essential energy everyday

Powered by Lead Batteries

INFORMATION BRIEF

The Circular Economy of Lead Batteries

As our need for energy storage in the renewable energy, automotive and digital technology sectors grows, so does our need for batteries — and a mix of battery technologies — to meet the demand. Long ignored, *environmental impact* must be equal to or greater than performance and cost criteria when evaluating battery options.

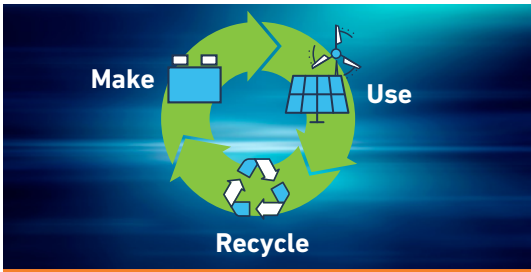
The goal: A battery industry that fosters a circular economic model that protects the environment and stays commercially competitive to meet future energy storage needs.

Introduction

Many batteries are designed, used and disposed of using a linear economic model, meaning a take-make-use-waste extractive industrial pattern. The opposite is a circular economic model. It promotes sustainable materials management throughout the life cycle of a battery, using a make-use-recycle-remanufacture (or closed-loop) pattern.

This circularity:

+ Promotes the sustainable management of our natural resources.
+ Moves us toward climate neutrality.
+ Protects national security.
+ Decouples growth from the use of natural resources.



Research shows that 62% of U.S. firms plan to move to a circular economy. The **lead battery industry leads the curve** by being in the 16% who already have.[1]

This Information Brief Will:

+ Explain the benefits of a circular economy, i.e., not just recycling, but also the remanufacturing of recycled components.
+ Show the circular business model of lead batteries and why it should serve as a blueprint for other battery chemistries and industries.

A Call to Action

We ask all stakeholders who evaluate, purchase, regulate and invest in energy storage technology to:

+ Consider the life cycle impact of battery chemistries. Compare their rates of recycling, reuse of materials and overall sustainable practices.
+ Recognize the urgency to reduce consumption of resources to mitigate depletion and climate change.
+ Support governmental investment to help lead batteries reach their full potential.

Ranking Sustainability: Lead Batteries Among Best

Top 5 Most Sustainable

Evaluating circularity requires translating the science of sustainability into quantifiable metrics and practical tools. The Sustainability Consortium (TSC), a global non-profit, puts **lead batteries among the top five consumer products in sustainability.**

> *"Lead batteries close the loop more effectively than any other product in the consumer goods space. We'd like to leverage the lessons of this industry to help others reach the same type of performance for their end-of-life products."*
>
> — Dr. Carole Mars, TSC Director of Technical Development & Innovation

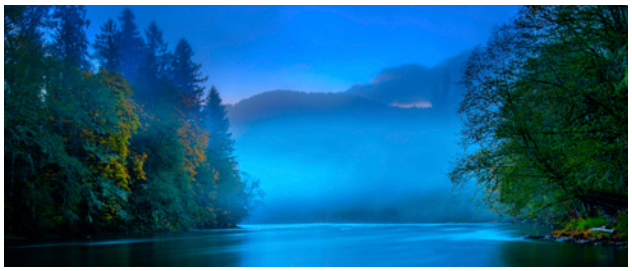
About the Report

TSC's mission is to help make consumer products worldwide more sustainable. Annually, TSC evaluates over 180 different product categories for sustainability key performance indicators (KPIs). The TSC 2017 Impact Report, titled "The Call for Collective Action Across Supply Chains," ranks lead batteries as one of only five consumer product categories to make the elite club scoring 64 and over (top score was 100).

THE SUSTAINABILITY CONSORTIUM™

Lead batteries scored high KPI's in product stewardship and recycled content, demonstrating an industry-wide commitment to closing the manufacturing loop. See SustainabilityConsortium.org.

Circular Economy Benefits



Conserves Resources, Creates New Value

In a circular economy, the value of products and materials is maintained for as long as possible; waste and resource use is minimized. When a battery has reached its end of life (EOL), its materials are kept within the economy, to be used again to create further value.

+ **99+%** The recycling rate of lead batteries in the U.S.
+ **80+%** A new lead battery is comprised of over 80% recycled material.[2]

Reduces Carbon Emissions

A more circular economy, such as the lead battery industry, can reduce CO_2 emissions, reduce the scale of the challenge of decarbonizing materials production, and contain the cost of achieving an industrial base compatible with a low-carbon economy.

