

CONSORTIUM FOR BATTERY INNOVATION

# CBI RFP Topic Overview 2026-2027

Multitechnology topics for advancements in Pb, Li, Na, and Zn

# RFP Summary – Where our research goes

## *Chemistries mapped to real-world applications, and the topics being developed for 2027*

### Applications and Chemistries

| Application | Battery Chemistry |
|---|---|
| Automotive (Micro-hybrid and Auxiliary) | Lead, Sodium and Lithium Batteries |
| ESS | Sodium, Zinc, Flow and Lead Batteries |
| UPS | Lithium, Zinc, Nickel and Lead Batteries |
| Telecom | Lead Batteries |
| Motive Power | Lithium and Lead Batteries |
| Low Speed Electric Vehicle (e-bike, e-rickshaw) | Lithium and Lead Batteries |

Research will be funded based on available allotted funds for each technology track. Both short term (3-9 months) and long term (12-24 months) projects will be acceptable. In this document preferred topics are described as well as estimated funding available for each technology stream, funding will change based on member interest in each battery technology track.

# 2027 Research Topics

**MULTI-TECHNOLOGY PROJECTS**

• Benchmarking Study • AI Data Center Test Standard • BMS Comparison • UL / NFPA / IEEE / ASHRAE Guides • Failure Mechanisms

**Lead Batteries**

- Hybrid Capacitor Study
- BMS for Data Centers
- Performance Improvements across Automotive, Motive Power and Stationary Applications

**Lead & Sodium**

- TCO Comparison in Motive Power and Industrial Applications
- Charge Acceptance & Cycle Life in Low- and High-Temperature Profiles

**Sodium-Ion Batteries**

- Failure Analysis in Float Applications
- Performance Comparison of Different Sodium Chemistries

**Zinc Batteries**

- Failure Analysis in Microcycling Applications

**Lead & Lithium**

- E-Bike Testing
- Hybrid Technology for Stationary Applications

**Lithium-Ion Batteries**

- E-Bike Durability Tests for Two- and Three-Wheeled Vehicles
- BMS Optimization in Motive Power

Projects will be funded based on member review, available funds, and alignment to CBI Battery Roadmap - [https://batteryinnovation.org/cbi-global-roadmap/](https://batteryinnovation.org/cbi-global-roadmap/).

CBI aims to fund work looking at improving battery technology and battery systems in the following applications:

1. Low voltage (LV) automotive applications, primarily for 12 V microhybrid/start-stop and auxiliary applications.
2. UPS/ESS/Distributed energy resources (DER)s used in standard compute and AI data centers
3. Development of batteries or battery management for use in ESS for BTM or FTM applications.
4. Improving battery performance and TCO for motive power and e-mobility applications (like e-bike and e-rickshaws).

CBI submission guidelines, proposal formatting, and information about what to include in proposal submissions can be found in Annex A of this document.

# Multitechnology Topics

## BMS Comparison – Shortfalls and Advantages – Short Term (3-9 months)

*Automotive - Comparison of BMS functionality and impact on ASIL levels and ISO 26262*

Small BMS devices are vital for lithium battery blocs and more recently sodium ion 12 V bloc products in microhybrid and auxiliary applications. CBI would like proposals for a short-term project to compare the current state of the art of lithium, sodium, and lead BMS (monitoring and/or management) on functionality toward ASIL and ISO 26262, and identify issues related to ASIL and ISO 26262. Furthermore, the proposal should, in detail, describe manufacturing issues with BMS installation and BMS related failure.

## Strategic Market Intelligence – Short Term (3-9 months)

*Stationary – The role of BMS in protection/safety/thermal runaway*

CBI will prepare guides for active research tracks for UL, NFPA, IEEE and other standards and codes that each battery type should be aware of and their related systems be conformant to in telecom, UPS, and ESS. This will compare complexity and issues related to testing and certification in each application and for each technology.

