CONSORTIUM FOR BATTERY INNOVATION

CBI Request for Proposals (RFP) 2022

THE CONSORTIUM FOR BATTERY INNOVATION

The Consortium for Battery Innovation is the only global pre-competitive research organization funding innovation in lead batteries for energy storage and automotive applications.

Our work

Research

Improving lead battery performance through pre-competitive research

Marketing

Improving recognition of lead battery benefits by end-users in all applications

Testing / Standards

Ensuring lead battery merits are recognized in key global tests and standards

Communication

Demonstrating innovation in lead batteries and the key role the technology will play in meeting future electrification and decarbonization goals

CBI membership

Map of members

INTRODUCTION

The Consortium for Battery Innovation (CBI) is the world's only pre-competitive lead battery research consortium funding cutting-edge research and promoting innovation in advanced lead batteries for all applications.

The Consortium has developed a Technical Roadmap which has defined research priorities for lead battery technology as Key Performance Indicators (KPIs). This reflects the principal research areas that our global membership believes present the most beneficial opportunities to advance the performance of lead batteries.

The information contained within this Request for Proposals (RFP) is specific to the KPIs set out in the Technical Roadmap.

CBI 2022 REQUEST FOR PROPOSALS

CBI is issuing an RFP for 2022, with the aim to fund **pre-competitive research and innovation** to improve lead battery performance in all applications. This document will cover the areas of preferred interest, but CBI and the membership will consider proposals focused on other applications.

In the case of other applications (such as automotive micro-hybrid or telecom/UPS), refer to key performance indicators and research areas outlined in the CBI Technical Roadmap.

For instructions on the desired proposal style and recommendations for content, please review this document.

GLOSSARY OF TERMS

1. BEV – Battery Electric Vehicle
2. BTMS – Behind The Meter Storage
3. CA – Charge Acceptance
4. C10: Discharge rate of a battery over 10 hours
5. DCA – Dynamic Charge Acceptance
6. DOD – Depth-of-Discharge
7. EFB – Enhanced Flooded Battery (+C - plus Carbon)
8. EN 50342: 2015
9. ESS – Energy Storage Systems
10. HTE – High Temperature Endurance Test
11. IEC Testing summary
    a. 60254-1 for Motive Power:
        i. https://webstore.ansi.org/Standards/IEC/IEC60254Ed2005
    b. 61427-1,2 for ESS:
        i. https://webstore.ansi.org/Standards/BSI/BSEN614272013
        ii. https://webstore.ansi.org/Standards/DS/DSEN614272015
12. LCOS – Levelized Cost of Ownership
13. OEM – Original Equipment Manufacturer
14. PSOC – Partial State-of-Charge
15. TCO – Total Cost of Ownership

For the sake of understanding how to improve DCA, the definition of DCA and the realistic desired outcome for a 12 V lead battery in the 12 V net of electrical system should be described. There are two main perspectives for DCA, one fundamental and one based in the product performance in a start-stop vehicle. The end goal is for the active material to be able to charge readily across a large SOC window, resulting in a 12 V net that is limited by the alternator output (not the battery). Eckhard Karden from Ford Aachen has approximated the desired DCA value to 2 A/Ah, a value in line with the battery being able to accept the ~3 kW power output available from the alternator.[1]

"Dynamic charge-acceptance is the ability of a battery to absorb high-rate charge pulses during microcycling operation within a partial state-of-charge (PSoC) window, where typical charge pulses for automotive applications would be characterized by brake-energy recuperation or recharge between two stop–start events in congested urban traffic. It is quantified as the average charging current (or charge integral) over either one or all recuperation pulses of a representative PSoC microcycling sequence, and can be normalized to the battery's nominal capacity, i.e., A/Ah."

[1] Garche, J.; Karden, E.; Moseley, P. T.; Rand, D. A. J. "Lead-Acid Batteries for Future Automobiles" **2017**, Elsevier, Chapter 1 (Karden, E.).

CBI RFP – 2022 – TOPICS AND PATHWAYS

The new CBI Technical Roadmap provides research areas and performance indicators for many lead battery applications. The market for lead batteries is bright and CBI would like to fund research in these key areas:

GENERAL TOPICS – FUNDAMENTALS

1. ***In situ/In operando* analysis of lead battery electrodes during test sequences representative of lead batteries in IEC testing related to motive power and ESS applications that have high DOD duty cycles.**
2. **New types of lead battery additives.**
    a. Research should focus on how additives contribute to better active material:
        i. Tortuosity of the active mass
        ii. Pore size distribution control
        iii. Enhancements in ionic mobility through the porous structure
    b. Preliminary work on how best to incorporate the additives in the active material is heavily encouraged.
3. **Studying the mechanism and degradation of lead batteries during PSOC and high DOD electrical regimes.**
4. **Understanding and improving high-rate performance without associated -capacity reduction.**
    a. Alloys and active material studies to enable thinner plates
    b. Acid concentration effects and impacts on diffusion
    c. Conductivity and structure of the active masses

AUXILIARY/LOW-VOLTAGE EV LEAD BATTERIES

(Tests under development – EN 50342-6:2015 Ford Run-In Test B for DCA, HTE for water loss)

