



UNITED STATES ADVANCED BATTERY CONSORTIUM LLC

**DEVELOPMENT OF ADVANCED HIGH-PERFORMANCE
BATTERIES FOR 48V HYBRID ELECTRIC VEHICLE APPLICATIONS**

REQUEST FOR PROPOSAL INFORMATION (RFPI)

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RFPI Agreement (to be signed and returned with each Proposal)

DEVELOPMENT OF ADVANCED HIGH-PERFORMANCE BATTERIES FOR 48V HYBRID ELECTRIC VEHICLE APPLICATIONS

REQUEST FOR PROPOSAL INFORMATION (RFPI)

1.0 Statement of Purpose/Objectives

The United States Advanced Battery Consortium (USABC) was formed in 1991 to sponsor development of advanced high-performance batteries for Electric Vehicle (EV) applications. USABC has carried out a number of battery development programs focusing on low-cost, long-life, high-energy, and high-power technologies. With this request the USABC intends to focus on the development of advanced battery systems for emerging 48V hybrid electric vehicle (HEV) applications.

The purpose of this RFPI is to identify developers having electrochemical energy storage technologies which have the capability of meeting or approaching the USABC targets, as listed in the attached Appendix A. The USABC expects that this work will be partially funded by the US Department of Energy through a cooperative agreement awarded to the USABC. The intended R&D approach of this subcontract is to develop an advanced energy storage cell or module first and then, if cell level data and system integration experience warrant full system work, to build and test full prototype systems that meet or surpass the technical requirements in Appendix A. USABC is not seeking proposals for any particular chemistry or technology, but rather seeks significant progress toward the complete set of end-of-life goals listed in the Appendix. Although project goals can be set that approach but not meet all of the USABC goals, a credible plan toward achieving all the USABC goals with a target for no later than 2020 large-scale commercialization must be provided.

The USABC intends to capitalize on the knowledge it has gained through the HEV, PHEV, and EV research and development activities it has been engaged in. We expect developers to bring past experiences and lessons learned from their high power and/or high-energy work to bear on developing energy storage technologies for this application.

2.0 Business Objectives

This USABC RFPI represents a unique opportunity for developers to leverage their resources in combination with those of the automotive industry and the federal government. For the automakers, this type of pre-competitive cooperation minimizes duplication of effort and risk of failure, and maximizes the benefits to the public of the government funds.

Beyond the efficient and timely usage of resources, the auto makers recognize that successful commercialization of these technologies will only be completed when the supplier base has been established for the selected components and subsystems. It is, therefore, a major business objective of USABC to enhance a supplier base as the development progresses.

All developers submitting proposals will be required to demonstrate that they have the potential to develop a commercially viable business, which can produce sufficient volumes to meet automotive requirements, and provide engineering and testing support to meet automotive implementation requirements. Research organizations with current, direct affiliations with businesses that derive a majority of their income from related product sales, will also be considered. At the time of submittal, all developers will be required to have demonstration hardware and test results available for USABC inspection. Testing performed in accordance with the USABC battery test procedures is preferred, however not mandatory. Inspection and test of hardware by the USABC may be included in the selection process. Developers who do not have hardware and test results available for inspection by USABC at the time of submittal need not respond. Proposals should be meaningfully different from other proposals previously offered to USABC.

3.0 Developmental Timing

The proposals must be accompanied by a development time chart characterizing the following:

1. Length of time the technology has been under development by the developer
2. Length of time remaining to full scale, 48V HEV prototype hardware availability
3. Time line for commercialization, including any preproduction phases that may be planned

4.0 Business Case

The submittal must be accompanied by a business case, divided into two sections. The first section shall state the cost assumptions used that will lead to the cost targets listed in Attachment A. These assumptions should be in general terms, broken down by major components, including material cost, processing cost and other costs. These costs should be presented in sufficient detail such that they can be used by the USABC to build confidence that its cost targets can be met by the technology.