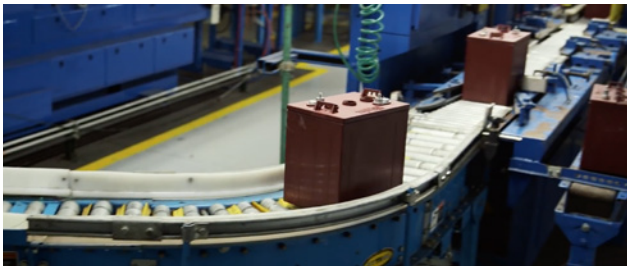
+ **56%** By 2050, a more circular economy can cut emissions from heavy industry by 56% in the European Union (EU) alone.[3]

Maintains National Security

Global competition for finite resources will intensify as world population and economies grow.[4]

Using recycled materials fosters energy independence and contributes to a more reliable secondary supply chain. This improves the security of power grids, Internet services, databanks, etc. as they confront challenges of an increasingly digital economy.

+ **70%** The approximate amount of lead that U.S. lead battery manufacturers source domestically from recycling facilities in the U.S.[5]



Boosts the Economy

Many batteries are not recycled (or recycled profitably) because the price of their recycled materials exceeds the price of their virgin materials. The exception is lead batteries.

+ **100 years** Lead batteries have been recycled for more than 100 years and model a profitable closed-loop system for other batteries — and industries.
+ **$4.5 trillion** The predicted amount of additional economic output generated by the circular economy by 2030.[6]

Lead Batteries: A Circular Economy Model

Following a lead battery's cradle-to-cradle (vs. cradle-to-grave) process demonstrates its circularity. In comparing sustainable practices across all life stages, no other battery chemistry equals lead batteries' closed-loop process and remanufacturing success.

Research and Innovation

The lead battery industry collaborates on significant research to reach a lead battery's full potential. Maximizing its performance and longevity can further reduce the use of natural resources and climate impact.

+ Lead battery life has increased by 30 to 35% in the last 20 years.
+ Major U.S. lead battery manufacturers and suppliers are working with Argonne National Laboratory on a fundamental research program to enhance battery performance efficiency.
+ Another collaboration includes evaluating renewable energy storage at Missouri University of Science and Technology.

NOTE: Additional lead battery research information is available at BatteryInnovation.org.

Design for Recycling and Efficiency

As lead battery manufacturers innovate and design new batteries, they collaborate with recyclers on designing batteries for recycling and resource efficiency. This helps streamline recycling key components (lead, plastic, acid) for reuse.

Sustainable Practices

The lead battery industry continually incorporates and adds to its deep sustainability practices to further lessen environmental impact.

> *"Advancing a circular strategy and a low-carbon value chain is required to unlock the capacity of batteries to contribute to the realization of the 2015 Paris Agreement."*
>
> — Mathy Stanislaus
> Circular Economy Fellow - World Resources Institute;
> Technical Consultant — Responsible Battery Coalition;
> Senior Advisor - World Economic Forum

Lead Batteries: A Circular Economy Model

Step 1: Manufacturing

Using a steady supply of recycled lead battery components, battery manufacturers use safe, sustainable practices to make innovative, new batteries. The established industry has high standards for creating more pure recycled byproducts.

Step 2: Use

The world entrusts 75% of its rechargeable energy storage needs to lead batteries.[7] Worldwide, nearly every hybrid and electric vehicle uses a lead battery. They're also essential everyday in medical, data and telecom, renewable energy, military and more.

Step 3: Collection

The EPA ranks lead batteries as the most recycled product in the U.S.[8] A nationwide infrastructure, high recycling awareness and the value of lead battery components ensures that consumers and industries return spent lead batteries. This supplies manufacturers with a steady stream of materials for reuse.

Step 4: Recycling

Modern, closed-loop recycling keeps more than 122 million lead batteries from landfills each year.[9] A strictly regulated lead battery recycling industry follows best practices to receive and process spent lead batteries.

+ Lead from spent lead batteries is melted, refined and poured into molds to create ingots (lead bricks). These are shipped to lead battery manufacturers to make new batteries.

+ The plastic covers and cases of spent batteries are crushed, melted and formed into pellets to make new battery covers and cases.

+ Spent acid is recycled for new-battery use, neutralized into water, or converted into sodium sulfate, an odorless powder used in laundry detergents, textiles and glass.

