Request for Technical Proposal

Battery500 Solid-State Battery Seedling Projects

Date: September 30th, 2022

**TIMETABLES:**
- **RFP Release Date:** 9/30/2022.
- **Submission Deadline:** 10/28/2022 at 5:00 PM Eastern.
- **Decision Deadline:** Review committee plans to make decisions by 11/30/2022 (subject to change)

Background

In support of U.S. Department of Energy (DOE)’s efforts in pushing the frontiers of science and engineering to accelerate decarbonization process through research, development and demonstration, and deployment and re-establishing battery materials and supply chain in U.S, proposals are sought for supporting Battery500 Consortium sponsored by Vehicle Technology Office (VTO) of Energy Efficiency and Renewable Energy (EERE), DOE.

The Battery500 Consortium (B500), initiated in 2016, supports DOE’s priority to achieve a carbon-free electricity sector by 2035 and to decarbonize the transportation sector by developing and manufacturing the next-generation, high-energy, low-cost batteries to enable a wide deployment of electric vehicles (EVs) in the marketplace. The overall goal of the Battery500 Consortium (Batt500) is to address the scientific challenges to enable next-generation high energy rechargeable lithium metal batteries. Specifically, Batt500 Consortium aims to increase the specific energy (up to 500 Wh/kg) relative to today’s battery technology, achieve 1,000 cycles, and reduce the cost of cells to significantly less than $100/kWh, an important DOE goal for carbon-neutral energy and electrification.

In phase 1(FY2017-FY2021), the Batt500 consortium has made significant progress. For example, the Consortium has successfully demonstrated prototype 350Wh/kg lithium metal pouch cells with 600 stable cycling by integrating innovations developed from the Consortium. In Phase 2 (FY2022-FY2026) the Consortium continues to move towards the goal of 500Wh/kg (cell level).

Seedling projects are now sought to support Batt500 Consortium through Pacific Northwest National Laboratory (PNNL), the lead institute of Batt500 Consortium. Given the significance of lithium metal batteries for EV and for military applications, US Army Ground Vehicle System Center (GVSC) will jointly support the selected Batt500 seedling projects.

**Key Considerations**
This solicitation seeks innovative R&D for solid-state lithium batteries, focusing on materials optimization and integration into high-energy density batteries with the potential to meet the Battery500 Consortium target of 500 Wh/kg. Increased energy density will rely on lithium metal anodes. To integrate solid state electrolytes into lithium metal batteries, there are a few requirements for the properties of solid-state electrolytes

1. Thickness of solid-state electrolyte needs to be thin, e.g., \( \leq 100 \, \mu\text{m} \) layer
2. Sufficiently high \( \text{Li}^+ \) ionic conductivity (\( \geq 10^{-3} \, \text{S/cm} \)) at room temperature
3. Low interfacial impedance especially with cathodes
4. Good mechanical properties to maintain intimate contact at electrodes
5. Block Li dendrite growth: sufficient to cycle at current density of \( \geq 1 \, \text{mA/cm}^2 \) for at least 300 cycles
6. Chemical and electrochemical stability: 0 V-4.5 V vs Li/Li$^+$

Proposed work should focus on aspects such as solid electrolyte synthesis, processing, and scale-up, electrolyte integration into electrodes and cells, and electrochemical cycling performance that pertain to an industry-defined challenge in solid-state battery cell design or manufacturing. These solid-state electrolytes should be incorporated into battery cell deliverables demonstrating the ability to reach the following performance targets:

**Performance Targets**

<table>
<thead>
<tr>
<th><strong>Energy Storage Performance Requirements</strong></th>
<th><strong>Cell Level Targets</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Useable Specific Energy @ C/3</td>
<td>Up to 500 Wh/kg</td>
</tr>
<tr>
<td>Calendar Life</td>
<td>15 Years</td>
</tr>
<tr>
<td>Cycle Life (C/3 deep discharge with &lt;20% energy fade)</td>
<td>1,000</td>
</tr>
<tr>
<td>Cost</td>
<td>( \leq $100/\text{kWh} )</td>
</tr>
</tbody>
</table>

Anticipated technology approaches include, but are not limited to:

- Solid electrolytes that can promote uniform lithium plating and have high ionic conductivity and low reactivity against lithium metal and against high voltage cathodes
- New polymer electrolytes that have the potential to operate at room temperature and possess the mechanical properties to prevent dendrites
- Novel architectures/cell designs to protect metallic lithium from dendrite formation
• Novel materials, interface, and cell designs, to enable cell cycling without excessive external pressure applied (i.e., ≤500 kPa)
• Novel approaches to integrate solid ionic conductors into cathode materials that can result in low interfacial impedance

Application and Submission Information
For all proposals, the proposal length shall not exceed 15 pages excluding cover letter and appendix. In addition to the technical proposal, a detailed work plan for the proposed project must be submitted along with the proposal as an appendix. A template of the appendix is provided.