The second portion of the business case is to address the anticipated capital investment required to support this initial program investment, including anticipated non-automotive markets for the technology, sources of capital, etc. A copy of the USABC cost model, which is a multi-stage spreadsheet, is available on the USABC website;

http://www.uscar.org/guest/article_view.php?articles_id=143. **USABC will not provide funding for capital expenses.**

5.0 Technical Challenges

Proposals must be accompanied by a clear description of the remaining technical challenges that the developer still needs to meet in order to commercialize the proposed technology and meet USABC's target criteria. The proposal will include performance issues, and also assembly and cost related issues such as commercial availability of materials required, and any special handling or assembly requirements. A narration of the technical challenges that have already been met to reach the present state of the demonstration hardware will also be useful. In the case a cell or system has already been constructed and tested at an early level of development, be sure to describe how the articles performed relative to expectations and how the results guide the work in this proposal. Any testing, by USABC, of pre-contract demonstration hardware will be done in

accordance with the USABC battery test procedures. The procedures for a 48V HEV battery are currently in development, but will be published at:

http://www.uscar.org/guest/article_view.php?articles_id=86

6.0 Information Requested

The information USABC is requesting from interested parties is specified in the following subsections. It includes: (1) a brief description of your company(s) background; (2) the advanced battery technology being proposed; (3) the development plan for the technology; (4) the proposed program deliverables, timing, and cost-share; (5) any formal or informal teaming arrangements planned; and (6) acknowledgement of export control compliance.

USABC does not expect to award contracts on the sole basis of responses to this RFPI. All responses will be considered by representatives of the USABC and other participants and will be ranked in order of merit. The submitters of the most promising proposals will be contacted by USABC to enter into negotiations that may lead to firm contractual arrangements. If the government and other funding become available, as now expected, USABC intends to award one or more development contracts. However, nothing herein should be interpreted as a commitment to award a contract.

Information requested below should be answered as thoroughly as possible within a maximum of twenty five pages, in total, for the response to the RFPI. Your submission package should be sent via electronic mail and shall contain a cover letter, a complete copy of your proposal and, a signed copy of the RFPI Agreement. All technical and financial material submitted to the USABC must be in the English language. If you have any questions concerning the RFPI, please contact Oliver Gross @ (248) 219-3011 or Maureen LaHote @ (313) 910-3720.

NOTWITHSTANDING PROPOSER'S MARKINGS TO THE CONTRARY, ALL INFORMATION SUBMITTED IN RESPONSE TO THIS USABC RFPI SHALL BE TREATED ON A NON-CONFIDENTIAL BASIS.

ALL PROPOSALS ARE TO BE SUBMITTED TO THE CONSORTIUM IN ACCORDANCE WITH THE ATTACHED RFPI AGREEMENT WHICH MUST BE EXECUTED WITHOUT MODIFICATION AND ACCOMPANY THE PROPOSAL. NO PROPOSAL SHALL BE EVALUATED BY THE CONSORTIUM WITHOUT PRIOR EXECUTION OF SUCH RFPI AGREEMENT.

SEND, VIA ELECTRONIC MAIL, YOUR PROPOSAL (including signed RFPI Agreement) TO:

**Maureen LaHote
Business Manager
United States Advanced Battery Consortium
E-mail: mlahote@uscar.org**

6.1 Company Background

In order to become more fully familiar with your company(s), the USABC needs background information about your business. If your proposal is for a team, furnish the requested information for each company that makes up your team. Please answer/furnish the following information:

- Describe your company's structure, ownership, product lines, and customer base, including domestic and foreign facilities for research and production of cells or larger battery units.
- Please describe how previous R&D successes (especially with USABC or DOE) have been incorporated into the current proposal.
- Please describe the company's experience (if any) in the high volume manufacture of cells of the size and or chemistry proposed, especially experience supplying automotive OEMs.
- If publicly owned, include the most recent 3 years of Annual financial statements. Also include the most recent, 10k, and 10Q Reports. If privately held, include the last 3 years of Balance Sheets, Income Statements, and a Sources & Uses of Funds Statement.
- Enclose a copy of your company's Business Plan for areas related to electrochemical energy storage technology.
- Describe the resources (headcount, expenses, and facilities) devoted to electrochemical energy storage technology development for the previous three years, currently, and forecasted through the expected project period of performance.
- Describe the modeling methods your company uses to estimate costs at sales volumes of 250,000 units/year and greater.
- Do you currently hold any licenses and/or patents or pending patent applications for advanced electrochemical energy storage technology and manufacturing processes? If so, please describe. Are there any restrictions on licensing this technology?
- Provide any projections on potential production for the proposed technology. Also, describe key technical innovations that could lead to high performance and cost effective electrochemical energy storage subsystems.
- Provide a brief resume on key personnel to be dedicated to the project.