1. **Support of pre-competitive harmonization and standardization activities for lead batteries in BEV applications**, also supporting Functional Safety applications. CBI may fund collaboration and shared activities but not product development or testing at individual battery companies. Proposals should demonstrate how application relevance is assured by links to standardization committees or other industry working groups.
2. **Operating conditions and failure mechanisms of 12V batteries in the growing customer fleets of BEV**: Data collection and data mining activities that are independent of individual OEMs and allow a better understanding and classification of typical customer usage profiles.
3. **Improving DCA and CA for lead batteries in auxiliary duty**, which is an extension of DCA improvements recently achieved for micro-hybrid EFB+C. Firstly, DCA test methods introduced for micro-hybrids should be extended to cover BEV duty cycles. Whenever DCA and CA is improved, the new HTE test must be used to demonstrate possible trade-offs against high temperature durability.

In lieu of specific goals, DCA, float charging and service life should be improved.

MOTIVE POWER AND FORKLIFT APPLICATIONS

(Testing – IEC 60254/ BCIS-06)

1. **Improving TCO**
    a. Improving opportunity charging capability
        i. Materials enhancements
        ii. Innovations in battery management
    b. Enhancements in energy throughput/service life in maintenance-free batteries.
        i. Using additives
        ii. Lowering internal resistance with new alloys and active materials
2. **Energy Density**
    a. Improving energy density by additives/electrode materials improvement.

The KPIs that are most important to focus on are cycle/service life while allowing light maintenance or maintenance-free operation. Please see the table below for more information.

Indicator	2021/2022	2025	2028
Service life	5	5-6	6-7
Energy throughput	1200 equivalent cycles	1400 equivalent cycles	1600 equivalent cycles
Cycle life **IEC 60254**	2400 (50% DOD)	2800 (50% DOD) 1750 (80% DOD)	3000 (50% DOD) 2000 (80% DOD)
Energy density (specific to charge efficiency)	35 Wh/kg	40 Wh/ kg [c]	42-45 Wh/kg [c]
Charge time to 30 – 80% Opportunity Charging (Highly dependent on charger/charge current)	Less than 2 hrs	1 – 1.5 hrs	1 hr or less
Technology requirements	- Maintenance free present - Management of the battery [a] - Harmonization with Chargers [b] - Few products capable of opportunity charging	- Maintenance free more common - Management and monitoring of the battery [a] - Harmonization with Chargers - Capable of opportunity charging	- Maintenance free typical. - Management and monitoring of the battery [a] - Harmonization with Chargers - Capable of opportunity charging

LEAD BATTERIES FOR ESS

(Testing – PNNL-Sandia 22010, IEC 61427 – 1,2)

1. **Failure mode analysis and study of failure modes of lead batteries from demand response, ESS for commercial and industrial applications, and renewable energy (PV, wind) arbitrage type use (on-grid and off-grid microgrids)**
    a. This work must be done with a good sample population where statistical analysis can be employed to differentiate between failure modes general to the application and manufacturing issues of the batteries the resulted in the failure
2. **Additives and electrode material enhancements for improvements in operational life and total energy throughput**
3. **Systems level developments**
    a. Maximizing energy throughput and improving LCOS using battery management
        i. Machine learning, artificial intelligence may be good routes – describe experiments with a high level of detail
    b. Unique power conversion and control automation design work tailored toward improving acquisition and/or operational costs of lead battery ESS

The KPIs that are most important to focus on are operational and acquisitional cost – cycle life and energy density improvements will assist with cost. Please see the table below for more information.

Indicator	**2021/2022**	**2025**	**2028**	Stretch Target **2030**
Service life (years)	12-15	15-20	15-20	15-20
Cycle life (80% DOD) as an estimate for C10 or higher rates	4000	4500	5000	6000
Operational cost for low charge rate applications (above C10) – Grid scale, long duration	0.12 $/kWh/energy throughput	0.09 $/kWh/energy throughput	0.06 $/kWh/energy throughput	0.04 $/kWh/energy throughput
Operational cost for high charge rate applications (C10 or faster) - BTMS	0.25 $/kWh/energy throughput	0.20 $/kWh/energy throughput	0.15 $/kWh/energy throughput	0.10 $/kWh/energy throughput

Indicator	2021/2022	2025	2028	Stretch Target **2030**
Energy Storage efficiency (Wh in vs Wh out)(%)	75-90	80-90	85-90	88-92
Round Trip Efficiency (%)	85	88	90	92
Acquisition Cost (cell level) ($/kWh – 10 MW assumption)	175	140	100	75
Energy Density (Wh/l)	80-100	110	120	140
Acquisition cost, ESS level ($/kWh)	350	325	300	275
Safety	Maintain safety – deploy charging algorithms to control gassing			

NEXT STEPS

Proposals should be sent to Dr Matthew Raiford, CBI's Senior Technical Manager, by 20th May 2022.

If you have any questions about the contents of CBI's 2022 RFP, please contact Dr Matthew Raiford: matt.raiford@batteryinnovation.org.

Contact us

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