<table>
<thead>
<tr>
<th>Organization Name</th>
<th>AMPED Project Title:</th>
<th>Contact Name:</th>
<th>Contact Address:</th>
<th>Contact Email:</th>
<th>Contact Phone:</th>
<th>Organization Type</th>
<th>Brief Description of Capabilities &amp; Other AMPED Related Service Offerings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive Research Center, University of Michigan</td>
<td>Control Enabling Situations with Ultrafine Strain and Temperature Sensor System for Relaxed Battery Life Cycle-Cost</td>
<td>Arasi Shinarapaddu</td>
<td>Mechanical Engineering, Univ of Michigan, 2944 W. Livy Auto Lab., 1222 N. Rose Ave, Ann Arbor MI 48109-2133</td>
<td><a href="mailto:arasi@umich.edu">arasi@umich.edu</a></td>
<td>734 615-8661</td>
<td>Sub-recipient</td>
<td>Will use readapted physics models for selecting the critical sensor locations, extracting the thermal and stress features for new battery control algorithms. On-board parameterization of control-oriented models for batteries and other power sources (exhausts, fuel cells and internal combustion engines). Sensor information fusion for estimation, decision, and control. Optimal control for range extension under mission constraints. Optimal cold start policy. Observability and diagnostics for imbalanced clusters of cells. Fault detection. In-vehicle measurements of real-time lithium concentration such as neutron imaging, radiography and efflux. Post-mortem morphological and electrochemical analysis.</td>
</tr>
<tr>
<td>Battelle Memorial Institute</td>
<td>Battery Fault Sensing in Operating Batteries</td>
<td>Jim Saunders</td>
<td>575 King Ave, Columbus, OH 43260</td>
<td><a href="mailto:jsa@battelle.org">jsa@battelle.org</a></td>
<td>614-444-3771</td>
<td>Non-Profit R&amp;D</td>
<td>Principal Organization</td>
</tr>
<tr>
<td>Battelle Energy Systems, a division of BWBC Corporation</td>
<td>SENSOR ENHANCED LIFE EXTENSION OF BATTERIES FOR ENERGY STORAGE</td>
<td>Brad Moore</td>
<td>4625 Center Ridge Road, North Ridgeville, OH 44039</td>
<td><a href="mailto:bmoore@battellecorp.com">bmoore@battellecorp.com</a></td>
<td>440-353-6257</td>
<td>Sub-recipient to DNV</td>
<td>Providing distributed energy storage system and operating expertise with second-use batteries to test sensor and validate life-extension model. Battelle energy systems is a manufacturer and integrator of the best available technologies to offer solutions for the emerging markets of energy storage, renewable energy integration and micro grids. Our products include LWH's lead battery modules, energy management controller (serves as master controller to coordinate equipment and battery management systems), and fully integrated, modular distributed energy storage systems of 25 kW ~ 100 kW with storage capacity of 1 ~ 6 hours.</td>
</tr>
<tr>
<td>DNV</td>
<td>Sensor Enhanced and Model Validated Life Extension of Batteries for Energy Storage</td>
<td>Dawson M Hill, PhD</td>
<td>5777 Forever Blvd., Dublin OH 43017</td>
<td><a href="mailto:Dawson.M.Hill@dtn.com">Dawson.M.Hill@dtn.com</a></td>
<td>614 761 1214</td>
<td>Sub-recipient to IAN</td>
<td>DNV is involved in the testing and qualification of an offgas sensor to monitor battery performance and stresses, and to validate its use as a state of health indicator. The demonstration will be with an energy storage system. DNV and OVIN KEMA service offerings include high power testing, certification of power electronics, and cycling and field testing of energy storage systems up to 20MW. Drawing upon the expertise within DNV Corporate Research, we expand upon certification and testing services into R&amp;D and system development. We also complement these testing services with modeling and techno-economic analysis. Our goal is to enable new energy storage technologies with validation and R&amp;D projects with a balanced analysis and testing approach.</td>
</tr>
<tr>
<td>DNV-KEMA</td>
<td>Sensor Enhanced and Model Validated Batteries for Energy Storage</td>
<td>All Nuclear</td>
<td>1211 Shannon Glen Blvd</td>
<td><a href="mailto:al.nourai@dnvkema.com">al.nourai@dnvkema.com</a></td>
<td>319-980-7487</td>
<td>Engineering consulting, testing, and research</td>
<td>Principal Organization</td>
</tr>
<tr>
<td>Eaton Corp</td>
<td>Predictive Battery Management System for Commercial Hybrid Electric Vehicles</td>
<td>Bryan Farrern</td>
<td>7945 Wayzata Rd., Eden Prairie, MN 55344</td>
<td><a href="mailto:BryanFarrern@Eaton.com">BryanFarrern@Eaton.com</a></td>
<td>512-937-7241</td>
<td>Large Business</td>
<td>Principal Organization</td>
</tr>
<tr>
<td>Gayle Technologies, Inc.</td>
<td>BATTERY Project</td>
<td>Jeremy Gayle</td>
<td>111 Rs, Microphonics and the</td>
<td><a href="mailto:jgayle@gayleton.com">jgayle@gayleton.com</a></td>
<td>615.564.0626</td>
<td>Large Business</td>
<td>Principal Organization</td>
</tr>
<tr>
<td>General Electric Global Research</td>
<td>Control Enabling Situations with Ultrafine Strain and Temperature Sensor System for Relaxed Battery Life Cycle-Cost</td>
<td>Aaron Knobloch</td>
<td>Research, North Niskayuna, NY 12309</td>
<td><a href="mailto:knobloch@research.ge.com">knobloch@research.ge.com</a></td>
<td>518-387-1950</td>
<td>Industry</td>
<td>Principal Organization</td>
</tr>
</tbody>
</table>
1. **National Renewable Energy Laboratory (NREL)**