General Proposal Requirements
Individual proposals must be submitted in PDF format as a single file (do not bundle multiple proposals in a single file). Proposals should be formatted for 8.5 x 11 paper and have 1-inch margins on each side. Typeface size should be 12 point font, except tables and figures which may be in 10-point font.

Proposals
Proposal content aligns with content required in this request for technical proposal, with additional information to assist reviewers in evaluating technical details. Applicants must include all content they wish to have reviewed in the proposal. References do not count toward the page limit.

Cover Letter
This section summarizes the basic information about the proposed project: title, VTO program, activity, and sub-activity the project serves, and project principal investigator (with contact information).

Project Overview
This section should contain a concise narrative that captures the problem statement, the major R&D challenges, and any context needed to provide the reader with a complete understanding of the project and how it supports office, program, and activity goals. If this is a multi-performer project, this section should include a description of each performer's role and responsibility.

Project Objectives
This section should describe the project-specific goals, objectives, and expected outcomes. The proposal should include a clearly defined, aggressive and quantitative end-of-project goal that supports larger VTO programmatic goals. Details on the technical aspects of the goals, objectives, and outcomes should be included in this section to explain the specific technical areas to be addressed and the scientific merit of the work as well as specifically how the approach is different from VTO’s current portfolio. The proposer should include the technology barriers addressed by the work and how the project addresses them.

Project Management
This section should define the key milestones to be addressed by the project (1 go/no-go at 12 months and quarterly progress measures), with dates and specific descriptions of what should be accomplished to meet the milestones. A more detailed work plan is required in the appendix.
Project Approach/Tasks
This section should list the key tasks and provide brief descriptions for each task, including roles and responsibilities of any partners. A cost estimate (total) for each phase should be provided here.

Technical Qualifications and Resources
This section should describe the project team’s unique qualifications and expertise, including those of key subrecipients, and the project team’s existing equipment and facilities that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project.

Diversity, Equity, and Inclusion (DEI)
Applicants must provide a description of how the project will support or implement a DEI Plan that describes the actions the applicant will take to foster a welcoming and inclusive environment, support people from groups underrepresented in STEM, advance equity, and encourage the inclusion of individuals from these groups in the project; and the extent to which the project activities will be located in or benefit underserved communities. The plan should include SMART milestones supported by metrics to measure the success of the proposed actions.
Appendix: Seedling Project Work Plan (template)

Seedling Project Work Plan

**IMPORTANT:** This document is provided as a template to allow the applicants to provide a work plan. The work plan does not count towards the page limit of the technical proposal.

**Background**
*What are the goals of the project. State the project objectives or desired result to fully describe and clarify the technical problem being addressed.*

**SOW Scope (high-level description for three-year work)**
*Describe the key technical activities and approach for producing the deliverables (e.g., descriptions of required experiments, tests, analyses, and special work procedures). Indicate how the sponsor will be involved in the work or review of projects or how non-PNNL collaborators will participate.*

**Task and Deliverables**

**Year 1 Tasks and Schedule**
*What specific activities is the Contractor required to perform, Identify the period of performance for the work and include or attach the project schedule.*

**Formal Deliverables and Milestones for Year 1**
*Describe formal project deliverables; This would be the things PNNL/sponsor is receiving once the work is complete (e.g. data analysis, presentation, prototype list, key milestones required to complete the work).*

**Year 2 Tasks and Schedule**
*What specific activities is the Contractor required to perform, Identify the period of performance for the work and include or attach the project schedule.*

**Formal Deliverables and Milestones for Year 2**
*Describe formal project deliverables; This would be the things PNNL/sponsor is receiving once the work is complete (e.g. data analysis, presentation, prototype list key milestones required to complete the work).*

**Year 3 Tasks and Schedule**
*What specific activities is the Contractor required to perform, Identify the period of performance for the work and include or attach the project schedule.*

**Formal Deliverables and Milestones for Year 3**
*Describe formal project deliverables; This would be the things PNNL/sponsor is receiving once the work is complete (e.g. Data Analysis, presentation, prototype list key milestones required to complete the work).*
complete the work).

Final Deliverables and Milestones
Describe formal project deliverables; This would be the things PNNL/sponsor is receiving once the work is fully complete (e.g. final study, presentation, prototype list key milestones required to complete the work. It could be identical to year 3 deliverable or a different deliverable which signifies the completion of the project as a whole).