6.2 Proposed Electrochemical Energy Storage Technology

In preparing a reply to the RFPI please provide a response to each of the following points. A thorough technical and financial evaluation review of each proposed technology is required prior to the award of any contract for development.

Provide a brief technical description of the proposed technology that will meet the 48V HEV criteria listed in Attachment A. Note the method used for the determination of each entry in Appendix A (USABC or other methods). Please indicate if the system numbers indicated are estimates.

Summarize the present status of the proposed technology, including:

- Physical, performance, and life characteristics of all relevant hardware built and tested at your facilities, or at independent test facilities
- Packaging constraints or limitations applicable to your technology, such as vertical-only orientation, minimum footprint, etc.
- Any environmental and safety issues relating to manufacturing, recycling, use and disposal of the proposed technology
- Dominant failure mechanisms that limit operating life, and use restrictions desired/required to maximize the life of the subsystem
- Summarize the characteristics of the current technology by using the table provided in Appendix A and adding an additional column that describes your technology on a pack level. This gap analysis should indicate the number of cells or modules used to calculate your technology's performance against the requirements. Targets and developer entries correspond to End-of-Life values (EOL), and thus a reasonable margin must be included to allow for degradation over life, commensurate with the cell technology's expected behavior.

Provide the cell-level attributes requested in Appendix B corresponding to the proposed technology's current status and projected performance characteristics at the end of the program. Unlike the system-level values in Appendix A, Appendix B entries correspond to Beginning-of-Life (BOL) conditions, and thus represent actual (measurable) cell performance.

- Provide any relevant quality-related metrics.

6.3 Proposed Technology Development Plan

Propose how the component/subsystem technology would be developed to meet the USABC technical criteria including:

- Barriers that must be overcome (should be closely based on the provided gap chart)
- Task objectives needed to overcome the barriers, including the approaches, contingency plans, success criteria, and demonstration tests. A work breakdown structure is helpful but not required.
- Feasibility and scale-up issues that must be resolved
- Transition from feasibility demonstration to prototype hardware

Separately propose how the technology could be produced in high volume. Define the raw materials, processes, capital equipment, and labor required at the desired production levels. Discuss the overall timing required to achieve initial production, including prove-out. Define any

intermediate steps required to reach initial rated production including pilot plants, technical challenges regarding the manufacturing process, and their time frame.

Define any additional technical issues, and their possible resolution, concerning the proposed technology relevant to a 48V HEV application. Propose a warranty structure for the subsystem corresponding to the initial commercial production level.

Provide a projected cost breakdown of the proposed technology, including costs projected for the desired production volumes. Costs related to warranty and/or replacement, and recycling should be clearly indicated. The manner in which the projected costs, volumes and time schedules are expected to be achieved should also be provided.

The proposals must be accompanied by a development time chart characterizing the following:

1. Length of time the technology has been under development by the developer
2. Length of time remaining to full scale, 48V HEV prototype hardware availability
3. Time line for commercialization, including any preproduction phases that may be planned

6.4 Proposed Program Schedule, Deliverables, Cost, and Cost Sharing

Developers must clearly identify their milestone objectives. The setting of major milestones and timing will be reviewed and agreed upon between each USABC Work Group and the corresponding subsystem developer/supplier team. It is anticipated that there will be intensive interaction between both parties in setting program milestones. The involvement of all team member organizations in the setting of program milestones is strongly encouraged.

The delivery of prototype hardware for test and evaluation will be scheduled, on a continuing basis, as developments warrant. Details of scheduling would be agreed upon with the developer and the USABC Work Group. The evaluation of deliverable hardware will be undertaken at several testing facilities, such as the National Laboratories and those of the USABC partners. The battery test schedule will be agreed upon by the USABC Work Group, subsystem developer, and the test facilities.

Developers are expected to contribute or cost share in the developmental costs. The developer should submit proposals indicating cost sharing as a percentage of the total proposed program development amount. The extent of cost sharing may be negotiated between USABC and the development team, taking into consideration whether the company is domestic, foreign, or foreign controlled, rights to license background and foreground technology, benefits to US economy, and other factors. However, a minimum of 50 percent developer cost share is contractually required. The Developer will agree that at least 75% of the direct labor billed to the USABC, for this project will be incurred within the United States.

