



# Mid-Format Battery Recycling: Ensuring Safe End-of-Life Management

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November 21, 2024

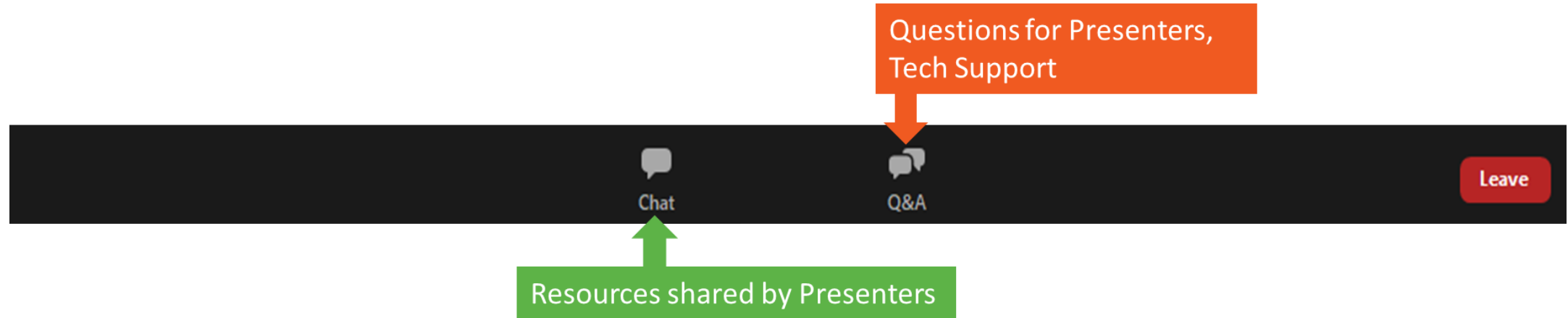
U.S. Environmental Protection Agency (EPA)



# Logistics and Agenda Review

Pat Tallarico, ERG Team

# Webinar Logistics



- **To ask a question:** Type your questions for presenters in the Q&A box. We will answer questions at the end of each presentation.
- **Technical difficulties:** If you are having technical difficulties, please send a message through the Q&A box or email [Audrey.Njo@erg.com](mailto:Audrey.Njo@erg.com)



# Agenda Overview

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1. Opening remarks, logistics, and agenda review
2. Department of Energy (DOE) Funding Opportunities for Local Governments and Battery Recyclers/Processors
  - **Amanda McAlpin**, U.S. Department of Energy Office of Manufacturing and Energy Supply Chains (DOE MESCC)
3. Logistics and Transportation
  - **Logan Blizzard**, U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (DOT PHMSA)
4. Packaging and Safety During Transportation
  - **Bob Richard**, Hazmat Safety Consulting
5. Recycling and End-of-Life Management
  - **Mark Hoffman**, Ecobat
6. *UL 3601 Measuring & Reporting the Circularity of Li-Ion & Other Secondary Batteries*
  - **Caitlin D'Onofrio**, *UL Standards & Engagement\**
7. Questions/Comments
8. Wrap Up/Next Steps

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\*Caitlin was unavailable to present on this date; however, her slides have been included for your reference.



# Background

**Ellen Meyer**, U.S. Environmental Protection Agency (EPA)

# EPA's Ongoing Battery-Related Projects

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Separate but complementary requirements in the Bipartisan Infrastructure Law (BIL):

- **Battery Collection Best Practices** to identify and increase accessibility to battery collection locations, promote consumer education, and reduce hazards from improper disposal [Sec. 70401(b)]
- **Voluntary Battery Labeling Guidelines** to improve battery collection and reduce battery waste by promoting consumer education and reducing safety concerns related to improper disposal. [Sec. 70401(c)]



# Vision for EPA's Resources & Guidance

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## Battery Collection Best Practices

- EPA will develop best practices for state, tribal, and local governments to recycle batteries in a manner that is:
  - Technically and economically feasible
  - Environmentally sound and safe
  - Optimizing value and use of materials, including critical minerals
- Anticipated resources for publication in 2025 and 2026
  - Best practices guidelines
  - Tailored outreach materials
  - Case studies



# Vision for EPA's Resources & Guidance

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## Voluntary Battery Labeling Guidelines

- EPA aims to develop guidelines for labels that will:
  - Identify battery collection locations
  - Educate consumers about recycling opportunities
  - Reduce safety concerns from improper disposal
- Anticipated resources for publication in 2025 and 2026
  - Sets of written guidelines for various battery categories
  - Guidance will build on existing standards; emphasize good ideas; and address inconsistencies.





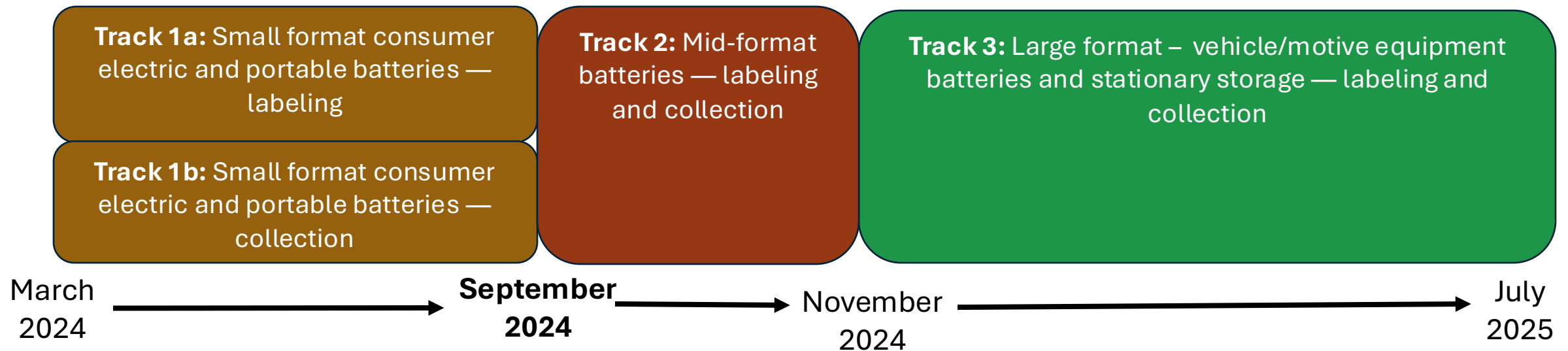
# Scope of Batteries

Category	Small format consumer electric and portable batteries		Mid format batteries	Large format batteries
Type	Single use (Primary)	Rechargeable (Secondary)	Rechargeable	Rechargeable
Use	Removable or embedded in electronics and electric devices, such as watches, hearing aids, cameras, key fobs, toys, portable radios, flashlights.	Removable or embedded in electronics and electric devices, such as phones, computers, appliances, small uninterruptable power supplies (UPS), power tools, power banks.	E-mobility including e-bikes, e-scooters.  Outdoor power equipment.  Portable power stations.	All scales of automotive starting and motive vehicle batteries.  Materials handling equipment (forklift, crane, etc.)  Recreational (golf carts, marine equipment, recreational vehicles, etc.)



# Conversation Timeline

- A sequenced approach to conversations
- Leveraging existing, in-person industry meetings to test ideas and share updates



# Highlights from Work to Date

Pat Tallarico, ERG Team

# Key Themes: Collection Best Practices

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- Convenient and well-marked collection locations
- Consistent and diverse outreach
  - Drivers – preventing fires and keeping batteries out of landfills
  - Clear call to action
- Train employees at collection sites and be prepared to respond
- Ensure that materials are properly labeled and packaged for shipment
- Partnerships for program implementation
- Hub and spoke models for rural/remote communities



# Key Themes: Labeling

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- Label and collateral information should
  - Help consumers
    - Recognize a battery and products with batteries
    - Know what to do and not do with a battery at end of life
  - Help make collection sites aware of the type and state/condition of batteries
- Labels may help keep batteries out of the recycling stream, but other technologies may be more helpful for identifying batteries/battery containing products if they get through
  - Can't eliminate all hazards—be prepared for fires



# Key Themes: Labeling

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- Space is limited/Lots of required information already.
  - Labels should direct consumers to a website for more information.
- Modifying existing labels takes time.
- Use of "chasing arrows" recycling symbol can be confusing without more information.
- Color has had/may have limited utility.



# Transitioning to Mid-Format

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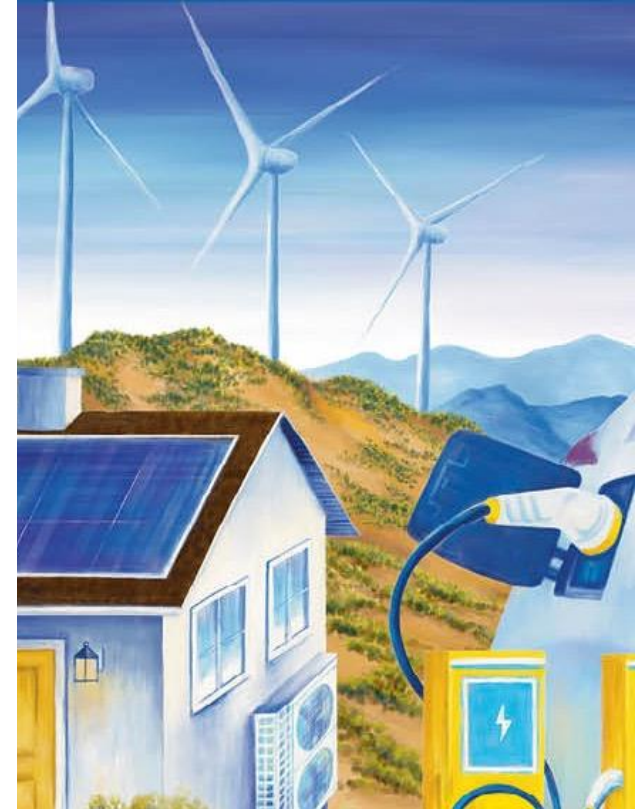
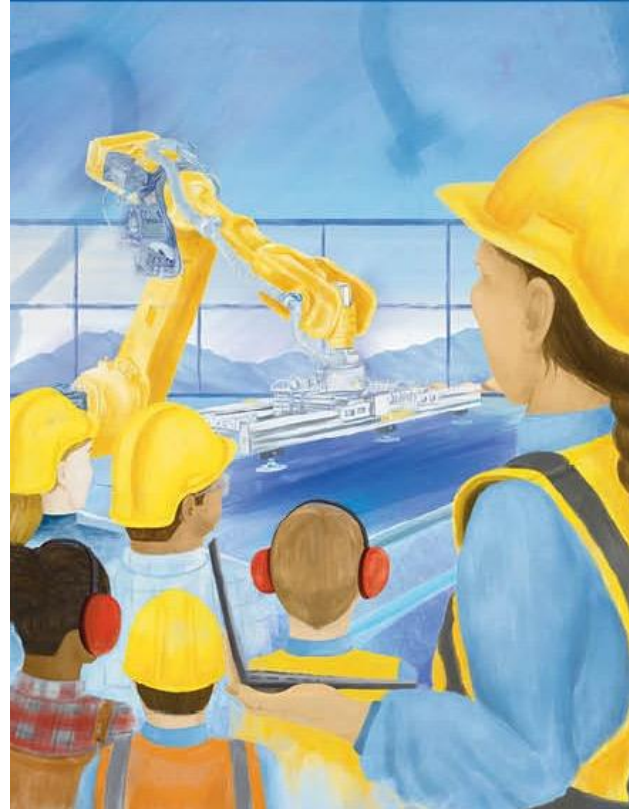
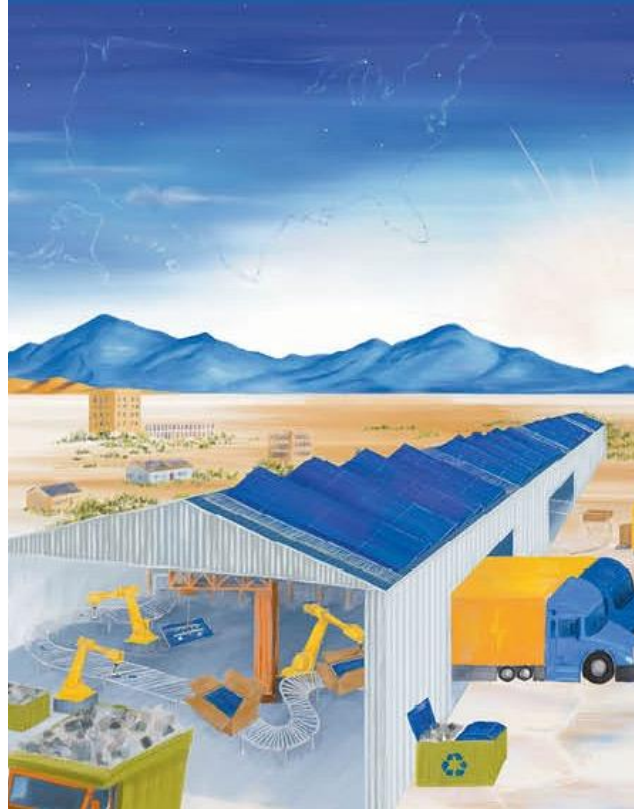
- Trend is to more electrification of equipment in the mid-format range (e.g., power tools, outdoor equipment, e-mobility).
- More power in smaller packages – longer battery life.
- Mid-format may be less likely to end up in landfills because of size of products.
- Transportation can get more complicated.
- Growing level of interest in regulating at the state level.
- Designating drop-off bins as "rechargeable" may get confusing to distinguish between small and mid-format.
- Safety is a key concern – misuse, "do-it-yourselfers", uncertified products.



