evolving local, state, and federal regulations, as well as the ability to ensure full compliance at every stage. Without specialized expertise, the risks of oversight, non-compliance, and added liability increase significantly.

For Peace of Mind, Outsource Battery Lifecycle Management to **Renewance**, a Qualified Leader in Battery Stewardship.

Partnering with a turnkey provider like **Renewance** reduces those risks and provides confidence throughout the process. From installation and commissioning to maintenance and end-of-life management, **Renewance** delivers complete lifecycle services that optimize performance and ensure safe, responsible handling from start to finish.

Adding to its credibility, **Renewance** brings unmatched expertise in commercial battery recycling as a winner of Phase III of the U.S. Department of Energy's Lithium-Ion Battery Recycling Prize, which recognized its disruptive solutions to accelerate and improve the battery reverse supply chain.

Partner with Renewance for battery decommissioning.

For more information about our services, visit **www.batterystewardship.com** or contact a representative of **Renewance** in the U.S. at **1-800-233-5038** or **sales@renewance.net**.

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