*Stationary – What are the current limitations of sodium and lithium ESS for behind the meter C&I/Is there a serious advantage for aqueous chemistries in C&I?*

Position paper – why have C&I application growth projections not been met? Do nonaqueous solutions offer higher performance at the cost of practical use in C&I environments? CBI will prepare a report that outlines why aqueous chemistries may be uniquely suited to meet not just the performance requirements needed in C&I, but the required level of liability and risk, total installed cost, and institutional trust needed.

## Benchmarking Studies – Long Term (staged by 6 months and 15 month test cycles)

This study and the automotive study will be funded from a unique separate budget, with this budget directly weighted based on membership fees. Projected budget is 150,000 USD for both studies.

*Benchmarking – Automotive Critical Support 12 V Batteries for Auxiliary Applications*

Thorough testing and comparison of performance will be gathered through parameterized testing of IEC 60098-5 testing protocols. The following parameters will be studied for sodium, lithium, and lead 12 blocs:

1. Temperature impacts on performance at 0°C,-10°C, -18°C, and -40°C. Specifically cataloguing not only discharge but charge performance at each temperature.
2. Ability of each technology to perform CCA checks according to IEC standard.

3. Charge recovery comparison.
4. PPC comparison
5. Static charge acceptance testing

The main test lab will test a small population of each type of technology (variants will be tested based on available budget). A special working group will be established acting in both an advisory role and contributive role, giving direction on what variables to test and in what use case scenarios. Furthermore, member testing will be encouraged, with member data offered to amplify sample populations



*Benchmarking – UPS for Data Centers (AI Inference and AI Training)*

Representative sample packs and cells will be tested in separate streams to understand the impact of the following parameters on battery life and failure for zinc, lithium, sodium, and lead battery products. The parameters to be studied will be:

1. Response time
2. Microcycling (simulated cycles at different timings – millisecond to multiple seconds)
3. Discharge rates
4. Different pack sizings
5. Temperature influence

The main test lab will test a small population of each type of technology (variants will be tested based on available budget). A special working group will be established acting in both an advisory role and contributive role, giving direction on what variables to test and in what use case scenarios. Furthermore, member testing will be encouraged, with member data offered to amplify sample populations.

*Generative AI – Best practices/standard for testing batteries for training/inference AI data center backup and buffering*

Tied to the benchmarking study for sodium, lithium, zinc, and lead batteries for GenAI, best practices and a preliminary test standard built around scenarios and use simulations will be offered. Proposal teams should either work directly with the investigators/test lab for the benchmarking study or with other efforts such as the Open Compute Project Energy Storage Working Group.

## Continuation of Magnetic Perturbation as a New Battery SOH Measure – Long Term (12-24 months)

CBI is interested in funding projects focused on using non-invasive external magnetic field to probe battery characteristics (electrolyte activity for instance) and performance. This project would be a continuation of the proof-of-concept work performed at Villanova University using

Hall Effect and other types of magnets to demonstrate the use these probes to determine SOH for lead and lithium batteries. The proposal team should focus on the use of magnetic sensors for impactful data gathering and establishing data driven models to link magnetic measurement to key performance indicators like SOH. CBI is looking for long term projects up to two years in duration.

# Lead Battery Track

Pb | LEAD-ACID

## Data Analysis facilitated by AI – Long Term (12-24 months)

*Applicable to all applications*

CBI is looking for proposals for the development of AI tools useful in processing large amounts of battery test and analytical data. Similar to the current Black Diamond Structures project, the AI based data analysis methodology would be used to scrutinize relevant electrical test data from historical and modern data sets (typically from JSON, .xcl, .csv, .txt file formats). The AI tool will be provided for use by member companies. Development will be governed not only by CBI staff, but special advisors will be appointed to give direct feedback to what functionality the tool may need.