# Department of Energy (DOE) Funding Opportunities for Local Governments and Battery Recyclers/Processors

**Amanda McAlpin**, U.S. Department of Energy Office of Manufacturing and Energy  
Supply Chains (DOE MESC)





**MESC**

OFFICE OF MANUFACTURING AND ENERGY SUPPLY CHAINS

# The Office of Manufacturing and Energy Supply Chains

Amanda McAlpin  
November 2024

# MESC is all about de-risking energy supply chains



## MESC'S VISION

To **eliminate vulnerabilities in US Clean Energy supply chains**, while driving unparalleled social, economic, and environmental impact through our programs & awards

## MESC'S CORE FUNCTIONS

### Manufacturing Investing

Strengthening and securing the energy supply chains America needs for a secure, clean and equitable energy system

### Workforce Investing

Supporting workforce skills development by directly funding cutting-edge energy manufacturing training programs

### Manufacturing Analytics Backbone

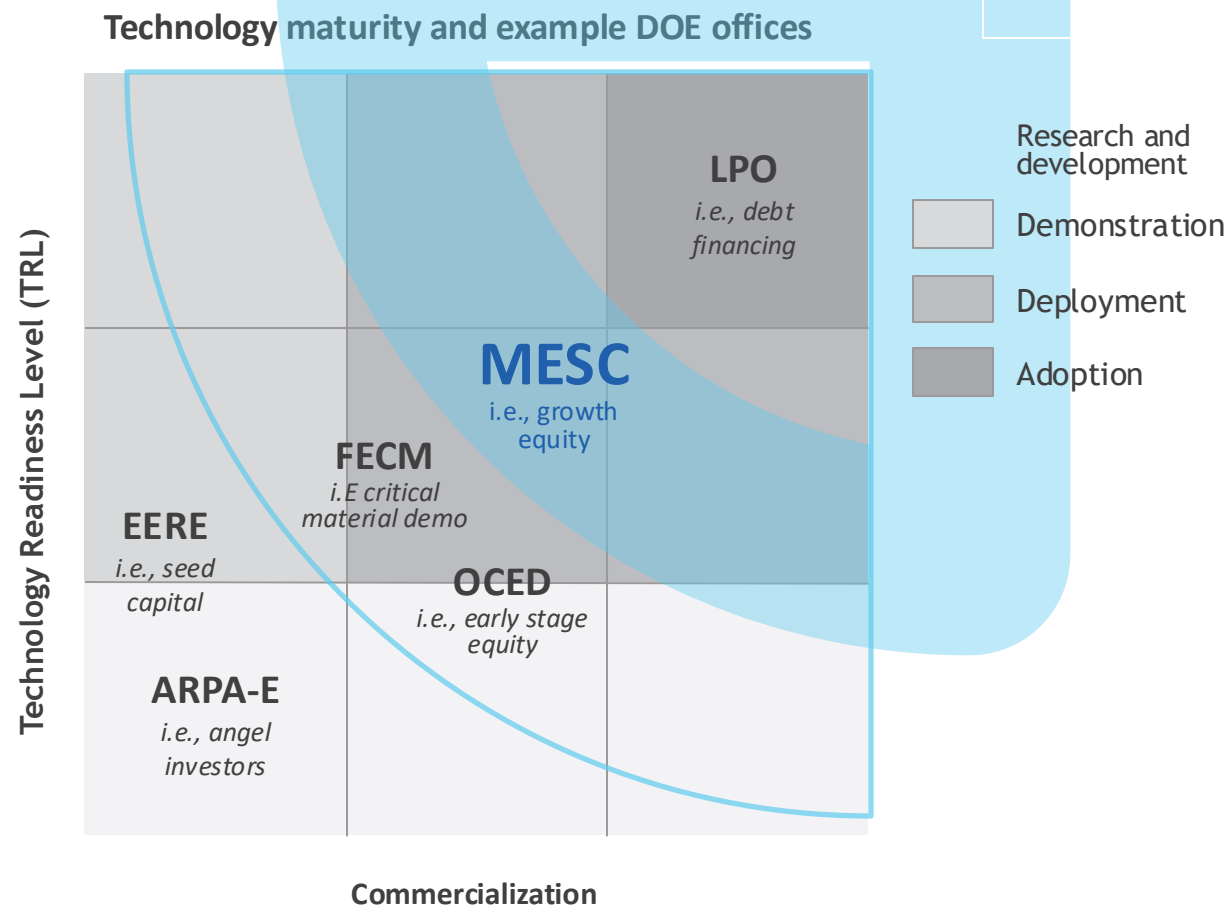
Robust modeling to guide and support DOE strategy and investments, private sector collaborative investments, and federal policy recommendations

# MESC operates in late-stage technology development, driving large-scale deployment of new technologies

The Office of Manufacturing and Energy Supply Chains is working alongside private capital to be a force multiplier to secure American supply chains domestically.

All DOE and MESC investments follow a data-driven approach, building on modeling, mapping, and analysis foundational from MESC experts.

MESC is supporting workforce through direct funding of cutting-edge energy manufacturing programs at universities, community college, and trade-schools to provide entry-level and mid-career support.



# Manufacturing is accelerating across clean energy technologies

## US MANUFACTURING INVESTMENT ANNOUNCEMENTS

\$120B+	Batteries
\$35B+	EVs & EV Chargers
\$16B+	Solar
\$3.5B	Offshore Wind
\$2B	Electrolyzers & Fuel Cells



# MESC is investing in Workforce Development and Training

## Expanded Industrial Assessment Centers

- Arizona Western College
- Atlanta Technical College
- Bridgevalley Community & Technical College
- Community College Of Rhode Island
- Illinois Community College Board
- Imperial Valley Community College District
- Insulation Industry International Apprentice and Training Fund
- International Training Institute for the Sheet Metal and Air Conditioning Industry
- Kern Community College District
- Miracosta Community College Technology Career Institute
- Mississippi Gulf Coast Community College
- Sinclair Community College
- Southwest Wisconsin Technical College
- Tri-Counties Sheet Metal Workers JATC
- Weber State University
- Wichita State University Campus of Applied Sciences and Technology



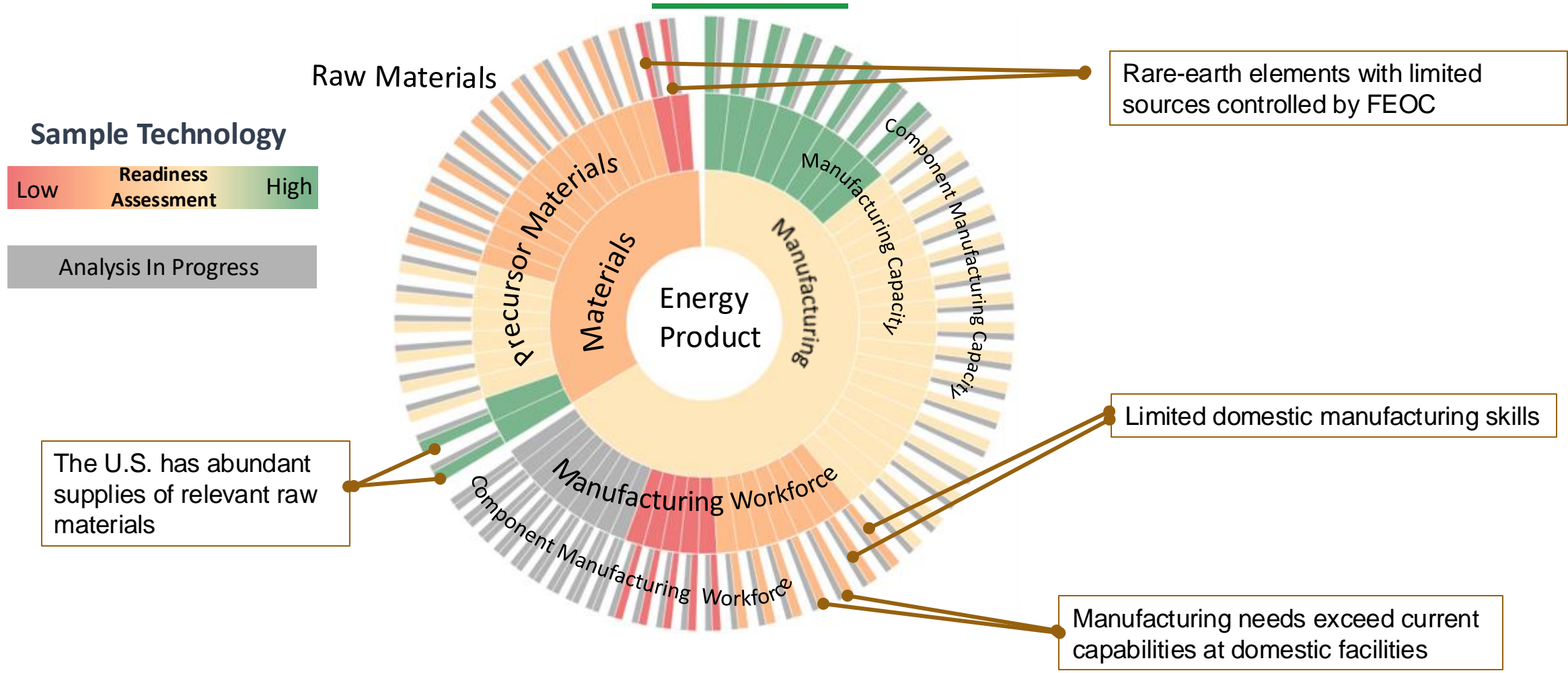
The Industrial Assessment Centers (IACs) help small and medium sized US manufacturers save energy, improve productivity, and reduce waste by providing **no-cost technical assessments** conducted by university-based teams of engineering students and faculty.

For the first time in their 40-year history, MESC expanded the network of IACs beyond higher education, **including trade schools and labor union programs** among the 27 projects selected. Over 75 percent of these awards will serve disadvantaged communities, and 13 of the 27 selectees are Minority-Serving Institutions (MSI).

**5** Regional Centers of Excellence  
**300+** Assessments  
**2,136** Recommendations  
**\$46.4M+** Aggregate cost saving recommendations



# MESC's Supply Chain Readiness Level (SCRL) framework enables deep supply chain vulnerability analysis



# MESC's Impacts To-Date



**\$3.9B+ private sector investment catalyzed**



**9,205 construction and permanent jobs created**



**38% of investments in energy communities or  
J40 communities**



**1000+ students trained annually**















**1.3M+ EVs enabled annually**



**\$54.5M+ in benefits flowing to communities  
through Community Benefits Plans**

# MESC Programs

OPEN FOR APPLICATIONS		UNDER REVIEW		SELECTED FOR NEGOTIATION	
	Industrial Assessment Centers Implementation Grants (\$400 million)		Advanced Manufacturing and Recycling Grants R2 (\$425 million)*		Advanced Manufacturing and Recycling Grants R1 (\$275 million)
	Extended Product System Rebates (\$10 million)		Battery Material Processing and Battery Manufacturing Grants (\$3.5 billion)		Consumer Electronics Battery Recycling, Reprocessing, and Battery Collection for States & Local Government (\$7.2 million) & Retailers (\$15 million)
	Smart Manufacturing & Recycling Tactics for States (SMART) Grant Program (\$63 million)				Defense Production Act – Heat Pumps Manufacturing R1 (\$169 million) & R2 (\$63 million)*
	Domestic Manufacturing Conversion Grants Program State set-aside (\$50 million)				Domestic Manufacturing Conversion Grants Program (\$2 billion)*
					IAC Clean Energy Manufacturing Workforce Training and Technical Assistance Awards R1(\$32 million) & R2 (\$24 million)
					State Manufacturing Leadership Program (\$22 million)

\* prior submission of a concept paper required for to submit a full application



# Bipartisan Infrastructure Law (BIL) Efforts

## Li-based Battery Supply Chain

### Upstream

Mining and Extraction

#### Raw Materials Production



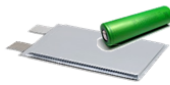
### Midstream

Cathode Powder Production, Separator Production, Electrode and Cell Manufacturing

#### Materials Processing



#### Cell Manufacturing



### Downstream

Pack Manufacturing, End of Life Recycling and Reuse

#### Pack Manufacturing



#### Electric Vehicles



#### Stationary Storage



#### National Defense



#### Aviation



#### End of Life Recycling and Reuse



**Sec. 40207(b) Battery Material Processing Grants**

(\$3 Billion Total over 5 years)

**Sec. 40207(c) Battery Manufacturing and Recycling Grants**

(\$3 Billion Total over 5 years)

**Sec. 40207(e) Lithium-Ion Battery Recycling Prize Competition** (\$10 Million total)

**Sec. 40207(f) Battery and Critical Mineral Recycling: Battery Recycling Research, Development, and Demonstration Grants** (\$125 Million total)

**Sec. 40208 Electric Drive Vehicle Battery Recycling and Second-Life Applications Program** (\$200 Million Total over 5 years)

# Consumer Electronics Battery Recycling, Reprocessing, and Battery Collection for State and Local Governments and Retailers

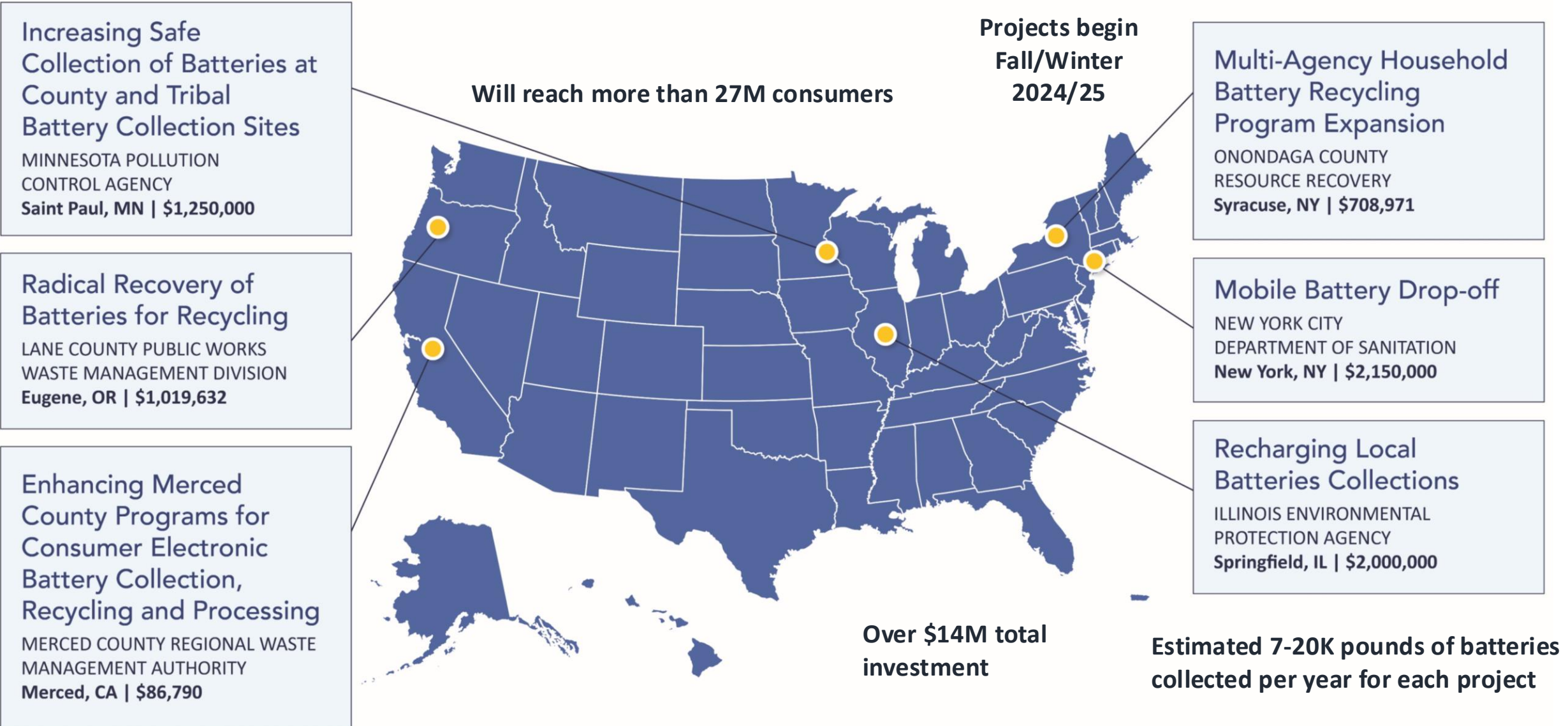
Appropriations of \$65 million to assist States and units of local government, and retailers with battery collection and recycling

Grants to establish or enhance battery collection, recycling, and reprocessing programs.

