

## CONSORTIUM FOR BATTERY INNOVATION\*



# Lead Battery Innovation Roadmap: Investing in a Proven Energy Storage Solution

Lead batteries are an irreplaceable link that connects, transports, powers and protects our way of life. Yet there remains significant untapped potential in lead battery technology and, thus, great opportunity for further innovation. Cutting-edge, pre-competitive research initiatives are underway to harness the full capability of lead batteries to help meet our critical energy storage needs. This document highlights new investment and research by the Consortium for Battery Innovation to ensure lead batteries continue to advance for decades.

## Lead Batteries ARE a Future Technology

Lead batteries have never been more relevant. The growing demand for electricity and energy storage requires a mix of proven battery technologies that includes lead batteries, which excel in:

+ **Performance** Significant innovations in lead battery design and chemistry have dramatically improved technical performance and versatility in a broad range of applications:

- Higher power density
- Improved recovery from partial discharge
- Improved durability
- Longer life
- Reduced lead content (and weight)

+ **Safety** Lead batteries present a lower safety risk to users, shippers, recyclers and first responders than other battery chemistries.

+ **Sustainability** Lead batteries are produced predominantly from domestically sourced recycled materials, have a nearly 100 percent recycling rate in the U.S., and have the lowest life cycle greenhouse gas emissions of any battery chemistry.

+ **Reliability** Lead batteries are the longest-serving, most reliable and best understood rechargeable battery technology available.

+ **Scalability** The lead battery industry is uniquely poised to scale for growth, with an established coast-to-coast network for efficient manufacturing, collection and recycling.

+ **Cost** Lead batteries provide superior cost-benefit value in comparison to other energy storage chemistries.

\*Formerly the Advanced Lead Acid Battery Consortium (ALABC)

## Research Objective

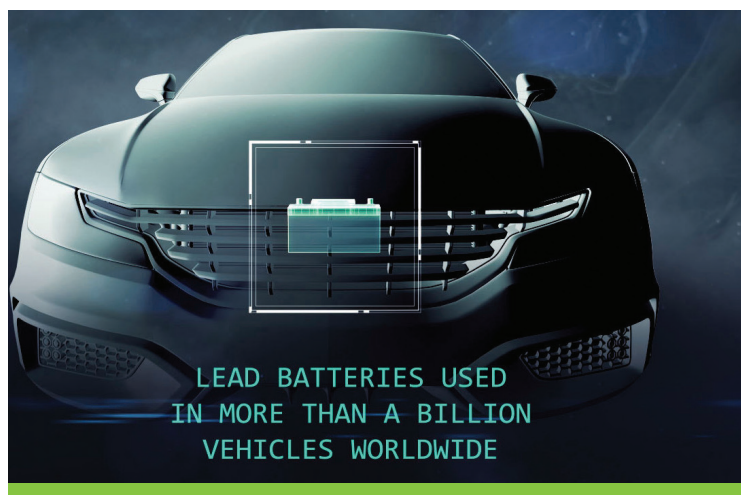
To support a market-driven research “roadmap” whose results will make a significant difference in lead battery performance. This roadmap is based on a detailed analysis of market trends and future technical requirements of end users.

## Research Priorities

1. Create foundational knowledge for the next wave of lead battery innovation.
2. Create key performance indicators (KPIs) in two critical market areas:
  - Automotive
  - Energy storage

## Research Goals: Automotive

- + Improve dynamic charge acceptance (DCA) and extend capability to lower temperatures
- + Improve high-rate partial state of charge (HRPSoC) life
- + Understand water loss under partial state of charge (PSoC) cyclic and overcharge conditions
- + Increase intrinsic high-temperature durability
- + Re-specify tests for cell/battery durability
- + Increase corrosion resistance of positive grids
- + Optimize state of charge (SoC)/state of health (SoH) measurement techniques
- + Optimize and standardize auxiliary batteries



PNM electric utility, New Mexico

## Research Goals: Energy Storage

- + Improve deep cycle life
- + Improve partial state of charge (PSoC) life
- + Increase corrosion resistance of positive grids
- + Increase high-temperature durability
- + Improve charge efficiency and fast charge capability
- + Develop and optimize battery management system functionality
- + Develop and optimize total cost of ownership (TCO), levelized cost of energy (LCOE), and levelized cost of storage (LCOS) modeling

## Research Spotlight: Argonne National Lab

This three-year (2018 – 2021) research initiative comprised of more than a dozen U.S. lead battery companies and suppliers, in collaboration with Argonne National Lab, will establish a data foundation to create the next generation of high-performance advanced lead battery technology.

**“... lead sulfation ... limits lead battery performance to less than half its potential. Tapping a significant portion of that unused potential would result in even better low-cost, recyclable batteries for mobile and stationary market applications.”**

— Tim Fister, Materials Scientist, Chemical Sciences and Engineering Division, U.S. Department of Energy's Argonne National Laboratory

**Essential Storage Today** Lead batteries supply 75 percent of the world's rechargeable battery energy needs and have been in use for more than 150 years. This track record has resulted in a highly efficient closed-loop economic system that far exceeds any other available battery chemistry.



Missouri University S&T Center for Research in Energy and Environment

## Current Research Projects

Projects around the globe are providing valuable opportunities to study and highlight the performance benefits of lead batteries in utility and renewable energy storage applications. Some current examples:

- + Solar Microgrid Demonstration Project**
  - Missouri University of Science and Technology, Rolla, Missouri (Student-designed solar homes form a unique EcoVillage and living laboratory.)
- + Solar Energy Storage Systems**
  - Alcatraz Island, San Francisco, California
  - Stafford Hill Solar Farm, Rutland, Vermont (The first solar microgrid funded by the U.S. Department of Energy.)
  - PNM electric utility, New Mexico
  - Remote areas of Nigeria and Tanzania
  - China Shoto Energy Storage

## + Wind Energy Storage System

- Otis Air National Guard Base, Cape Cod, Maine (The first wind-powered microgrid in the U.S. Department of Defense.)

## + Multi-Renewable Energy Storage Systems

- (Wind, Solar, Hydro)
- Narada Power Source Company, Germany
- City Utilities of Springfield, Missouri
- Eigg Island, Scotland Isles of Canna and Sanday, Fair Isle, Scotland (The UK's largest off-grid system.)

## Conclusion

Today's advanced lead battery technology is proving to be a critical player in the mix of battery technologies needed to meet growing energy storage demands. In states such as California, lead batteries will be critical to achieving ambitious climate and low carbon energy mandates. Yet much more potential exists. It is essential to support the lead battery industry's innovation roadmap to stretch the boundaries of peak performance and power for exciting future applications.

## Contacts



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## ABOUT THE CONSORTIUM FOR BATTERY INNOVATION

The mission of the Consortium for Battery Innovation is to serve the needs of its members by supporting cutting-edge pre-competitive scientific research and promoting innovation in lead battery technology.

Learn more at [EssentialEnergyEveryday.com](http://EssentialEnergyEveryday.com)