## BMS for AI Data Centers – Short Term (3-9 months)

*Applicable for UPS, and likely ESS*

AI data centers now require a much higher level of both data acquisition and transparency. Parameters like V, I, IR, T, dV/dQ, impedance, conductance, and other ohmic values are used en masse to help understand SOC, SOF, and SOH levels so battery backup and uptime can be managed more directly by data center energy and power management. Battery monitoring and management for lead batteries are usually at a low level, due to a historical lack of massive data streams for lead battery UPS systems. CBI is looking for proposals focused on the study of what level of monitoring/management equipment, software/firmware, and capability is required to meet AI data center specifications and data needs. This project would be a short term project (less than year).

## The use of impedance and impedance spectroscopy in BMS and product quality measurements for lead batteries – Long Term (12-24 months)

*More applicable to applications for stationary batteries, some use for motive power*

Impedance at low and high frequencies has shown promise as a methodology for decades to better understand battery state of health. The need for better SOH measurements has been amplified in capitally intensive markets, such as AI data centers and ESS for FTM LDES. CBI is interested in funding projects looking at how impedance and impedance spectroscopy could provide new insights into lead battery blocs *and strings*. This fundamental project would be conducted for up to two years.

*Sub-topic: Use of impedance in product quality (for markets like automotive and motive power)*

Additionally, CBI is interested in projects focused on using impedance to study product quality disparity in the manufacturing process. Mass manufacturing of lead batteries has increased




quality over the last decade, but product disparities are still difficult to measure coming off manufacturing lines. CBI would like to fund proposals focused on in-line impedance instrumentation and measurements to rapidly identify and potentially model product disparity and performance differences *in the manufacturing setting*. This project would first be funded as a proof of concept, short term project with potential follow-up funding if agreed upon metrics are met at the first stage.

## Motive Power Battery State of the Art Comparisons – Short Term (3-9 months)

### *TCO Comparison of Sodium, Lithium, and Lead Batteries in Motive Power Applications*

Total Cost of Ownership (TCO) is key in the 24/7 and multishift warehousing market, with major penetration of lithium-ion batteries in the market due to a better TCO vs. other options. With sodium-ion on the horizon, CBI would like to fund a short-term study to compare the TCO of all three types of batteries in motive power applications for class 1 and 2 lift trucks. Furthermore, CBI would like to use this work in a greater effort to understand if sodium ion is viable alternative in the market.

## Material Investigation for Auxiliary Applications – Long Term - (12-24 months)

### *Influence of Separator Characteristics on Battery Performance*

In the past, CBI has funded several research projects to investigate the effect of NAM and PAM additives on the performance of lead batteries. The same approach is aimed to study the impact of physical and chemical properties of AGM separators. For instance, a range of separators having different pore size distribution or various surface groups can be selected to analyze their impact on the electrochemical performance of lead electrodes (e.g. Oxygen Evolution Reaction & Oxygen Recombination Reaction) by using Cyclic Voltammetry measurements. Further, the study should be extended to electrical testing to determine the charge acceptance and recovery of lead batteries.

## Separator Process Changes Impacts on Performance – Short Term – (3-9 months)

The manufacturing process for separators in flooded battery applications is evolving, impacted by changing regulation on solvents and economic flux on the pricing of oils and extractants useful in the separator industry for processing. CBI would like to fund work on an initial project to understand if separator member process changes impact the resulting battery performance.

# Lithium Battery Track

## BMS Related Topics – Short Term – (3-9 months)

*Motive Power – Impact of lithium-ion BMS issues on field failure rates*

Lead and lithium batteries serve as the main battery solutions for motive power in forklifts, industrial trucks, and golf-carts. Each technology has distinct advantages and issues, lead battery pack total-cost-of-ownership (TCO) suffering from needed improvements in opportunity charging and lithium products having inconsistent BMS technology. Member feedback has revealed BMS-related failures and issues are a consistent issue with lithium-ion motive power products. CBI is looking for short term projects focused on describing this issue and how configuration/software adjustments can be made to decrease BMS related faults.