- Programs can focus on any or all recycling steps such as collecting, handling, sorting, storing, and transporting spent and discarded batteries and electronics containing batteries up to the physical recycling process.

Up to \$10M per grant, proposal must include a 50% cost share.

# Consumer Electronics Battery Recycling, Reprocessing, and Battery Collection - State and Local Programs



**Increasing Safe Collection of Batteries at County and Tribal Battery Collection Sites**  
MINNESOTA POLLUTION CONTROL AGENCY  
Saint Paul, MN | \$1,250,000

**Radical Recovery of Batteries for Recycling**  
LANE COUNTY PUBLIC WORKS WASTE MANAGEMENT DIVISION  
Eugene, OR | \$1,019,632

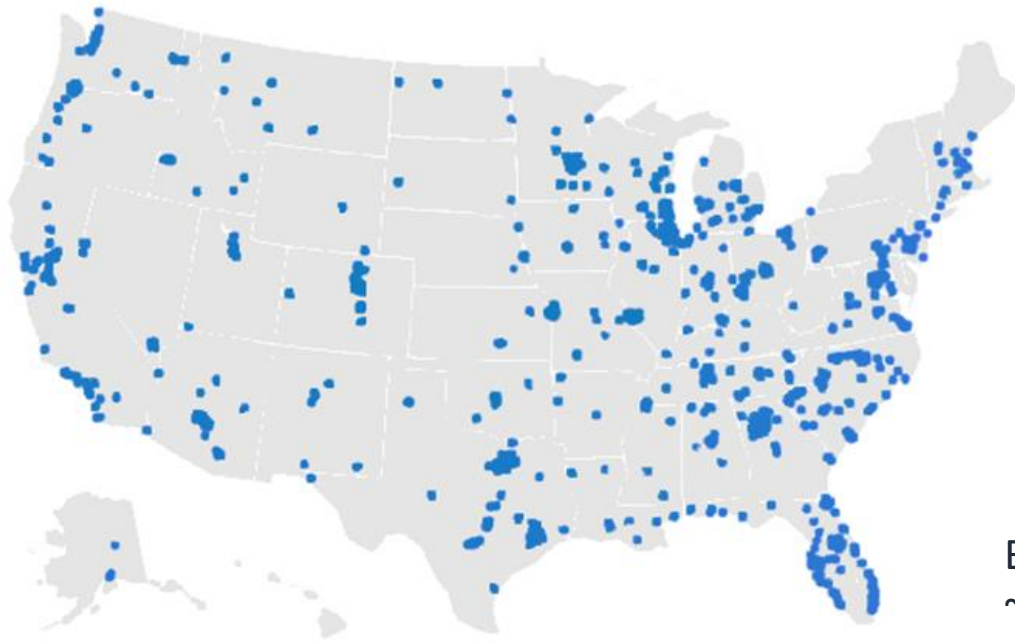
**Enhancing Merced County Programs for Consumer Electronic Battery Collection, Recycling and Processing**  
MERCED COUNTY REGIONAL WASTE MANAGEMENT AUTHORITY  
Merced, CA | \$86,790

**Multi-Agency Household Battery Recycling Program Expansion**  
ONONDAGA COUNTY RESOURCE RECOVERY  
Syracuse, NY | \$708,971

**Mobile Battery Drop-off**  
NEW YORK CITY DEPARTMENT OF SANITATION  
New York, NY | \$2,150,000

**Recharging Local Batteries Collections**  
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY  
Springfield, IL | \$2,000,000

# Consumer Electronics Battery Recycling, Reprocessing, and Battery Collection - Retailer Programs



Projects begin  
Fall/Winter  
2024/25



More than 1,000 collection points across  
the US

Battery collection potential for  
~ 20 M batteries/Year  
~ 6 M + lbs. / Year

Over \$30M overall investment



No cost to consumers, predicted to  
increase battery recycling by 100% over  
pilot programs

# MESC's State Manufacturing Leadership Program

**\$50M to states to support smart manufacturing adoption for small-and medium-sized manufacturers (SMMs)**

- Bipartisan Infrastructure Law (Section 40534) funded.
- Competitive grants to states to build or expand programs that **support SMMs** to:
  - Implement **smart manufacturing technologies** and practices, or
  - Access **High-Performance Computing (HPC)** resources.
- Up to **\$2 million per grant** with up to a 3-year term. At least a 30% cost match required.

## Round 1 Selections (2023):

**12 projects, \$22M in federal funds**



### State Program Breakdown:

- 9 New Programs
- 3 Expansions of Existing Programs
- 12 Supporting Smart Manufacturing access
- 4 Supporting access to HPC resources

### State Program partners include:

- Manufacturing USA institutes/satellites
- NIST-MEPs
- Industrial Assessment Centers
- Community Colleges/Networks
- Minority, Women, or Veteran-Serving Orgs
- Unions
- Historically Black Colleges and Universities

### Anticipated Round 1 Impact:

>\$450M	Economic Impact for SMMs
3,500	SMMs receiving TA or project scoping
1,200	Smart manufacturing assessments
280	Direct financial assistance to SMMs

## STAY TUNED!

Remaining program funding available soon for states to help SMMs access smart manufacturing technologies!


# Lithium-ion Battery Recycling Prize Effort – Background

The prize was designed to create end-to-end solutions to help DOE achieve an overall **lithium-ion battery (LIB) recovery rate of 90%**.

Previously, the prize **has awarded a total of \$5.5 million** in cash prizes to contestants in three progressive phases over approximately four years.

Each participating team **conceived a solution to collect, sort, store and transport spent LIBs to recyclers**; developed a prototype; and demonstrated the viability of their proposal.

Phase III **winners implemented a pilot validation** of their end-to-end solution and gathered data to support the solution's projected impact.



**LITHIUM-ION BATTERY RECYCLING PRIZE**

**Phase I (\$1M)**  
**Concept Development and Incubation**  
15 winners receive a cash prize of \$67,000

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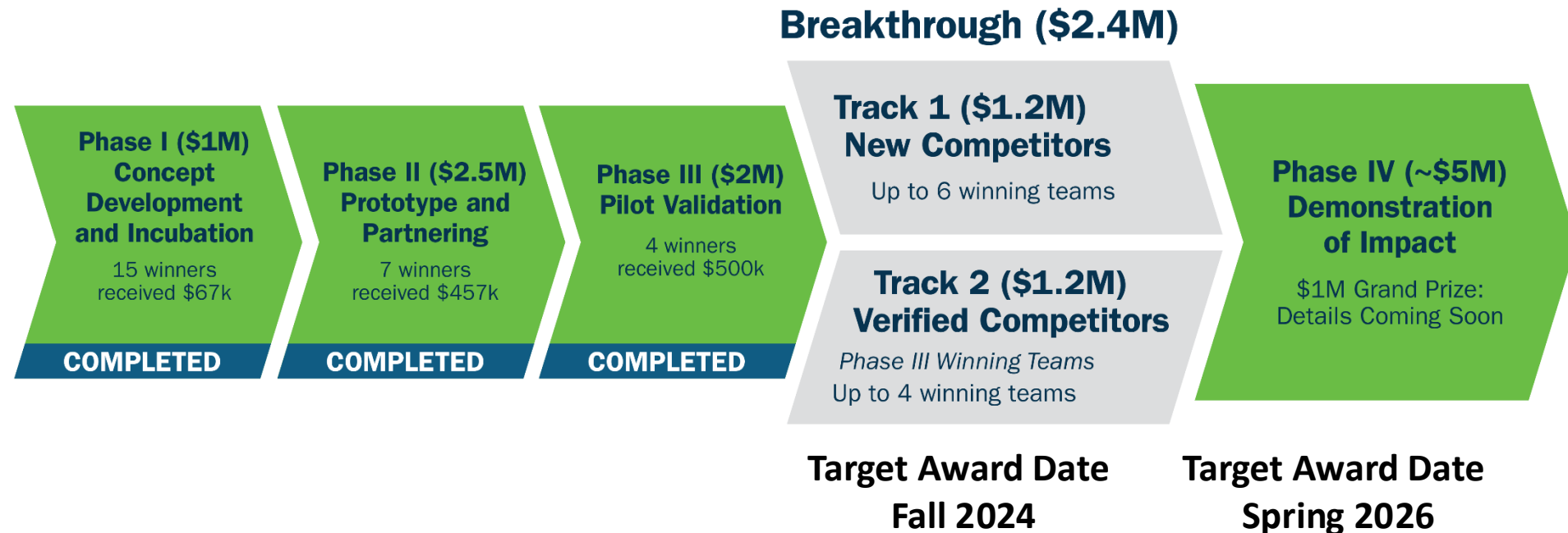
**Phase II (\$2.5M)**  
**Prototype and Partnering**  
7 winners receive a cash prize of \$357,000 and up to \$100,000 in vouchers

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**Phase III (\$2M)**  
**Pilot Validation**  
4 winners receive a cash prize of \$500,000

# Lithium-ion Battery Recycling Prize Effort – Continuation

- The continuation of the Lithium-Ion Battery Recycling Prize aims to further the goal of contributing to the **recovery target** through innovative solutions to current challenges in collecting, sorting, storing, and transporting discarded lithium-ion batteries.
- This continuation is designed to **bolster participation from new competitors** while providing additional support to Phase III winning teams.



# Connect With MESC

[energy.gov/mesc](https://energy.gov/mesc)



MESC@hq.doe.gov



Office of Manufacturing and Energy Supply Chains, U.S. Department of Energy



**MESC**  
OFFICE OF MANUFACTURING AND ENERGY SUPPLY CHAINS



# Logistics and Transportation

**Logan Blizzard**, U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (DOT PHMSA)

# U.S. DOT Regulations for “Mid-Format” Lithium Batteries



**Logan Blizzard**  
**Transportation Specialist, Office of Hazmat Safety**  
**Pipeline and Hazardous Materials Safety Administration (PHMSA)**  
**U.S. Department of Transportation**



# Overview

- **Part I: DOT/PHMSA Regulatory Overview**
- **Part II: Requirements for Shipping Fully-Regulated Lithium Batteries**
- **Part III: End-of-Life and DDR Shipments**
- **Part IV: Compliance Resources**



# Part I: DOT/PHMSA Regulatory Overview



U.S. Department of Transportation  
Pipeline and Hazardous Materials  
Safety Administration

To Protect People and the Environment From the Risks of  
Hazardous Materials Transportation



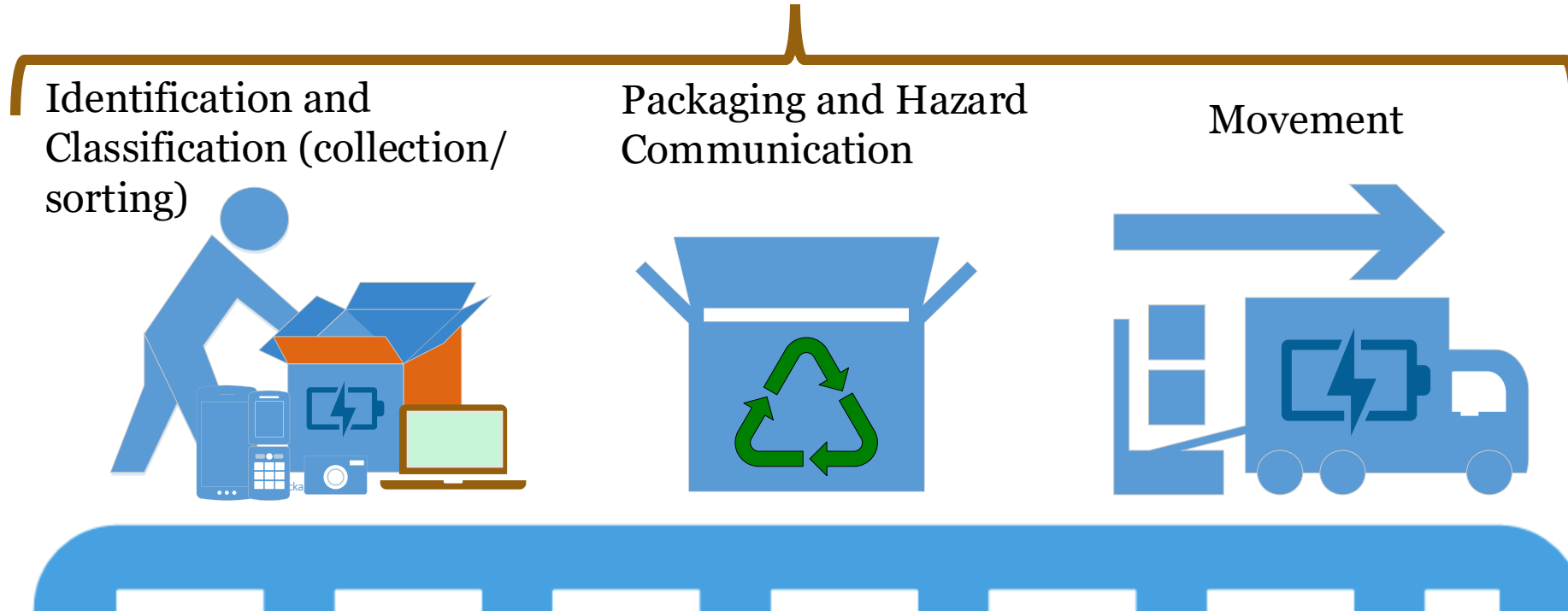
# Federal Hazmat Law

- The Hazardous Materials Regulations (HMR), found in ([49 CFR Parts 171-180](#))
- Govern transportation of hazardous materials by highway, air, rail, and vessel
- “Protect against the risks to life, property, and the environment which are inherent in the **transportation of hazardous materials** in intrastate, interstate, and foreign **commerce**”