   - **1. Power Management of Large Battery Packs**: with Utah State University, the team develops electronic hardware and control software for advanced battery management systems. The focus is on the physical design and implementation of the battery management systems and the development of solutions that can optimize performance and safety.
   - **2. Battery Management System Design**: with Washington University, the team focuses on the design of battery management systems that are optimized for performance and safety.
   - **3. Predictive Battery Management for Hybrid Vehicles**: with Eaton Corp.

   Ahmad Pasearan
   15013 Denver West Parkway, Mail Stop H333, Golden, CO 80401-3305
   Ahmad.pasearan@nrel.gov
   303-275-4441

   - **1. Researchers at NREL will work with the Utah State University team to develop electronic hardware and control software for advanced battery management systems that can monitor the performance and safety of large battery packs.**
   - **2. Eaton Corporation will collaborate with NREL to develop a control system for optimizing the operation of commercial-scale electric vehicle batteries, integrating NREL’s battery life prediction models with Eaton’s control algorithms.**

2. **PolyPhase Energy Corporation**

   - **1. Power electronics and battery systems**: PolyPhase Energy Corporation specializes in the development of high-performance power electronics and battery systems for electric vehicles and renewable energy applications.
   - **2. PolyPhase Energy Corporation has extensive experience in all aspects of lithium-ion and supercapacitor applications.**
   - **3. PolyPhase Energy Corporation offers end-to-end solutions for battery and supercapacitor systems, including design, development, and deployment.**

   *Note: The information provided is a summary of the text and does not include all details.*
Advanced Battery Management Systems

Principal Organization

UCSD, Dept. MAE, Department of Academic

(210) 522-

Battery Management System based on thermal-electrochemical

Federally Funded

Academic

4120 Old Main Hill

4005 Miranda

Robust Cell-level Modeling and Control of Seedling project – 314-935-5676

Dr. Nalin Chaturvedi (435) 797-

Washington University in Utah State University

Colorado Springs (UCCS)

San Diego

University of California,

Southwest Research Laboratories

sandia.gov

Sensor Technology

Stationary Batteries

Robert Bosch LLC

Management Techniques

Modeling and Adaptive Battery Batteries Based on Real Time Predictive Optimal Operation and Management of large battery packs

Robust cell-level modeling and control of advanced physics-based electrochemistry models using estimation methods for partial differential equations. Design of controllers for battery management (of the state of charge based on state of health and other constraints). SwRI leads the Energy Storage System Evaluation and Safety (EssEs) Consortium in developing pre-competitive detailed testing on electrochemical batteries from a diverse range of manufacturers and products. SwRI performs research to advance the testing methodologies to benchmark batteries and evaluate cells with respect to performance, cycle life, and safety/abuse in steady-state and transient conditions present in vehicular and grid-storage applications. New map-based cycle life approaches were developed for multiple applications including very aggressive cycling at variable charge/dischage rates that approach the boundary of cell operating envelope. An analytical tool has been developed for dynamical behavior and life degradation prediction that can be used to maximise the lifespan of batteries. SwRI also uses accelerated durability tests to address the safety of Li-ion battery packs including overcharging, thermal shock, and thermal runaway (using rate calorimeters). Furthermore, SwRI is developing SOC and SDH sensors under ARM T to improve the survivability of electrochemical battery-powered equipment.

Institution

Advanced Battery Management Systems

Advanced Battery Management Systems

Utah State University

University of California, San Diego

University of Colorado, Colorado Springs (UCSS)

University of Utah

Advanced Battery Management Systems

Advanced Battery Management Systems

Advanced Technology/Battery Energy Storage (BES)

Global Optimal Operation and Management of Batteries Based on Real Time Predictive Modeling and Adaptive Battery Management Techniques

Venkat Subramanian

Department of Energy, Environmental and Chemical Engineering, Washington University in St. Louis, MO 63130

WLSU Battery Management System based on thermal/electrochemical model

BMS based on nearest physics based models. Enabling real-time simulation, optimization and control of most detailed physics based model

February 2013

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