## E-bike Battery Comparison – Short Term – (3-9 months)

*A Performance and Economic Comparison of Lithium, Sodium, and Lead-based batteries for E-bikes and E-rickshaws*

The E-bike battery and E-rickshaw market are major regional markets in Asia, responsible for billions of dollars of battery sales across India, China, Bangladesh, Vietnam, Laos, and Cambodia. CBI would like to fund a proposal to understand the safety, economic, regulatory, and performance drivers for e-bike and e-rickshaw batteries in these regions. This short-term study would then be used to develop innovation goals and projects for the three technologies.

## Lithium BMS Optimization for AI Data Centers – Long Term – (12-24 months)

Early failure of LFP modules has been observed in AI data center UPS and ESS applications. CBI is interested in studying this issue and is accepting proposals to study the impact of the BMS configuration and methodology on early failure in these applications. This would be a long-term study focused on describing this issue and detail and discussing the contributions to current BMS strategies to early failure. Furthermore, this study would focus on whether current lithium-ion packs (and BMS) are capable of being incorporated into data center facility energy and power management schemes to a more functional level, or if not, what technical barriers are causing better control of lithium-ion UPS systems.

# Zinc Battery Track

Zn | ZINC-BASED

## Failure Analysis in Micro-cycling Applications – Short Term (3-9 months)

*Battery breakdown and posttest analysis in AI duty cycle benchmarking study*

With available funds, CBI would like to fund a failure analysis study of Zn-based technology, performed on samples after testing in the benchmarking study. The majority of Zn-based battery technology failure analysis in stationary applications is for standard compute UPS systems and other backup applications. Identifying main failure modes will allow Zn battery community to better understand the necessary manufacturing and technology innovation research areas to focus on within their respective development roadmaps.

## Understanding high-rate charge capabilities in zinc batteries – Long Term (12-24 months)

*What allows high rate (above 10 C) charging and high-rate discharge (40 C) in specific types of zinc batteries?*

Bold claims of charge and discharge capability in NiZn and $ZnMnO_2$ batteries have been circulated recently in literature and within the industry. However, most findings are at the cell level. CBI is interested in proposals studying high-rate charge and discharge capability for cells and blocs using zinc-based electrodes. Proposal teams should focus on both fundamental phenomena (e.g. electrolyte effects, surface area of the electrodes, mechanical strength of active materials) that contribute to effective high-rate capability and low electrode degradation and additionally on supportive testing of bloc products at a TRL of 6 or higher.

# Sodium Battery Track

Na | SODIUM-ION

## Impedance as a Probe for Charge Acceptance Behavior Trends in sodium batteries – Long Term – (12-24 months)

*Automotive applications – Auxiliary (Critical Support) and Microhybrid*

Three types of Na-ion batteries (Polyanionic (NFS and NFPP), metal oxides and Prussian blue & white) are investigated for a range of applications such as start-stop and low voltage EV. Different Na chemistries (e.g. NFPP, NFS) can be studied to investigate the charge acceptance at low temperatures (especially below -10°C), cycle life (at different C-rates, above 40°C) and capacity retention over cycling. The property-performance relationship should be identified for several characteristics such as electrolyte properties (e.g. viscosity, decomposition), polarization effects, sodium deposition, SEI film and side reactions. Studies focusing on understanding of electrochemical mechanism are encouraged (e.g. electrochemical impedance spectroscopy and cyclic voltammetry measurements). The research topics can cover not only auxiliary but also start-stop applications. Further, all studies should follow the draft version of the IEC standard for Na-ion batteries. The test standards used to understand performance enhancement will be the IEC standards (60095-6,8 for auxiliary)

## Understanding the impact of float charge conditions on service in sodium batteries – Long Term – (12-24 months)

*Stationary Applications – Float charging conditions and Failure Cause of Polyanionic and PBA Sodium Battery Types*

Sodium-ion batteries are still relatively untested at the product level in many float applications. CBI would like to fund work looking at the impact of float on sodium ion types, like Prussian blue analog and polyanionic types like NFPP. The proposal should consist of a test regime and failure analysis, with a focus on optimizing charge voltage and current through a suggested probing method, such as impedance spectroscopy. All studies should adapt float charging schemes according to existing IEC standards.