# DOT in the Supply Chain

## Oversight of the Transportation Process



# Classification: Type of Lithium Batteries

## Lithium Metal (primary)

- Metallic lithium or alloy
- Size measured in grams
- Generally not rechargeable (single-use)
- Typical configurations : coin cell, cylindrical, and rectangular
- Examples: watches, thermometers

## Lithium Ion (secondary)

- Lithium compound
- Size measured in Watt-hours (Wh)
- Generally rechargeable
- Typical configurations: cylindrical, rectangular, and pouch packs
- Examples: laptops, tablets, cell phones, power tools



# Classification: UN ID Numbers

UN3480

- Lithium Ion Batteries

UN3481

- Lithium Ion Batteries Contained in/Packed with Equipment

UN3090

- Lithium Metal Batteries

UN3091

- Lithium Metal Batteries Contained in/Packed with Equipment

\*\* Excludes UN3171 (battery-powered vehicles) and UN3536 (energy storage systems)





# Classification: Battery Size

- Energy capacity is an important consideration – larger batteries and quantities are subject to increased regulation
- Thresholds:

## Lithium Ion (Smaller Batteries)

- $\leq 100$  Wh
- $\leq 300$  Wh ground only\*

## Lithium Metal (Smaller Batteries)

- $\leq 2$  g
- $\leq 25$  g ground only\*

\* Additional hazard communication is required



# Part II: Requirements for Shipping Fully-Regulated Lithium Batteries



# General Requirements

- Shipping papers: must prepare and offer a hazardous materials shipping paper, per §§ 172.200-205
- \*\*Not the same as an EPA waste manifest!
- Emergency response info: must provide appropriate emergency response information and emergency response telephone number per §§ 172.600-606



# Training – 49 CFR § 172.704

- Four parts:
  1. General awareness/familiarization
  2. Function-specific
  3. Safety
  4. Security Awareness
- Testing is required
- Training records must be kept and made available
- No official training program
- No minimum hours require (not HAZWOPER)



# Stand-Alone Batteries



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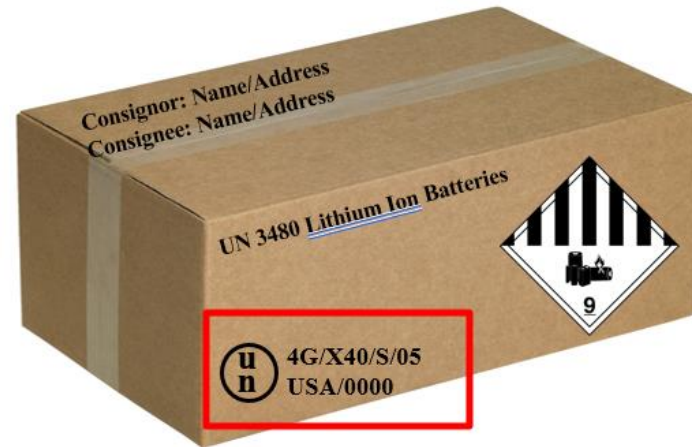
# Inner Packaging (Standalone)

- Cells and batteries must be:
  - Protected against short circuiting. This means that terminals must be protected!
  - Placed in non-metallic inner packagings that completely enclose the cell or battery and separate them from contact with electrically conductive materials (e.g., metal) in the packaging.
  - Packed to prevent shifting that could cause damage to the cells or batteries within the outer packaging.



# Outer Packaging (Standalone)

- Outer packaging must be a UN specification packaging meeting Packing Group II performance requirements
- All packaging instructions provided by the packaging manufacturer must be followed



# Hazard Communication (Standalone)



Cargo Aircraft Only Label § 172.448  
(if being shipped for air transport)



Class 9 Lithium Battery Label  
§ 172.447

Consignor (shipper) or  
Consignee (recipient)  
Name and Address -  
§ 172.301



UN ID Number and  
Proper Shipping  
Name -  
§ 172.301



4G/Y50/S/19/  
USA/0000

Sample UN Specification Package Marking

For UN Specification packaging, always  
follow the packaging manufacturer's  
packaging and closure instructions





# Batteries Packed-with/Contained-in Equipment



U.S. Department of Transportation  
Pipeline and Hazardous Materials  
Safety Administration

To Protect People and the Environment From the Risks of  
Hazardous Materials Transportation



# Packaging (Packed-with)

- Cells and batteries placed in non-metallic inner packagings that completely enclose the cell or battery and separate them from contact with equipment or electrically conductive materials
- A UN specification packaging meeting Packing Group II performance requirements must be used as either the outer packaging for any spare batteries or the outer packaging for both the batteries and the equipment



# Packaging (Contained-in)

- Outer packaging, when used, must be constructed of suitable material of adequate strength and design in relation to the capacity and intended use of the packaging, unless the lithium cells or batteries are afforded equivalent protection by the equipment in which they are contained



# Hazard Communication

- Class 9 Lithium Battery Label
- Cargo Aircraft Only Label, if shipped by air and lithium cells or batteries exceed 5 kg net weight
- UN ID Number – UN 3481 or UN 3091
- Proper Shipping Name Mark – “Lithium [ion/metal] batteries packed with equipment” or “Lithium [ion/metal] batteries contained in equipment”
- Consignor (shipper) or Consignee (recipient) name and address
- Special provision 181: package containing both lithium ion and lithium metal batteries must include hazard communication for both types
- When overpacked, the Class 9 Lithium Battery label, Cargo Aircraft Only label (as applicable), UN ID number, and Proper Shipping Name must be visible or replicated on the overpack



# Part III: End-of-Life & DDR Shipments



# Shipped for Disposal or Recycling

- By highway *only*
- Excepted from
  - UN 38.3 testing requirements,
  - UN specification packaging requirements (when in strong outer packaging).
- All other requirements of the HMR apply

[49 CFR § 173.185\(d\)](#)



# Identifying Damaged, Defective, Recalled (DDR)

- Batteries to Look For:

- Defective
- Leaked or vented
- Sustained physical or mechanical damage
- Cannot be diagnosed (i.e., cannot say for sure they are not damaged)

- Consider:

- Acute hazards (e.g., gas, fire, electrolyte leaking)
- Known misuse of the battery
- Signs of physical damage (swelling, corrosion, discoloration)
- Damage to safety features, components, or short circuit protection

Source: 21<sup>st</sup> Revised Edition of the UN Model Regulations 3.3.1, Special Provision 376

[49 CFR § 173.185\(d\)](#)



# Packaging DDR

Batteries must be **individually** packaged as follows:

- Non-metallic, inner packaging that completely encloses the battery
- Inner packaging surrounded by non-combustible, non-conductive, and absorbent cushioning material
- Single inner packaging must be placed in **performance-oriented packaging at the Packing Group I performance level.**
  - **MUST** follow the packaging manufacturer's instructions **EXACTLY**, including the use of any specific packaging components specified (e.g., cushioning, tape)





# DDR Hazard Communication

- Requires the same hazard communication as a fully-regulated lithium battery (e.g., marks, labels, shipping paper)
- “Damaged/defective lithium ion battery” and/or  
“Damaged/defective lithium metal battery” as appropriate



# Part V: Compliance Resources



U.S. Department of Transportation  
Pipeline and Hazardous Materials  
Safety Administration

To Protect People and the Environment From the Risks of  
Hazardous Materials Transportation



# Lithium Battery Guide for Shippers



## LITHIUM BATTERY GUIDE FOR SHIPPERS

A Compliance Tool for All Modes of Transportation

Revised October 2024



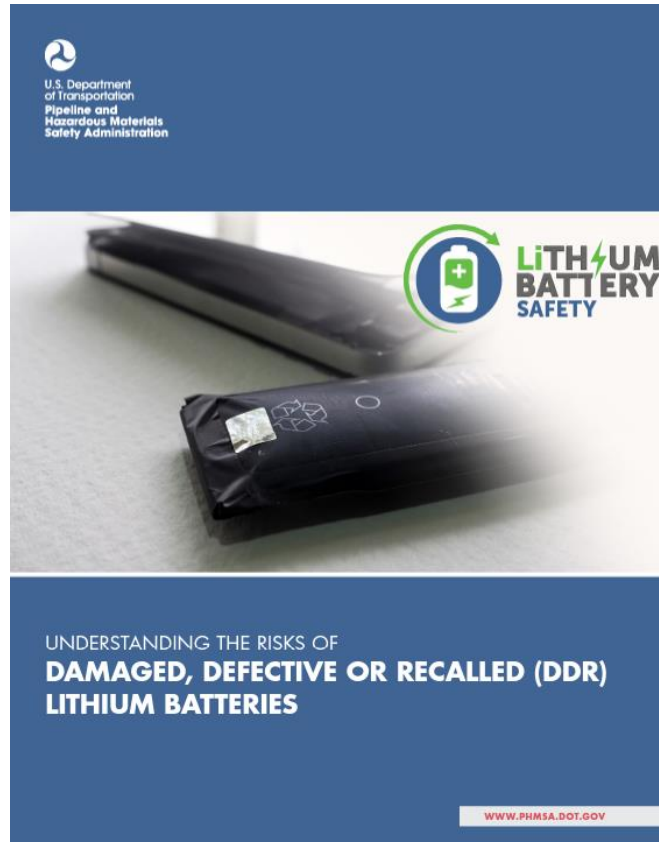
U.S. Department



<https://www.phmsa.dot.gov/training/hazmat/lithium-battery-guide-shippers>



# Lithium Battery Guide for Shippers



<https://www.phmsa.dot.gov/training/hazmat/understanding-risks-damaged-defective-or-recalled-ddr-lithium-batteries>



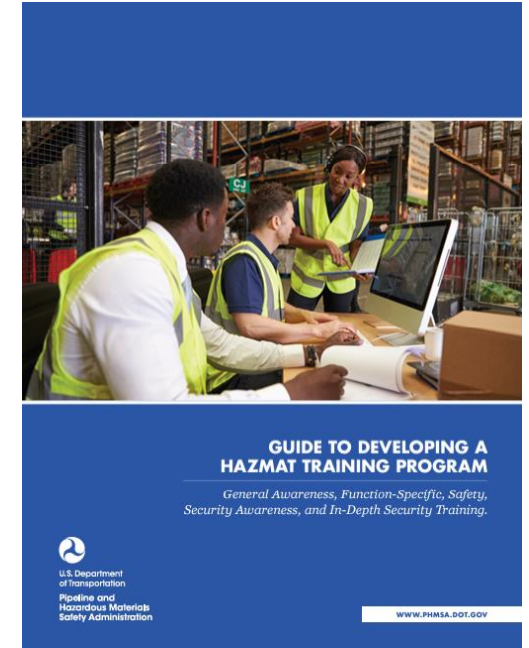
# Training Requirements



<https://www.phmsa.dot.gov/training/hazmat/hazmat-transportation-training-requirements>



<https://www.phmsa.dot.gov/training/hazmat/guide-developing-hazmat-training-program>



# Hazardous Matters Newsletter



*Introducing "Hazardous Matters"—the quarterly newsletter for PHMSA's Office of Hazardous Materials Safety. As always, it is packed with the latest news, expert tips, and essential insights for the safe handling and shipment of hazardous materials. Stay informed, stay safe!*



<https://www.phmsa.dot.gov/training/hazmat/phmsas-quarterly-hazmat-newsletter>



U.S. Department of Transportation  
Pipeline and Hazardous Materials  
Safety Administration

To Protect People and the Environment From the Risks of  
Hazardous Materials Transportation



# Contact Info

- Logan Blizzard, [logan.blizzard@dot.gov](mailto:logan.blizzard@dot.gov)
- Hazardous Materials Info Center  
1-800-HMR-4922 (1-800-467-4922)  
Email: [infocntr@dot.gov](mailto:infocntr@dot.gov)



# Packaging and Safety During Transportation

**Bob Richard**, Hazmat Safety Consulting



# Hazardous Materials Regulations

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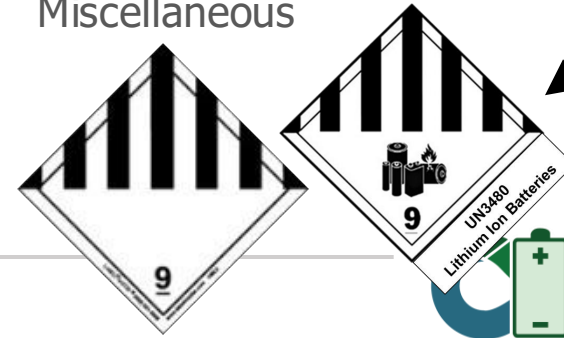
## Hazardous Materials Regulations (HMR)

- The HMR govern the packaging and safe transportation of hazardous materials by highway, air, rail, and water
- Covers:
  - Identification and Classification
  - Hazard Communication
  - Packaging Requirements
  - Operational Rules



# Hazardous Materials

Hazardous Materials: Articles or substances that pose a risk to health, safety, property, or the environment in transport

<p><b>Class 1</b> Explosives</p> 	<p><b>Class 2</b> Gases</p> 	<p><b>Class 3</b> Flammable Liquids</p> 	<p><b>Class 4</b> Flammable Solids</p> 	<p>Lithium Batteries</p> 
<p><b>Class 5</b> Oxidizers &amp; Organic Peroxides</p> 	<p><b>Class 6</b> Poisons &amp; Infectious</p> 	<p><b>Class 7</b> Radioactive Material</p> 	<p><b>Class 8</b> Corrosive</p> 	<p><b>Class 9</b> Miscellaneous</p> 

# Training Provisions

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Hazmat training is required for staff involved in:

- Packaging & loading hazardous materials;
- Applying hazard marks and labels;
- Completing shipping paperwork; and
- Transporting hazardous materials.

Certification valid for 3 years (2 years int'l), then recurrent training is required.

Training records must be maintained on-site.



# How To Ship HazMat

Classification

Selecting  
Packaging

Hazard  
Communication

Documentation

**ONLY SHIP LITHIUM BATTERIES FOR RECYCLING VIA  
GROUND or OCEAN TRANSPORT**



# Common Violations



Folded Over the Edge or Battery Mark Covered



Failure to Maintain Training Records



*Mandatory Report to DOT*



Discovery of Undeclared Shipment



# Common Battery Recycling Violations

Common violations and safety problems noted during PHMSA investigations include:

- Large numbers of used batteries, of many different types, are collected in large containers that do not adequately prevent damage to the batteries or prevent their release during transportation.
- Outer packages are not marked and labeled as required to indicate that they contain batteries; the shipments are not described as required on accompanying shipping documents.





# Customer education is key

## Inbound Packaging & Sort Process

The inbound volume of used electronics and batteries received by recyclers is enormous. The inbound batteries, packaged by consumers and retail employees, are typically in large fiberboard gaylords or metal/plastic drums.

These rarely comply with the packaging, marking, labeling and documentation regulations of the US DOT's Hazardous Materials Regulations (49 CFR Parts 100-180).