The proposer shall provide cost breakdown between labor, materials, indirect costs, etc. and a separate analysis of total costs for each major task. The tasks that each subcontractor will complete and the funding they will receive should be clearly indicated in the cost breakdown.

Contractors will provide quarterly reports to USABC, including test data and development progress. A final report will be submitted to USABC at the end of the contract period.

6.5 Cooperative Relationships

The proposal should indicate any additional resources that may be required beyond those of the contractor to achieve program goals. This would include the development of cooperative relationships between component developers, component manufacturers, and subsystem integrators. Other cooperative relationships could involve National Laboratories or Universities for materials research, test facility development, test and analytical procedures, or other techniques available only at specialized locations.

6.6 Export Control Compliance

The proposer will be required to acknowledge that export control rules limit or prohibit the transfer of covered technology to foreign nationals and agrees to establish and maintain internal controls and procedures adequate to insure accurate determination by the proposer of whether and when its technology falls within the ranges and definitions of the currently effective export control regime.

RFPI AGREEMENT

NOTWITHSTANDING PROPOSER'S MARKINGS TO THE CONTRARY, ALL INFORMATION SUBMITTED IN RESPONSE TO A UNITED STATES ADVANCED BATTERY CONSORTIUM (USABC) REQUEST FOR PROPOSAL INFORMATION (RFPI) SHALL BE TREATED ON A NON-CONFIDENTIAL BASIS.

AGREED:

BY _____

TITLE _____

PROPOSER _____

DATE _____



APPENDIX A - USABC Goals for Advanced Batteries for 48V Hybrid Electric Vehicle Applications

USABC Requirements of Energy Storage Systems for 48V HEV's at EOL

Characteristics	Units	Target
Peak Pulse Discharge Power (10 sec)	kW	9
Peak Pulse Discharge Power (1 sec)	kW	11
Peak Regen Pulse Power (5 sec)	kW	11
Available Energy for Cycling ¹	Wh	105
Minimum Round-trip Energy Efficiency	%	95
Cold cranking power at -30 °C (three 4.5-s pulses, 10s rests between pulses at min SOC)	kW	6 kW for 0.5s followed by 4 kW for 4s
Accessory Load (2.5 minute duration) ¹	kW	5
CS 48V HEV Cycle Life ²	Cycles /MWh	75,000 / 21
Calendar Life, 30°C	year	15
Maximum System Weight	kg	≤8
Maximum System Volume	Liter	≤8
Maximum Operating Voltage	Vdc	52
Minimum Operating Voltage	Vdc	38
Minimum Voltage during Cold Crank	Vdc	26
Maximum Self-discharge	Wh/day	1
Unassisted Operating Temp Range (Power available to allow 5s charge and 1s discharge pulse) at min. and max. operating SOC and Voltage	°C	-30 to +52
30 °C - 52 °C	kW	11
0 °C	kW	5.5
-10 °C	kW	3.3
-20 °C	kW	1.7
-30 °C	kW	1.1
Survival Temperature Range	°C	-46 to +66
Max System Production Price @ 250k units/yr	\$	\$275

¹Total usable energy will include cycling energy and accessory load energy. The usable energy will be 313Wh

²Each individual cycle profile includes six (6) start-stop events, for a total of 450k events over the duration of the test.

A blank GAP chart form is available at:

http://www.uscar.org/commands/files_download.php?files_id=362

**APPENDIX B –Attributes of Cell Technology
Proposed for 48V HEVs for FY 2020 Commercialization**

Cell Level Attributes (supplied by developer)	Units	Current State (baseline) (i)	End of Program Target (i)
Cell Capacity (1-C discharge)	Ah		
Cell Volume (without terminals/tabs)	Liter		
Cell Mass	g		
Vmin continuous, V max continuous (0 and 100% SOC)	V, V		
Vmin pulse, V max pulse	V, V		
Vnominal	V		
Energy Density (volumetric)	Wh/l		
Specific Energy	Wh/g		
Power Density (10 sec. HPPC power)	W/l		
Specific Power (10 sec. HPPC power)	W/g		
Target Cost / unit (>3 million cells/annum rate)	\$		
Cell format (cyl/pris)	can/pouch/etc .		
Cell dimensions: (height x width x thickness)	mmxmmxmm		
Proposed Architecture to Achieve System Targets			
Battery Size Factor (BSF)	#		
Parallel-Series Configuration	_p_s		

i Values correspond to Beginning-of-Life (BOL)