CONSORTIUM FOR BATTERY INNOVATION

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CBI Request for Proposals (2020) - Pathways to increase lead battery performance in energy storage system (ESS) applications

Background

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 innovation 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 for energy storage applications. CBI and our membership, however, will consider proposals in other applications, for example automotive. In this case, refer to KPIs and research areas outlined in the CBI technical innovation roadmap.

All proposals should follow the CBI Proposal Preparation Guidelines. Projects that do not follow these guidelines may not be considered for funding.

Request for Proposals

Lead batteries in battery energy storage systems (ESS) are utilized in a wide array of duty cycles and environments across the world. From frequency regulation and microgrids, to peak shaving and shifting, lead batteries provide high technical performance, reliable and safe energy storage for utility and renewable energy projects as well as in back-up applications for data centers and UPS.

As a new application, further research is needed into the operational regimes of lead batteries for ESS applications, in the field and through laboratory testing studies. In order to gain deeper insights into understanding total energy throughput in ESS applications, it is necessary to further understand these operational regimes. Therefore, CBI requests funding proposals focused on research increasing service life and total energy throughput in ESS systems using flooded, VRLA (valve-regulated lead-acid)/AGM (absorptive glass mat), gel, and EFB (enhanced flooded batteries), bipolar type, and other advanced lead batteries. Special consideration is given to proposals concerning peak-power shaving (demand response) using ESS for commercial and industrial applications, and renewable energy (PV, wind) arbitrage type use with on-grid, off-grid microgrids, and load following purposes. Consideration will also be given to other applications such as automotive.

The topics outlined in this document are provided as examples and utilize a failure mode focus as a pathway to increase cycle life and total energy throughput for lead batteries in ESS applications. Tied to these topics are the study of the growth/dissolution and morphology of the electrode active material to increase specific energy and mass utilization. The below topics are provided examples and in the case of other topics please refer to KPIs and research areas outlined in the CBI technical innovation roadmap for lead batteries in ESS applications.

The KPIs outlined in the technical innovation roadmap describe numerical goals related to lifetime that will achieve desired operational and acquisition requirements for energy storage in peak-power shaving (demand response) using ESS for commercial and industrial applications, and renewable energy (PV, wind) arbitrage type use with on-grid, off-grid microgrids, and load following. Lowering operational cost (by increasing total energy throughput or cycle life/capacity turnovers) and acquisition cost (related to specific energy and mass utilization) of lead batteries is key for the advancement of this technology in all ESS applications.

Topics for possible studies include:

a. Observation and study of the electrochemical and structural changes of the phases present in lead batteries in ESS or under standardized tests (IEC 61427-1,2, PNNL 22010 (Rev. 2), IEEE P2030.3).
    i. **Due to the length of time of these tests, samples from batteries during different stages of testing will be obtained for study (CBI will directly assist).** Understanding structural changes over the course of testing (and in use) is important and research proposals should study electrodes at multiple and different stages of testing and service life.

b. Optimizing the use of balancing charges by understanding polarization effects (processes that inhibit current flow) related to cumulative damage of lead ESS battery electrodes in PNNL 22010 and IEC 61427 standardized testing, and if possible, from 'in-field' batteries.
    i. Notes on polarization effects (overpotential or overvoltage):
        1. 'Activation overpotential', which results from limitations imposed by the kinetics of charge transfer at the electrode.

        2. ‘Concentration overpotential’, which results from the kinetics of mass transfer of active materials to the electrode surface during the passage of current.
        3. ‘Resistance overpotential’, which results from the ionic resistance of the electrolyte and the electronic resistance of the other cell components.
    ii. In the case of ‘in-field’ batteries, highly detailed usage data must be provided to put the phenomena in perspective.

c. In operando structural analysis techniques for battery electrodes under realistic charge regimes (PNNL/IEC 61427/IEEE) (**must use a proven technique!**)
    i. Please provide preliminary experiments where applicable.

d. Failure mode analysis and study of failure modes (and degradation) of lead batteries from demand response, ESS for commercial and industrial applications, and renewable energy (PV, wind) arbitrage type use (on-grid/off-grid microgrids).
    i. This work **must be done with a suitable sample population** where statistical analysis can be employed (with high confidence levels, 90%) to differentiate between failure modes general to the application and manufacturing issues of the batteries that resulted in failure.
    ii. Investigate failure mode of battery strings or blocks with different technologies (Flooded, AGM or GEL) under ‘on grid’ applications cycling profiles as defined in IEC 61427-2 norm:
        1. Load following: failure modes should be investigated that could be different depending on battery technologies (VRLA/Flooded) and State of Charge management.
        2. Peak-power shaving: failure mode is most likely related to the positive electrode. Nevertheless, this should be confirmed, and potential counter measures investigated in order to improve cycle life to achieve the performance goal targets set by CBI.
        3. PV energy storage-time shift: deep cycling under this service is probably the main failure mode. To improve battery endurance and thus reduce the total cost of energy storage in this application, it is necessary to investigate and subsequently develop a means to slow down active mass wear-out.

Next steps

Proposals should be sent to Dr Matthew Raiford at the address below by 24 April 2020, who will be pleased to provide additional information.

Guidelines on how to submit your proposal can be found our website. We would stress that proposals that do not follow the guidelines may not be considered for funding.

Successful proposers may be requested to provide further details and on receipt, CBI will enter into research contracts with the successful bidders.

Contact

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