It is important to keep in mind that, per federal and international regulations, it is the shipper's responsibility to comply with applicable rules.

It is critical to educate customers to ensure compliance!



# PHMSA Battery Recycling Advisory Letter

## [Informational Bulletin for Persons \(somerset.nj.us\)](http://somerset.nj.us)

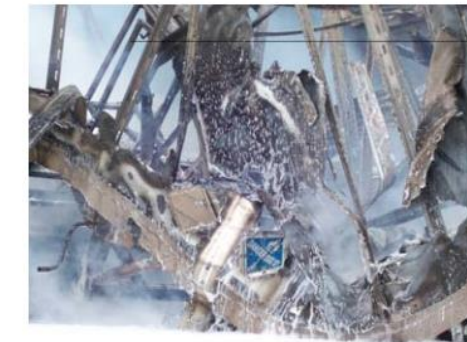
Includes several examples of packaging methods that meet the requirement to be packed in a manner that prevents short circuits.



(November 2006 truck fire in Galesburg, IL)

DOT encourages and supports the safe recycling and disposal of used batteries. However, we take an aggressive approach to swiftly investigate and enforce the safety requirements in the HMR for complaints and transportation incidents such as the parcel carrier delivery truck battery incident in November 2006.

PHMSA has also investigated two additional parcel carrier delivery truck fires. These incidents occurred in April and of July 2008. Both of these incidents involved batteries destined for recycling.





# Energy Content Thresholds

## Lithium Metal Batteries (measured in grams of lithium content)

Regulatory Category	Vessel	US Ground	Canadian Ground
<i>Large Format</i>	> 2.0 g	> 2.0 g	> 2.0 g
<i>Medium</i>	N/A	> 2.0 & ≤ 25 g	N/A
<i>Small</i>	≤ 2.0 g	≤ 2.0 g	≤ 2.0 g

## Lithium Ion Batteries (measured in Watt-hour rating)

Regulatory Category	Vessel	US Ground	Canadian Ground
<i>Large Format</i>	> 100 Wh	> 300 Wh	> 100 Wh
<i>Medium</i>	N/A	101 – 300 Wh	N/A
<i>Small</i>	≤ 100 Wh	≤ 100 Wh	≤ 100 Wh



# Mid Format Li Batts via Ground & Ocean

## Lithium ion batteries outer package examples

Standalone	Packed with Equipment	Contained in Equipment
 <p>The package is a brown cardboard box. On the left side, there is a shipping label with fields for 'From', 'Address', 'TO', 'Address', a barcode, and 'GND Prepaid'. Below the label is a red-bordered box with the text: 'LITHIUM BATTERIES - FORBIDDEN FOR TRANSPORT ABOARD AIRCRAFT AND VESSEL'. On the right side, there is a large orange and black 'CARGO AIRCRAFT ONLY' label with an illustration of a cargo plane and the text 'FORBIDDEN IN PASSENGER AIRCRAFT'. Below this is a white label with a red border, showing an illustration of lithium batteries and the text 'UN3480' and 'For additional information call: 1-555-555-5555'.</p>	 <p>The package is a brown cardboard box. On the left side, there is a shipping label with fields for 'From', 'Address', 'TO', 'Address', a barcode, and 'GND Prepaid'. On the right side, there is a white label with a red border, showing an illustration of lithium batteries and the text 'UN3481' and 'For additional information call: 1-555-555-5555'.</p>	 <p>The package is a brown cardboard box. On the left side, there is a shipping label with fields for 'From', 'Address', 'TO', 'Address', a barcode, and 'GND Prepaid'. On the right side, there is a white label with a red border, showing an illustration of lithium batteries and the text 'UN3481' and 'For additional information call: 1-555-555-5555'.</p>
<p>Package weight limit: 66 lbs.</p>	<p>No weight limit</p>	<p>No weight limit</p>



# U.S. Ground Hazard Communication

“Medium” lithium batteries must follow the ground shipping requirements of “small” lithium ion batteries, with one additional mark



**LITHIUM BATTERIES -  
FORBIDDEN FOR TRANSPORT  
ABOARD AIRCRAFT AND VESSEL**

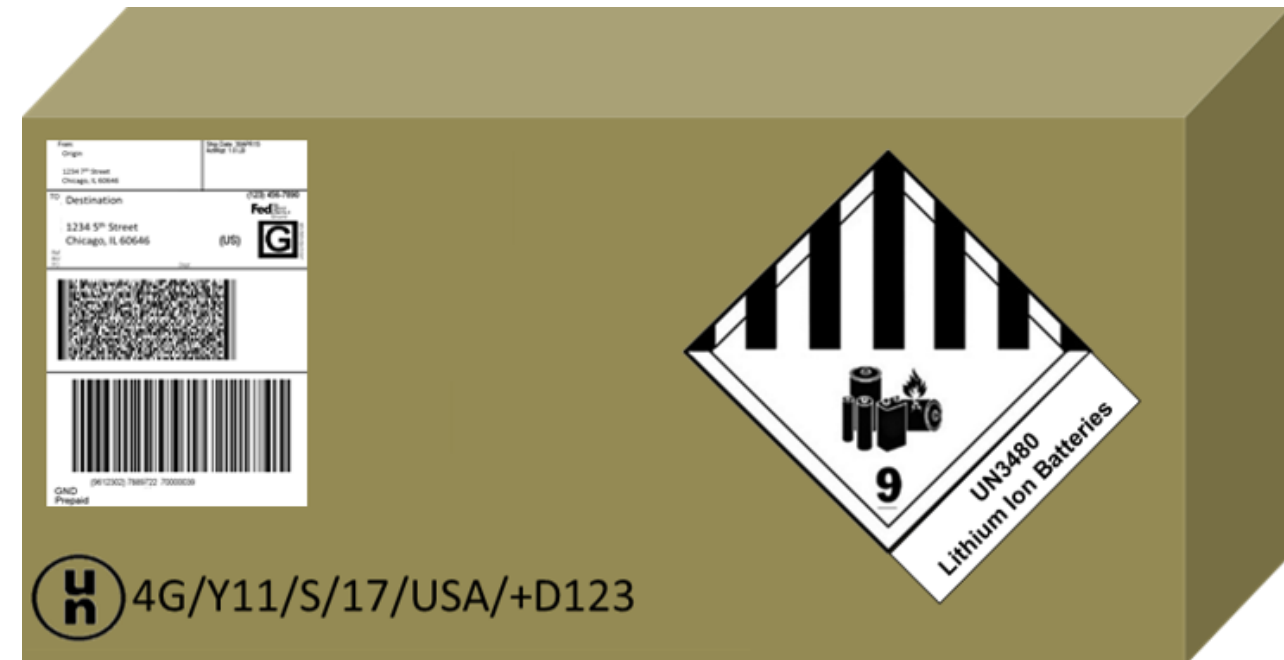


# Ground Shipping Large Batteries

Shipments will require:

- ✓ UN Performance Packaging (standalone & packed with)\*\*
- ✓ Proper shipping name and UN Number mark
- ✓ Class 9 hazard class label
- ✓ Shipping papers

**\*\* UN PERFORMANCE PACKAGING IS  
NOT REQUIRED IF SHIPPING  
LITHIUM CELLS & BATTERIES FOR  
RECYCLING/DISPOSAL.**



# What does §173.185(d) mean?

Protection against short circuit includes:

- Individual protection of battery terminals (tape);
- Inner packaging to prevent battery contact (plastic bags);
- Batteries with recessed terminals;
- Electrically non-conductive and non-combustible cushioning to fill empty space and prevent contact (e.g. vermiculite or CellBlock FCS)



# Using a Gaylord Box

A Gaylord box is a great item to use for shipping, storage, and moving lithium batteries shipped for recycling.

To meet the requirement for 49 CFR § 173.185(b)(3)(i) the gaylord needs a plastic liner or the batteries must be individually placed in inner packaging.

Batteries must be packed to prevent movement and to fill empty space and prevent contact



- ✓ Class 9 Lithium Battery Hazard Label
- ✓ UN Number: UN3480
- ✓ Proper Shipping Name: LITHIUM ION BATTERIES
- ✓ Cargo Aircraft Only Label



# Large batteries > 12 kg

A large lithium-ion battery weighing 12 kg or more with a strong impact resistant outer casing can be transported on a pallet or handling device in accordance with § 173.185(b)(5) without being placed into a strong outer packaging when it is moved for recycling or disposal.



# Hazard Communication

Packages containing large format lithium ion batteries must display (standalone battery example):

1. Proper Shipping Name

Lithium Ion Batteries

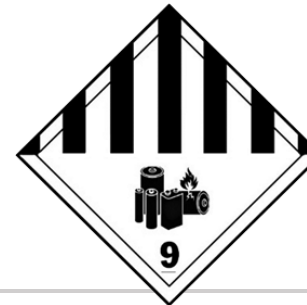


2. UN ID Number

UN 3480



3. Class 9 Label





# Documentation

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Shipments of hazmat must be accompanied by a *shipping paper* that contains:

1. Basic description of hazardous material;
  - UN Number, Proper Shipping Name, Hazard Class, PG
2. Number and type of packages;
3. Total quantity (weight) of hazmat shipped;
4. Emergency response phone number
5. Emergency response information; and
6. Shipper's certification.

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***Note: Must maintain a copy of each shipping paper at least two (2) years***



# Shipping Papers

October 12, 2018

Page 1 of 1

<b>SHIP FROM</b>				<b>Bill of Lading Number:</b>			
Company A 123 Main Street Milwaukee, WI 53201							
<b>SHIP TO</b>				<b>Carrier Name:</b>			
Company B 1234 Fake St. Minneapolis, MN 55404				Trailer number: Serial number(s):			
<b>Special Instructions:</b>							
EMERGENCY CONTACT PHONE NUMBER: +1 (414) 555-1231							
<b>CARRIER INFORMATION</b>							
<b>Package</b>						<b>LTL Only</b>	
Qty	Type	Weight	HM (X)	Commodity Description		NMFC No.	Class
1	Fiberboard Box (4G)	15 lbs.	X	UN3480, Lithium ion batteries, 9			
				ERG Page 147			
<b>Shipper Signature/Date</b>				<b>Carrier Signature/Pickup Date</b>			
John Smith							
This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation				Carrier acknowledges receipt of packages and required placards. Carrier certifies emergency response information was made available and/or carrier has the DOT emergency response guidebook or equivalent documentation in the vehicle. Property described above is received in good order, except as noted.			

Total Quantity of HazMat

Number & Type of Packages

Shipper's Certification

Emergency Response Phone

Basic Description

Emergency Response Info



# Emergency Response Information

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When a shipping paper is required (large-format battery shipments), the shipping paper must include a 24-hour emergency response telephone number.

This number must be monitored at all times the package is in transport by someone knowledgeable about the materials being shipped and the emergency response actions should an incident occur.



# Questions and Contact

Thank you

Bob Richard

[Brichard@hazmatsafety.com](mailto:Brichard@hazmatsafety.com)

+1 773-540-0837



# **Recycling and End-of-Life Management**

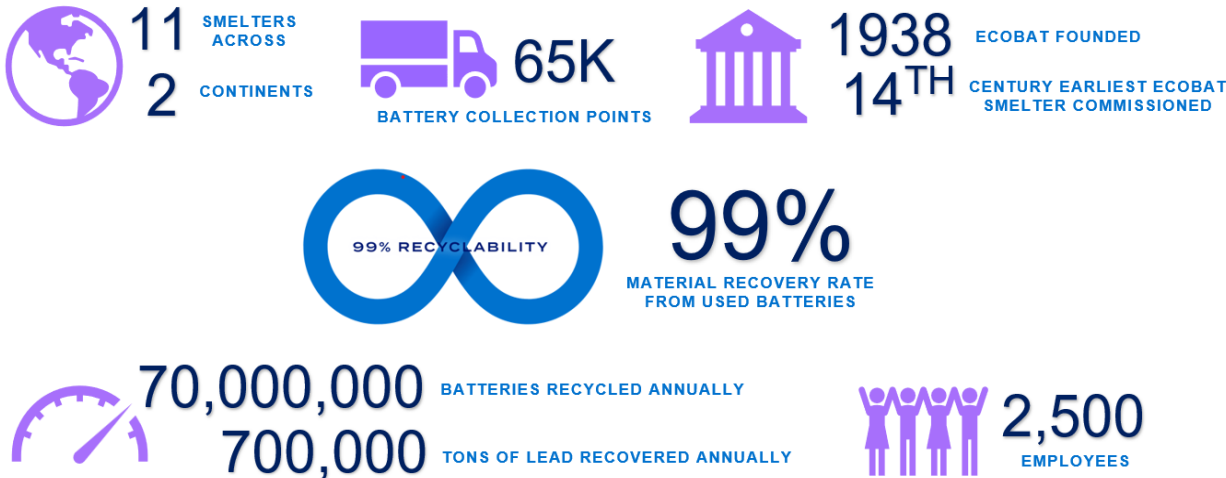
**Mark Hoffman**, Ecobat

# Mid-Format Batteries: Understanding Current Challenges to Promote Safe End of Life Management

November 2024

# About Ecobat

- Ecobat is the world's biggest battery recycler, operating on three continents with over 2,500 employees.
- We meet essential energy storage needs by making the business of batteries safer and more sustainable for a circular energy economy



# Lead Batteries are the #1 Recycled Product in the U.S.



### A Model of Sustainability and Circularity

Lead batteries are the most environmentally sustainable battery technology.