## Thermal Degradation Study of Sodium ion Batteries - Short Term (3-9 months)

*Thermal Runaway Testing of Sodium Ion Variants*

Thermal runaway intensity should be lower for sodium ion batteries compared to lithium-ion variants. However, the use of a flammable electrolyte and new active materials means new thermal runaway byproducts, and possibly hydrogen production, and could contribute to further issues. CBI would like to fund a preliminary study to determine if Na PBA and NFPP create toxic gases, hydrogen, or other detrimental issues during thermal runaway.

# Annex A: CBI PROPOSAL PREPARATION GUIDELINES

1. General guidelines
2. Proposal process
    a. Submission
    b. Timeline
3. Review process
    a. Procedure
    b. Timeline
4. Proposal document
    a. Title
    b. Principal Investigator and contact information
    c. Proposal Summary
        i. Acceptable length
        ii. Information to include
    d. Objectives (relate them to Key Performance Indicators CBI Battery Roadmap - https://batteryinnovation.org/cbi-global-roadmap/.
    e. Keywords
        i. Acceptable words
        ii. Reasoning and usefulness

**THESE SECTIONS SHOULD FIT ON ONE PAGE**

    f. Total CBI cost and cost share (do not need to detail here) and duration of project
    g. Abstract and graphic
    h. Introduction
        i. What to include and general guidelines
        ii. Preliminary experiments (if applicable)
            1. If preliminary experiments have been conducted, please add as an additional titled section.
    i. Technical Discussion of Work
        i. Project plan
        ii. General guidelines for this section
    j. Breakdown of Budget and Cost Share
        i. Guidelines for calculating cost share
        ii. Advice
        iii. Duration of Project
    k. Literature reference guidelines
    l. Experience: Curriculum Vitae or Resumé
    m. Supporting Information (if necessary)

# GENERAL GUIDELINES

Advice for writing a proposal for CBI

1. CBI funds pre-competitive research for batteries. Precompetitive is underlined, because that is the mainstay of the organization and proposals that feature material that is obviously competitive (i.e. the body of work only benefits your organization) in nature will not be acceptable.
2. Write your proposal with the idea that the person reviewing may not be an expert in a specific technique, methodology, or subject like you are. Ultimately the proposals are reviewed first by a panel of experts (in some area of battery science or engineering) and then by technical representatives of the CBI membership. This is your audience, write to them! Many are fully aware of the science and engineering involved for batteries, but might not know much of your expertise.
    a. You must convey what the state-of-the-art is for your proposal. If you are suggesting a new additive, in your introduction there should be a firm and referenced recount from literature providing precedent and reason to your work.
3. Construct your proposal to sell what you would like to do in the first 2 pages, the rest of the proposal is for detail.
4. Preliminary experiments are a huge plus.
    a. If you are looking to use a technique that has never been used for batteries, initial experiments will help demonstrate that it your work is possible.
    b. Precedent builds trust.
    c. Refer to your experience and accomplishments in similar projects (this should be accentuated in the CV and background experience section.)
5. Refer to the CBI global roadmap, please use the key performance indicators as a guide to how your work can provide insight or a solution to a problem.
6. Gather a team, there are many leading institutions and companies in battery research. You may not know everything about battery science and technology, and a team conveys that the proposal will be handled thoroughly and via a multi-disciplinary approach.

# PROPOSAL PROCESS

Please submit all proposals to matt.raiford@batteryinnovation.org

In general, the proposals are due six weeks after issuing of a request. Following receipt of your proposal, a panel of experts will review the documents and ask for additional clarification. After this period, the proposals will be circulated and reviewed by CBI membership.

# REVIEW PROCESS

As mentioned above, the review process includes an expert panel that will measure your proposal based on each of their individual expertise as a battery scientist/technologist and grasp of battery research. Following their suggestions, the proposals are sent for scoring and ranking by CBI members.

The rankings will be discussed and then principal investigators will be contacted with the status of their proposal.