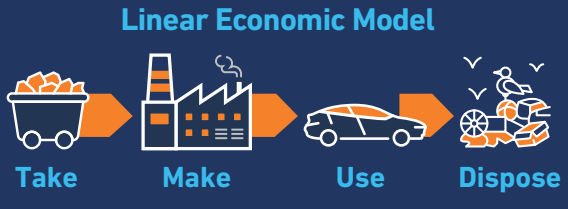
Step 5: Sourcing & Materials Efficiency

A new lead battery is comprised of over 80% recycled material[2] and the lead from lead batteries can be infinitely recycled with no loss of performance. That, coupled with the battery's high recycling rate, greatly reduces the mining of virgin materials.

Why Few Lithium-ion Batteries Are Recycled

Recycling lithium-ion batteries is technologically challenging. Lithium-ion is not a single chemistry design, but a family of designs that each requires different recycling technologies. This adds complexities to end-of-life management costs. In addition, these batteries contain a large number of blended materials that are often not designed for ease of disassembly to recycle. Thus, the residual value ends up in landfills rather than recycled.

+ In recognition of the challenges and need to recycle lithium-ion batteries, the U.S. Department of Energy has established a $5.5 million prize to "accelerate the development of [lithium-ion battery recycling] solutions from concept to prototype to demonstration."[10]



Lead Battery Industry: Sustainability Examples

The lead battery industry is incorporating many sustainability practices that contribute to a circular economy and lessen the environmental pressures exerted by battery manufacturing and recycling.

Advanced Battery Concepts, Michigan: Designing Efficiency

Michigan-based Advanced Battery Concepts has taken lead battery sustainability to a new level. The company developed and patented GreenSeal® technology, which reduces the amount of lead by 46%, making the battery lighter, with quicker charging, higher power, and saving the average vehicle 20 to 30 gallons of fuel per year. Even better news: GreenSeal batteries remain 100% recyclable and easily fit into existing recycling processes.

East Penn, Pennsylvania: Minimizing Waste

East Penn is the largest single-site lead battery manufacturer in the world. It creates sustainability by designing high quality products that are built to last and are manufactured with innovations implemented to conserve natural resources. For instance, the company was the first to invent a patented process for recycling acid and now recycles millions of gallons annually for use in new batteries. In addition, 100% of the company's industrial wastewater is recycled through a zero-discharge system (31.5 million gallons of water recycled and reused annually). The company also produces a liquid fertilizer solution for agricultural use from the sulfur fumes created during lead smelting.

Lead Battery Industry: Sustainability Examples

Exide Technologies, Georgia: Sustainable Manufacturing

Exide Technologies is a global provider of stored energy solutions for the automotive and industrial markets. It's also forging a path forward for manufacturers to reduce their carbon footprint and move towards products produced free of CO_2. To power its production facility and recycling plant in Portugal, Exide will rely on two groundbreaking solar installations (featuring 10,000 photovoltaic panels) with a total capacity of 3.8MWp. The production facility project is one of the largest self-consumption generation units with storage in Europe. Exide's investment showcases the exciting potential for renewable energy systems of this kind to be deployed at scale in manufacturing facilities.

Gopher Resource, Minnesota: Renewing Resources

For nearly 75 years, Gopher Resource has been protecting the earth and preserving natural resources through innovative recycling solutions for lead batteries. The company set a sustainability example by investing nearly $5 million in a storm water collection and reuse distribution system. Annually, the system replaces nearly 17 million gallons of water with collected storm water. Gallon for gallon, that is groundwater left in the aquifer for other uses.

Conclusion

Sustainable materials management in battery manufacturing requires a paradigm shift from a linear to a circular economic model. Stakeholders must factor in a battery's life cycle environmental footprint when selecting a battery technology. The lead battery industry, with its established circular infrastructure, is a model for other battery chemistries — and industries — in how to responsibly source, use, reuse and manage materials.

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Essential Energy Everyday exists to increase awareness of the critical importance of lead batteries to power our daily lives. We encourage continued investment in sustainable lead battery technology to store and provide energy on demand. Our initiative is supported by the two global trade associations that represent the lead battery industry, Battery Council International and the International Lead Association.

Learn more at EssentialEnergyEveryday.com

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6. *Waste to Wealth: Creating Advantage in a Circular Economy*, Accenture, 2015
7. *The Rechargeable Battery Market and Main Trends 2016-2025*, Avicenne Energy, Oct. 2017
8. *Advancing Sustainable Materials Management: 2014 Fact Sheet*, Environmental Protection Agency, Nov. 2016
9. *National Recycled Rate Study*, Battery Council International, 2017
10. *Energy Department Announces Battery Recycling Prize and Battery Recycling R&D Center*, Department of Energy, Jan. 2019