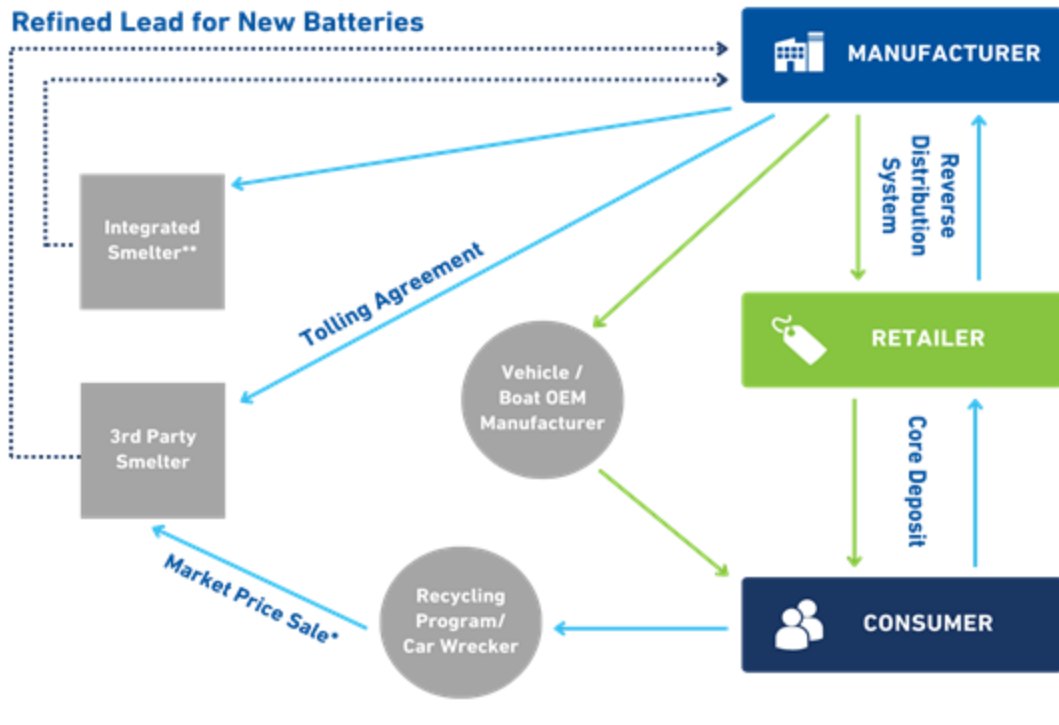
- 100% Recyclable Components**  
A lead battery's three main components are infinitely recyclable.
- +160M Recycled Annually**  
The number of lead batteries kept from landfills in the U.S.
- #1** Lead batteries are the most recycled consumer product in the U.S.
- 99% of lead batteries are safely recycled**  
in an established, coast-to-coast network of advanced recycling facilities, far surpassing any other battery chemistry including lithium-ion (<15% recycled).

[\\*U.S. Lead Battery Industry by the Numbers | Battery Council International](#)



# Lead Acid Battery Recycling: Proven System

## Simplified SLI Lead Battery Recycling Chain



Used Battery Deliveries → New Battery Deliveries →

\*Battery manufacturers and integrated smelters also may purchase Used Batteries at market prices.

\*\*No tolling agreement if the smelter is owned by the battery manufacturer.

## Established, Reliable Battery Recycling Process

- Aggregates approximately **6.4 billion pounds** of end-of-life lead batteries annually across the U.S., including 3.8 billion pounds of lead
- Serves **over 300,000+** retail collection locations nationwide
- Collects more than **160 million** medium and large-format batteries each year

Courtesy Battery Council International



# Labeling

Criticality across the lifecycle

# Lithium Battery Identification



Lithium Battery Identification made easy



# Lithium Battery Identification Complexity



**Battery  
identification  
can prove  
difficult upon  
receipt**



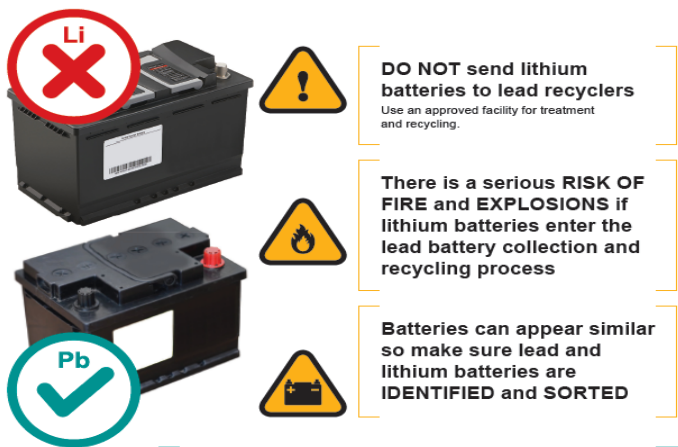
# Challenges of mixed streams

Identifying and Addressing Safety and Environmental Concerns

# Lithium Batteries – Communication of Safety Risks

## Important Safety Notice

Warning to all battery collectors, handlers and sorters



**DO NOT** send lithium batteries to lead recyclers  
Use an approved facility for treatment and recycling.

There is a serious **RISK OF FIRE and EXPLOSIONS** if lithium batteries enter the lead battery collection and recycling process

Batteries can appear similar so make sure lead and lithium batteries are **IDENTIFIED and SORTED**

**Tips to identify battery types**  
**Read the label** - Look out for the **Pb** symbol on lead batteries or the **Li** symbol on lithium batteries. You may also be able to identify them by their manufacturer.  
**Notice the weight difference** - Although they have similar dimensions lithium are much lighter than lead batteries.

Published by International Lead Association, Bravington House, Bravington Walk, London N1 9AF. For more information contact [eng@ila-lead.org](mailto:eng@ila-lead.org)

[www.ila-lead.org](http://www.ila-lead.org)

**ila** International Lead Association  
**Battery Council**  
**association of battery RECYCLERS**

- As a lead acid battery reclamation facility, Ecobat has seen the hazards lithium batteries pose firsthand.
- To ensure safety and compliance, Ecobat provides detailed battery packing specifications to suppliers, which include guidelines on safe packaging practices and criteria for identifying materials that should be rejected.
- Ecobat provides educational material on lithium batteries hazards, including:
  - Risk of Explosion
  - Risk of Fire
  - Various battery types can appear similar so make sure proper identification and sorting



# Identification and Intervention: Non-conforming batteries

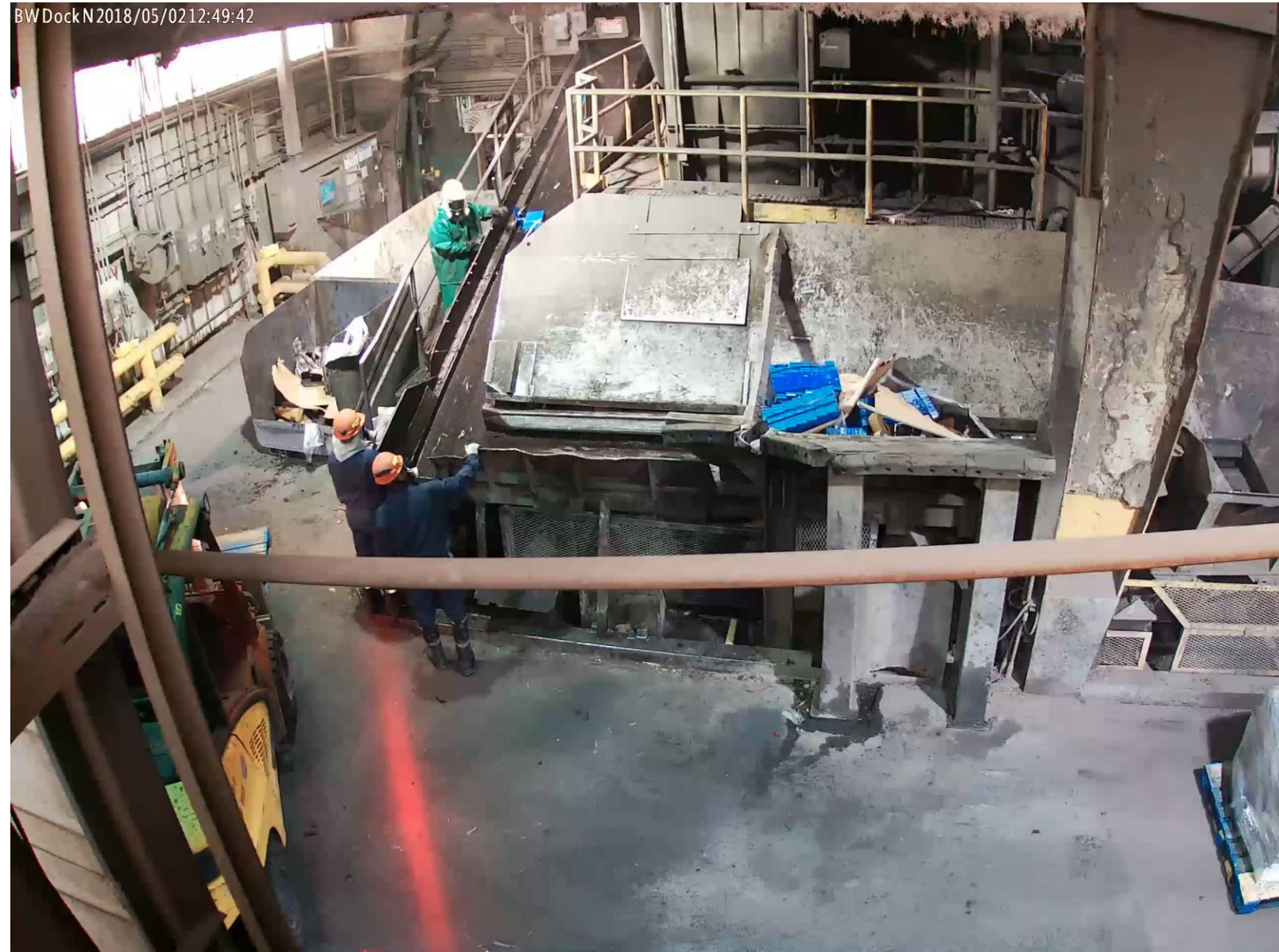
- Personnel are trained to identify lithium and other non-conforming batteries:
  - Identification aids, such as photographic signage, are prominently displayed along the conveyor to assist in the detection process
- Battery Wrecker personnel are required to halt the feed belt whenever there is any uncertainty regarding the conformity of the incoming material
- This process relies on the vigilance and judgment of the employees to ensure safety and proper handling



# Lithium Incidents

May 2018 - NY Facility

Lithium Battery Enters Wrecker





# Lithium Incidents

June 2018 –  
California Facility

Lithium Battery  
Enters Wrecker



# Non-conforming isolation and storage

## Lithium Packaging and Storage

### ENSURING SAFETY: PACKAGING IS CRITICAL

- Battery terminals of each individual lithium battery to be securely isolated using insulation putty and/or insulation tape
- Inspect the batteries for markings to determine if the chemistry is lithium metal or lithium ion
- Once terminals are isolated, individually stretch wrap each battery and store in the designated outdoor flammable cabinet

### ENSURING SAFETY: ADVANCED FIRE DETECTION, MONITORING & ALARM

- Fire Resistant Sheds with fire alarm systems
- Class D fire extinguishers located around storage area
- Proper spacing from buildings and structures



Lithium battery ignited on inbound load (2018)



Mixed with steelcase batteries in containment building - battery self ignited (2020)

# Ecobat Lithium Site Best Practices: Storage & Monitoring

Thermal Monitoring



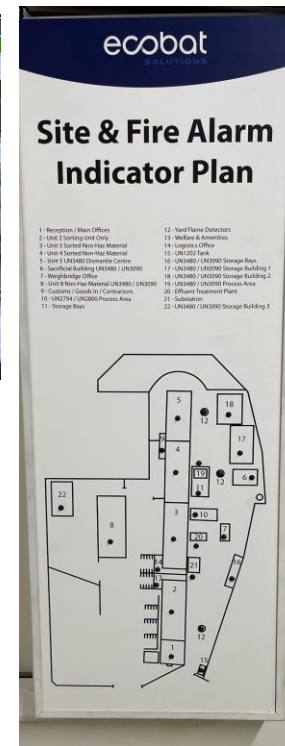
Thermal Rated Storage



CCTV Monitoring



Alarm Systems



## Storage Risk Mitigation

- On-site and off-site monitoring of batteries and materials
- Thermal Detection Systems & Monitoring
  - Redundant manual temperature readings taken during operations
- Thermal Barriers and thermal containers with fire suppression
- Proper spacing utilized
- Trained fire marshals on staff
- Multiple methods of fire extinguishing being used
- Audits to ensure controls are in place and working
- Training of local fire departments

Thermal Barriers



Proper spacing



# Established Process

## ESTABLISHED, RELIABLE BATTERY RECYCLING PROCESS

Collects more than 160 million medium and large-format batteries each year

Lead battery recycling chain is proven and should not be modified

Consideration should be given to replicating for lithium recycling chain

- Require battery manufacturers, distributors and retailers to accept used batteries upon new purchase
- Consumer Education
- Incentives
- Disposal prohibitions

# Summary Mixed Streams

## LABELING IS THE MOST CRITICAL

Safety hazards when combining different chemistries

Education to the collection facilities and recyclers

- Battery packing specifications
- Guidelines on safe packaging practices
- Incentivizing proper sorting

Labeling! Labeling! Labeling!

# Storage Risk Mitigation (Li)

## ADVANCED FIRE DETECTION, MONITORING & ALARM

On-site and off-site monitoring of batteries and materials

Thermal Detection Systems & Monitoring

- Redundant manual temperature readings taken during operations

Thermal Barriers and thermal containers with fire suppression

Proper spacing utilized

Multiple methods of fire extinguishing being used

Audits to ensure controls are in place and working

Training of local fire departments

esoboot

# **UL 3601 - Measuring and Reporting the Circularity of Li-ion and Other Secondary Batteries**

**Caitlin D'Onofrio**, UL Standards and Engagements



# UL 3601 - Measuring and Reporting the Circularity of Li-ion and Other Secondary Batteries

Standard Overview and Update

Caitlin D'Onofrio  
Senior Standards Program Manager, Sustainability  
UL Standards & Engagement