# PROPOSAL DOCUMENT

### Generic rules for proposals

1. The proposal must be understandable, please proof-read for clarity and legibility. There are professional reviewers (e.g. American Journal Experts) that are a cost-effective way (~$400) to get valuable improvements overall, especially for the proposal summary.
2. Please use either Arial, Calibri, or Times New Roman, 12 font, single spaced, single columned.
3. Please include page numbers.
4. Literature references should be at the end of the proposal, started on a new page.

## One-page summary

These sections should be included on a one-page summary of the proposal.

1. Title – do not make this a paragraph. The title should describe the approach and subject, not the objectives.
2. Principal investigator and contact info
    a. Example:
        Matthew Raiford, mraiford@batteryinnovation.org
        Consortium for Battery Innovation, 2530 Meridian Parkway
        Suite 115, Durham, NC 27713
3. Proposal summary
    a. The summary should convey the innovation and goal for your proposal. In terms of the innovation be direct in what your proposal aims to do to improve lead battery performance.
    b. Include objectives for your proposal as a bulleted list within the summary. Save technical detail for the proposal.
4. Keywords
    a. What applications (if any) are you focusing on? Automotive batteries? Industrial?
    b. What performance indicators from the roadmap will be improved?

   c. Techniques used
5. Duration and financial info
   a. Please list:
      i. Duration of project
      ii. Cost for CBI and any cost share that you will provide.

## Body of work

For the rest of the proposal include technical detail about your innovation. If you use terms or acronyms specific to the discipline or techniques utilized, please define them. Make sure to caption, number, and describe figures, graphics, and any tables.

## Introduction

1. The introduction should provide a technical background for the topic area that is the focus of your proposal (i.e. negative active material additives, *in situ* studies, materials science of the phases, etc.) This section should be supported by research in journal articles, conferences, patents, etc. Make sure to summarize what the state-of-the-art is for the subject, what is currently being done.
2. Cover the background of any specific technique or method that you are bringing into the work. Not from the basis of how the technique works, but why the technique may be useful and any similar precedence in the literature.
3. **PRELIMINARY EXPERIMENTS**
   a. In the case of utilizing a new method or technique, **conducting preliminary experiments is a major advantage to the proposal.** These would be proof-of-concept type of experiments that describe validity and probability of success for your innovation.
   b. This is not restricted to more fundamental science-based work. For instance, if exploring a new type of battery electrode, initial electrical testing in test cells or electrochemical evaluation could be preliminary experiments.

## Technical Discussion of Work

Ultimately, the innovative aspects and technical details of your proposal should be organized effectively.

1. Describe your thought process, why you think your proposal could help the performance of lead batteries.
2. Please include graphics and figures that describe important steps of your work plan.
3. A work plan **must** be included showing a timeline for deliverables and major milestones in the program.
   a. For instance, a Gantt chart can be effective (just an example).

## Duration, Budget, Cost Share

1. Duration
    a. Please choose an appropriate duration for the work and describe in the work plan why the project will take so long.
2. Budget
    a. Please outline all of the costs of the project in detail.
        i. Labor, materials, instrument time, **travel**, outside testing (if applicable), overhead, etc.
3. Cost share
    a. CBI is a non-profit organization that funds pre-competitive research for battery research and any cost share is a major plus.
    b. This can be calculated by describing labor or facilities that will be utilized that won't be a cost to CBI.
        i. In the case of university-based proposal teams, time from assisting faculty and staff, instrument use that is "in-house", etc.

## Literature Referencing Guidelines

Please use the same format for the references, American Chemical Society, Elsevier, and other formats are acceptable. Please include the DOI or link for your resources.

## Experience

In this section you would describe the experience of every person involved in the project, their company or institution and include a curriculum vitae and/or resumé for each contributor. Also, for industrial partners or co-leaders, please add contact info.

Try to specify how the team experience and expertise will strengthen the probability of success for the proposal.

## Supporting Information

If the introductory or technical work sections feature lengthy data sets, please include a representative piece of data in the proposal and include the rest of the data in a supporting information section.