## Standards & Engagement

Over **1,700** standards and documents published

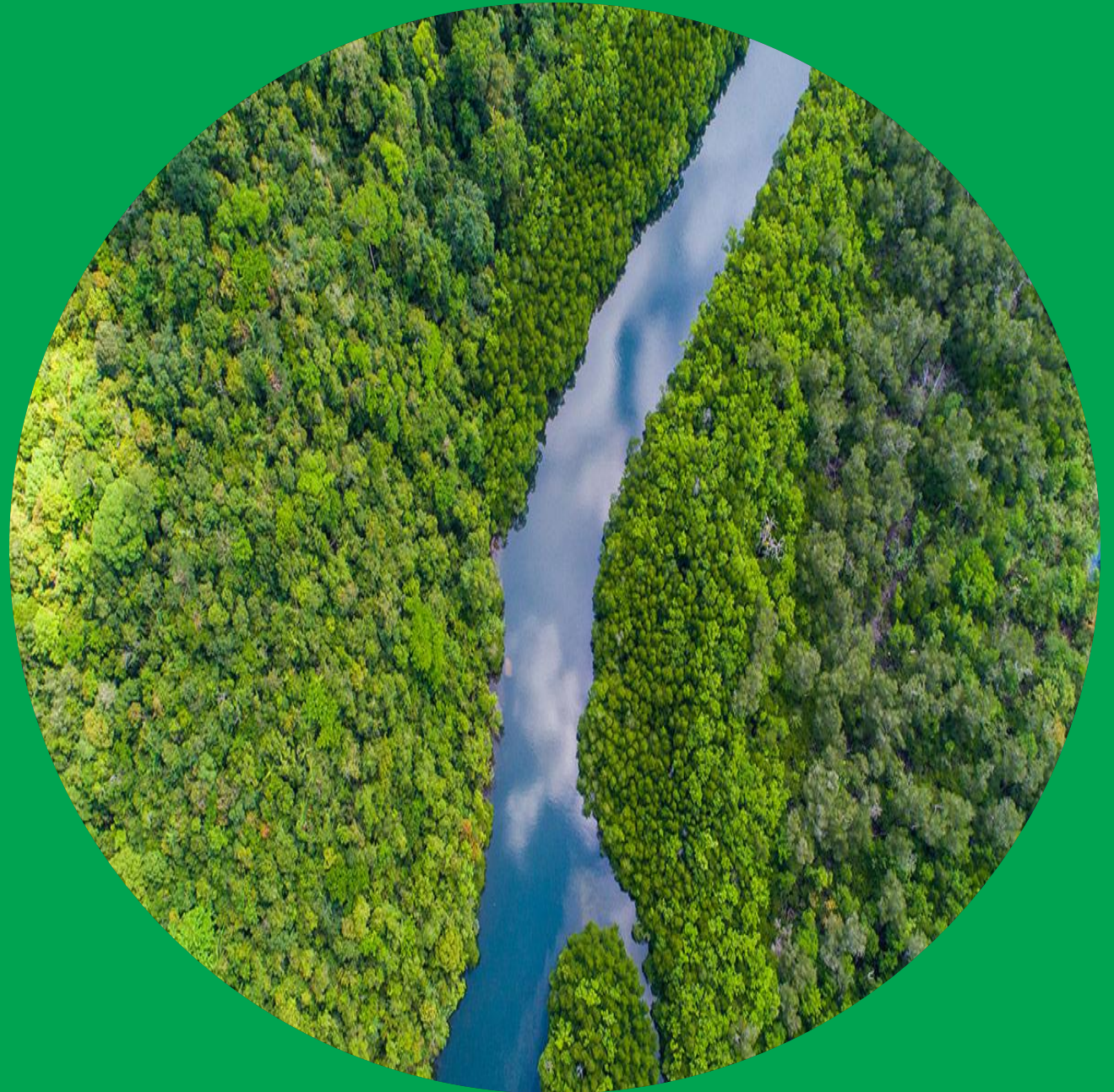
**400** technical committees with over **4,000** technical members

**100+** dedicated staff located in 8 countries





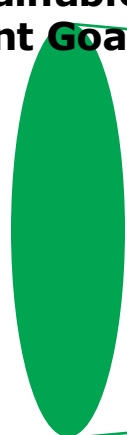
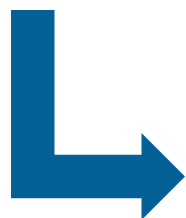
# Sustainability Program



# Our approach to prioritizing sustainability areas begins with the 17 SDGs and narrows to a list of 8 priority Sustainability Program standards

## Overview of our approach to identifying focus areas

17 UN Sustainable Development Goals (SDGs)



8 in-scope SDGs with 70 potential areas<sup>1</sup>

29 core sustainability areas

10 highest-priority areas

44 standards-level topics

8 priority Sustainability standards

**A Omit out-of-scope SDGs** which do not pertain to environmental sustainability

**B Filter sustainability areas** based on relevance to standards and sustainability

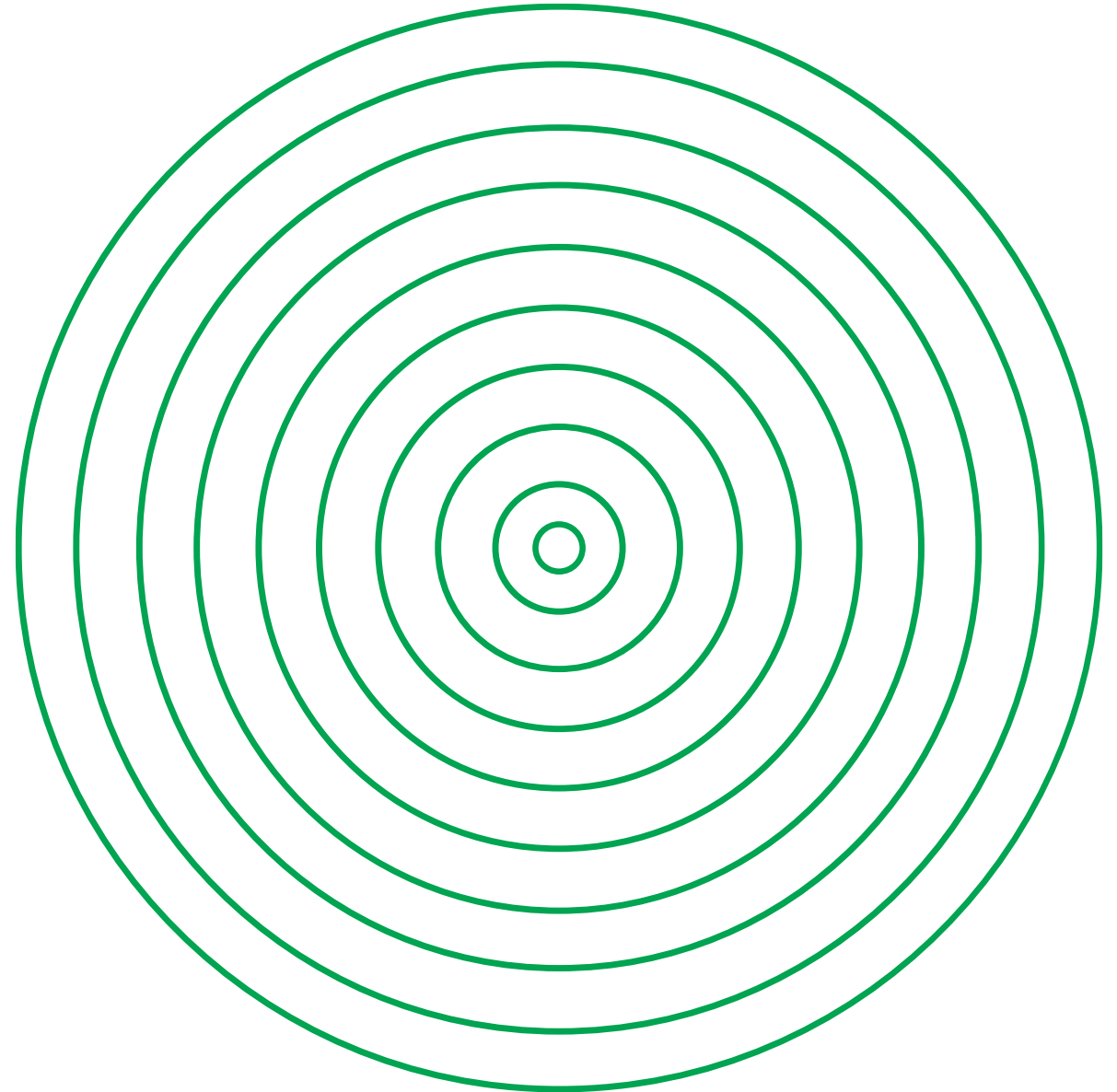
**C Prioritize potential areas** according to 6 assessment criteria

**D Propose specific standards-level topics** within high-priority areas, differentiating between **topics for ULSE Sustainability team and other programs**

**Prioritize vertical and horizontal Sustainability standards for implementation**

1. Areas derived from "Targets" defined by UN within each SDG

# UL 3601 Overview



# UL 3601: Standard for Measuring and Reporting Circularity of Li-ion and Other Secondary Batteries

Developing a standard for battery circularity is essential to reduce environmental impact by promoting the reuse and recycling of valuable materials, thus conserving resources and minimizing waste.

## Market drivers



**Rising demand:** Global demand for lithium-ion batteries is expected to grow by over 500%, with the number of GWh required increasing from ~700GWh in 2022 to ~4.7TWh by 2030.<sup>1</sup>



**Environmental pressure:** By 2030, it's projected that waste batteries will hit 1.2 million tons.<sup>2</sup> Circular strategies could reduce environmental impact and enable the use of recycled materials in new batteries.



## UL 3601 value



**Technical guidance:** The standard will help companies better understand best in-class practices to implement circularity in battery design, production and management.



**Market recognition:** Certification and alignment with the standard will help build trust in the market for the adoption of more sustainable and circular batteries.

### Sources:

1. [Global Li-ion battery demand 2022-2030 | Statista;](#)
2. [Lithium batteries – 1.2m tons ready for recycling by 2030 – pv magazine International \(pv-magazine.com\)](#)

# UL 3601: Standard for Measuring and Reporting Circularity of Li-ion and Other Secondary Batteries

ULSE has developed the **Standard for Measuring and Reporting Circularity of Li-ion and Other Secondary Batteries** seed document to help improve the circularity of lithium ion and other non-acid chemistries

## Intended uses for the batteries covered in this standard include:

- a. Electric vehicle (EV) batteries;
- b. Industrial batteries; such as those used for solar energy storage;
- c. Batteries for light means of transport; such as e-bikes, electric scooters, and golf carts;
- d. Electric outdoor power tools; such as lawn mowers and leaf blowers; and
- e. Emergency power backups.

## This standard does not cover:

- a. Primary (non-rechargeable) batteries;
- b. Small portable batteries used in applications including such as cell phones, flashlights, cameras, e-cigarettes, and laptops;
- c. Lead-acid type batteries.

## This standard does not cover:

- a. Electrical safety; and,
- b. Mechanical safety.



# Compliance, Evaluation and Assessment Criteria

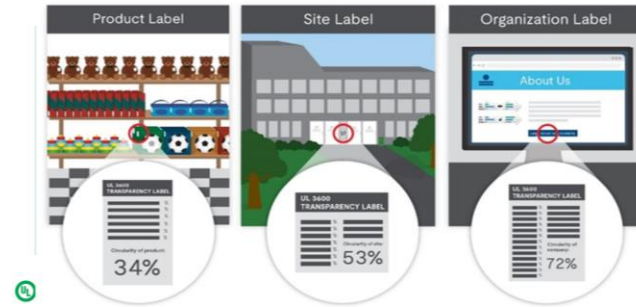
UL 3601 will apply a hybrid approach that combines levels of achievement matrix, with circularity calculations that create a product circularity label as part of the requirements.

## Levels of achievement

Level of Achievement	Points Needed
Bronze	Required
Silver	Required criteria + 50% of available optional points
Gold	Required criteria + 75% of available optional points

The standard applies a levels of achievement approach for pass/fail criteria to score efforts to implement circular practices, similar to UL 110. The manufacturer is ranked on minimum performance and any additional steps to fulfill standards requirements .

## Nutritional label



In addition to levels of achievement, the product circularity (Cprod) of the battery shall be calculated and reported. While there is no minimum or maximum product circularity percentage to be considered in compliance with the standard, reporting the product circularity is required to conform to the standard. Circularity guidance borrows from product circularity guidance in UL 3600, minus bio-based circularity

# Compliance, Evaluation and assessment criteria

To develop the achievement matrix, various standards were used as a reference point. A significant scoring weight was placed on Materials to emphasize their critical role in the battery circularity journey. All sections contain both required and optional criteria except for corporate practices (only optional).

Section	Maximum points
Design	15
Materials	38
Manufacturing and operations	13
Packaging	14
Marking	-
Battery use	21
Extension of useful life	-
End of life management	10
Corporate practices	10
<b>Total points</b>	<b>121</b>

# Topics addressed under UL 3601

The standard is targeted towards battery manufacturers and is designed to encompass all the stages of the battery's life-cycle. The following sections were developed as part of the report:

Section	Description
<b>Introduction</b>	Information pertaining to the entire standard and its intended application and interpretation
<b>Compliance, Evaluation and Assessment Criteria</b>	Information on the methods used determine environmental performance
<b>Design</b>	Design strategies to support battery circularity
<b>Materials</b>	Enabling sustainable material selection and use for circular lithium-ion batteries and related material compliance obligations
<b>Manufacturing and operations</b>	Supporting users to implement manufacturing and operations practices supporting the circularity of batteries
<b>Packaging</b>	Supporting the adoption of sustainable packaging adapted to batteries health and safety specifications and requirements
<b>Marking</b>	Marking on the batteries for first and second life applications
<b>Battery use</b>	Outlining energy use requirements and battery charging efficiency to support extension of battery useful life
<b>Extension of useful life</b>	Supporting refurbishment and remanufacturing of batteries to extend the useful life of batteries
<b>End of life management</b>	Supporting effective end of life management including design for recycling, reparability, and end of life management
<b>Corporate practices</b>	Describing effective corporate practices to measure the impact of circular transition and external communication requirements





# ANSI/UL 36

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- Preliminary Review Closed Oct 21, 2024
  - Review Preliminary Review Comments
  - Open Ballot/Public Review end of Q4 2024
  - Resolve any Ballot Comments received Q1 2025
  - Target Publication Q2 2025
- 



# The ULSE Sustainability Program Team



**Caitlin D'Onofrio**  
**Senior Standards  
Program Manager,  
Sustainability**  
**Co-TC Chair**

[Caitlin.Donofrio@ul.org](mailto:Caitlin.Donofrio@ul.org)

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**Heather Sakellariou**  
**Sustainability Technical  
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**Leslie Malaki**  
**Sustainability Senior  
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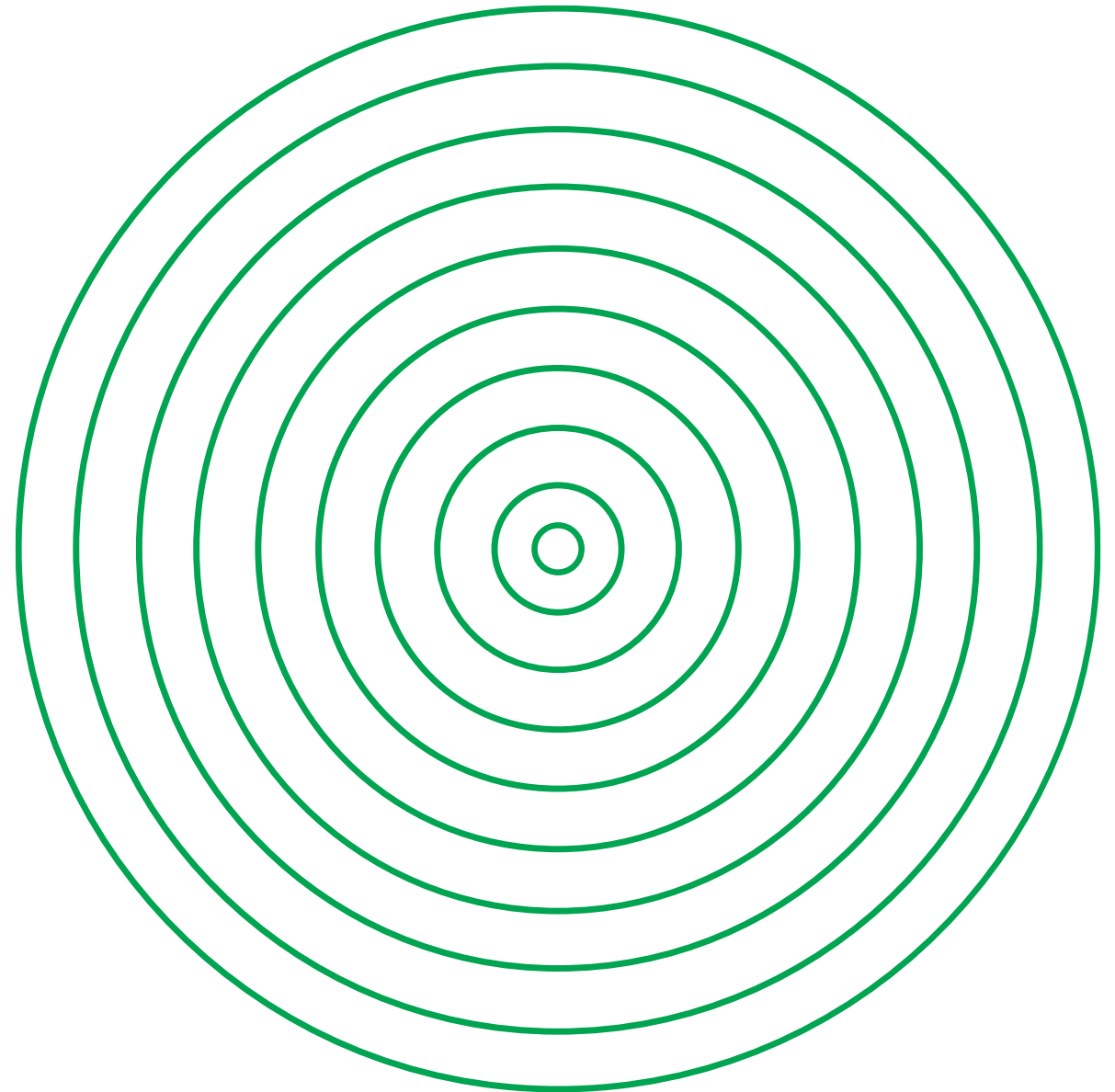
Thank you

[ULSE.org](https://ul.org)



**Standards &  
Engagement**

# Appendix: Compliance and evaluation



# Design

## Requirements:

- **Design Strategies:** During the design phase, the manufacturer shall apply one or more of the design strategies to promote circularity of the battery identified in the optional requirements.
- **Life-cycle assessment:** The manufacturer shall perform a Life Cycle Assessment (LCA) on the battery in accordance with ISO 14040 and ISO 14044.

Criteria	Title of section
<b>Design</b>	
<b>Required</b>	Design strategies
Optional	Form factor and interoperability
Optional	Battery design
Optional	Battery disassembly
<b>Life cycle assessment (LCA)</b>	
<b>Required</b>	Life-cycle assessment
Optional	Availability

## Rationale and justification

- The section contains the most relevant circular design strategies manufacturers can apply and the relevant requirements as per the feedback received from the stakeholders. The different design strategies refer to respective UL standards where applicable.
- The life-cycle assessment requirement was developed using the LCA requirements from UL 110



# Materials

## Requirements:

- **Percent byproduct synergy:** The manufacturer shall calculate the percent of materials sourced from byproduct or waste of the production process using the calculation approach as described in Annex C.
- **Percent recycled content:** The manufacturer shall calculate the percent of materials used in the battery that are sourced from recycled content using the calculation approach as described in Annex C.
- **Sourcing of critical raw materials and conflict minerals:** The manufacturer shall publicly disclose if the supply chain for the materials used to manufacture the battery includes conflict minerals that are essential for the battery's functionality or production.

Criteria	Title of section
<b>Materials</b>	
Optional	Minimum recycled content
<b>Required</b>	Percent byproduct synergy
<b>Required</b>	Percent recycled content
Optional	Substances of concern
Optional	Substitution assessment
<b>Supply chain management of materials</b>	
<b>Required</b>	Sourcing of critical raw materials and conflict minerals
Optional	Supplier responsibility
Optional	Material management and traceability

## Rationale and justification

- The minimum percentage of recycled contents provided were defined as per *Recycled content in industrial batteries, electric vehicle batteries, LMT batteries and SLI batteries*, of EU 2023/1542.
- The optional criterial in the Materials sub-section are focused on the different calculations required for the nutritional label disclosed in Annex C as well as materials restrictions and substitution assessment.
- Supply chain due diligence requirements from Regulation 2023/1542 were referenced for the sourcing of critical raw materials and conflict minerals.



# Manufacturing and operations

## Requirements:

- **Environmental management system:** The manufacturer shall have an environmental management system in accordance with ISO 14001.
- **Occupational health and safety:** The manufacturer's occupational health and safety systems shall be in accordance with ISO 45001.
- **Testing requirements:** The manufacturer shall apply testing requirements on the battery according to the applicable standards for the battery's end use application (UL/ULC 2271, UL/ULC 2580, UL 1973)
- **Environmental emission:** The manufacturer shall control emissions to air, water and soil in accordance with local rules and permit limits.
- **Repurposing system:** To the extent that manufacturers repurpose or remanufacture batteries, the manufacturer shall have a management system and production process in accordance with UL 1974.

Criteria	Title of section
<b>Environmental management systems</b>	
<b>Required</b>	Environmental management system
Optional	Final assembly facilities
Optional	Supplier facilities
<b>Production quality</b>	
Optional	Quality management systems
<b>Required</b>	Occupational health and safety
<b>Manufacturing and production line testing</b>	
<b>Required</b>	Testing requirements
Optional	Energy management
<b>Required</b>	Environmental emissions
<b>Required</b>	Repurposing system

## Rationale and justification

The requirements have been built to be applied globally. Alignment to standards was proposed instead of compliance as it may be challenging to obtain in certain regions.





# Packaging

## Requirements:

- **Transport:** The manufacturer shall ensure that all sustainable packaging solutions are designed to comply with 49 CFR 173.185 or applicable international battery transport guidance such as:
  - a) ST/SG/AC.10/1/Rev/22 (Vol.I), Recommendations on the Transport of Dangerous Goods Model Regulations, Volume I;
  - b) IMDG Code, International Maritime Dangerous Goods Code;
  - c) ICAO Doc 9284, International Civil Aviation Organization Technical Instructions for the Safe Transport of Dangerous Goods by Air;
  - d) IATA DGR, International Air Transport Association Dangerous Goods Regulations; or
  - e) Additional applicable guidance or legislation in countries of operation.

Criteria	Title of section
<b>Transport</b>	
<b>Required</b>	
<b>Material selection</b>	
Optional	Fiber-based materials
Optional	Plastic materials
Optional	Biobased and compostable materials
Optional	Reduction of substances of concern
<b>Packaging resource efficiency</b>	
Optional	Packaging optimization
Optional	Reusable packaging

## Rationale and justification

The requirements have been built to propose recommendations to improve the sustainability and circularity of battery packaging in alignment with existing standards (ISO 18602 and 18604 ) and industry best practices, while aligning to strict battery safety transport rules. For instance, UL 2710 was adopted for the optional recommendations for plastic materials and, UL 1497 ECVP and ASTM 6866 were adopted for the optional recommendations for biobased and compostable materials



# Marking

## Requirements:

- **Testing:** New batteries shall comply with marking requirements in UL 1642 or UL 62133-2; and
- Repurposed or remanufactured batteries shall comply with marking requirements in UL 1974.
  - The markings on the battery shall include:
    - Battery type;
    - Battery chemistry;
    - Recommended disposal methods; and
    - Recommended recycling methods.
- The markings on the battery shall be durable and resistant to environmental conditions to ensure legibility throughout the battery's life cycle.

Criteria	Title of section
Marking	
Required	Testing

## Rationale and justification

Marking requirements are aligned to existing standards to provide manufacturer and end of life treatment information, in addition to marking requirements for second-life batteries. Section does not allocate points as these are standard best practices manufacturers should implement in accordance with regulations and other standards



# Battery use

## Requirements:

- **Primary use:** The electronic product's battery charging includes the model of external power supply (EPS) or charger recommended publicly by the manufacturer for primary use with the battery, tested as a system for use with the electronic product and made publicly available to the purchaser, by the manufacturer.
  - If a manufacturer recommends multiple external power supplies or chargers publicly without designating one as "primary", the manufacturer shall designate one of the recommended external power supplies for "primary use".
- **External power supply energy:** The external power supply (EPS) for the battery shall meet the efficiency requirements of the U.S. Department of Energy (DOE) Efficiency Regulations for External Power Supplies for direct EPS in effect at the time the battery is determined to be in conformance to this standard

Required criteria	Title of section
<b>Battery charging system</b>	
Required	Primary use
Required	External power supply energy
Optional	Reduced maintenance mode
Optional	Performance
Optional	Cycle life
Optional	Thermal management
Optional	Battery management system

## Rationale and justification

Requirements are focused on the use of the batteries and mechanisms to promote extended battery lifetime during the use phase Energy use specifications in the standards are manipulated from UL 2710 "Sustainability for electronic products", section 8 ("Energy use requirements").



# Extension of useful life

## Requirements:

- **Repurposing and remanufacturing:** The manufacturer shall implement a battery repurposing and remanufacturing system in accordance with UL 1974. Upon implementation of a battery repurposing and remanufacturing system, the manufacturer shall obtain certification of the new product to the relevant standard based on applicability.
- **Reuse rate:** The manufacturer shall calculate the percent of battery that was reused using the calculation approach as described in Annex C
- **Refurbishment rate:** The manufacturer shall calculate the percent of battery that was refurbished using the calculation approach as described in Annex C

Criteria	Title of section
<b>Extension of useful life</b>	
<b>Required</b>	Repurposing and remanufacturing
<b>Required</b>	Reuse rate
<b>Required</b>	Refurbishment rate

## Rationale and justification

Requirement for battery manufacturers to be considered circular they must have repurposing and remanufacturing systems in place in alignment with 1974. The section also provides a calculation methodology in alignment with UL 3600 to calculate the reuse and refurbishment rate to be integrated into their circularity score.



# End of life management

## Requirements:

- **Take-back program:** Manufacturer shall provide a take-back program, hereinafter referred to as program, for batteries, either directly or through a contracted third-party.
  - The program shall aim to recover materials including, but not limited to, lithium, cobalt, and nickel.
  - The program shall be publicly disclosed to the user through the manufacturer's website.
  - The take-back program shall be structured in one of the followings: manufactured owned and operated, contracted third-party or membership in industry program for collection
  - Requirement to comply to existing laws and/or regulations for the collection and recycling of batteries for the collection and recycling of batteries
- **Third-Party Certification – Primary Recyclers:** Primary recyclers must be certified to an Environmental Management System in accordance with a standard ( ISO 14001/RIOS/EMAS/other) and be in conformance at least one certification.

Criteria	Title of section
<b>End of life management</b>	
<b>Required</b>	Take-back program
<b>Required</b>	Third-Party Certification – Primary Recyclers
<b>Required</b>	Recycling rate
<b>Required</b>	Disposal of recovered batteries and damaged and rejected parts
<b>Required</b>	Disposal rate
Optional	Closed-loop recycling programs
<b>Required</b>	Closed loop content



# End of life management (continued)

## Requirements:

- **Recycling rate:** The manufacturer shall calculate the percent of battery that was recycled using the calculation approach as described in Annex C.
- **Disposal of recovered batteries and damaged and rejected parts:** requirements applicable to batteries that cannot be recovered and/or recycled based on the activity completed by the handler (sorting, transport, disposal etc.)
- **Disposal rate:** The manufacturer shall calculate the percent of battery that was disposed of into landfill or waste to energy using the calculation approach as described in Annex C.
- **Closed loop content:** The manufacturer shall calculate the percent of battery that uses closed-loop content using the calculation approach as described in Annex C.

Criteria	Title of section
<b>End of life management</b>	
<b>Required</b>	Take-back program
<b>Required</b>	Third-Party Certification – Primary Recyclers
<b>Required</b>	Recycling rate
<b>Required</b>	Disposal of recovered batteries and damaged and rejected parts
<b>Required</b>	Disposal rate
Optional	Closed-loop recycling programs
<b>Required</b>	Closed loop content

## Rationale and justification

Blend requirements for having effective end of life treatment strategies and material stewardship, in addition to a list of metrics to be calculated to factor into their circularity score. There is an optional closed loop system requirement to improve the material circularity of batteries through manufacturer operated systems. However, this requirement is optional as not all market operators will have capacity to set one up and may work through contracted third-party recyclers.



# Corporate practices

## Optional

There are no requirement in this section. Optionality for battery sold by the manufacturer to be accompanied by an individual digital product passport.

- The battery shall be marked with a QR code in accordance with ISO/IEC 18004 that shall be printed or engraved on the battery.
- The digital product passport shall comply with the requirements of EU Regulation 2023/1542.

Criteria	Title of section
<b>Digital product passport</b>	
Optional	Digital Product Passport

### Rationale and justification

Digital product passports are an emerging tool to provide information through a battery's life-cycle. The decision to align with EU requirements stands, as these are at the moment the most advanced and will significantly influence the structure of battery passports across markets. Other industry initiatives such as Global Battery Alliance are working to align DPPs, and are doing so with EU requirements in mind



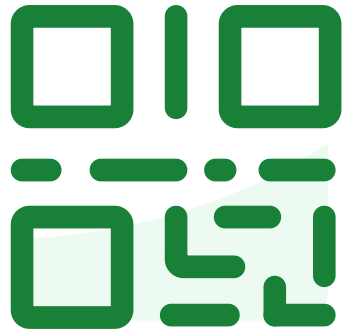
# Questions/Comments

Pat Tallarico, ERG Team



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# Wrap Up/Next Steps

**Ellen Meyer**, U.S. Environmental Protection Agency (EPA)

# Large Format Batteries Working Sessions

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## Upcoming Sessions

Large Format Batteries	Meeting Topic	Meeting Date
Labeling and Collection	Current Standards and Practices for Large Format Batteries	February 2025
Labeling and Collection	Unique Battery Management Challenges for Vehicles	March 2025
Labeling and Collection	Expanding End of Life Management for Large Format Stationary Batteries	April 2025
Labeling and Collection	Expanding End of Life Management for Large Format Vehicle Batteries	May 2025



# Contact Us:

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Email [batteries@epa.gov](mailto:batteries@epa.gov) if you have an interesting story to tell about battery collection

