This is a contacts list of Advanced Management & Protection of Energy-storage Devices (AMPED) project investigators who wish to actively pursue teaming opportunities for any current or future funding announcements related to HESM.
More information on the AMPED program and the individual projects funded under AMPED can be found at http://arpa-e.energy.gov/?q=projects/view-programs .

| Organization Name: | AMPED Project Title: | Contact Name: | Contact Address: | Contact Email: | Contact Phone: | Organization Type: | Organization Affiliation w/ AMPED Project: | Focus Area of AMPED Related Work: | Brief Description of Capabilities & Other AMPED Related Service Offerings: |
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| **Automotive Research Center, University of Michigan** | Control Enabling Solutions with Ultrathin Strain and Temperature Sensor System for Reduced Battery Life Cycle Cost | **Anna Stefanopoulou** | Mechanical Engineering, Univ of Michigan, 2044 WE Lay Auto Lab , 1231 Beal Ave, Ann Arbor MI 48109-2133 | annastef@umich.edu | 734 615-8461 | Academic Institution | Sub-recipient | U-M will use multiphysics 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 (capacitors, fuel cells and internal combustion engines). Sensor information fusion for estimation, decision, and control. Optimal strategies for range extension under mission constraints. Optimal cold start policy. Observability and diagnostics for imbalanced clusters of cells. Fault detection. In-situ measurements of real-time lithium concentration such as neutron imaging, radiography and diffraction. Post-mortem morphological and electrochemical analysis. |
| **Battelle Memorial Institute** | Battery Fault Sensing in Operating Batteries | **Jim Saunders** | 505 King Ave, Columbus, OH 43201 | jhs@battelle.org | (614) 424-3271 | Non-Profit R&D | Principal Organization | The AMPED project is focused on developing an optical sensor to detect local faults, including the growth of dendrites in the battery. The program will also determine whether it is possible to use optical means to detect the degradation of electrodes or electrolytes in the battery using optical means, and whether local heating can be determined. | Battelle is a multi-disciplinary R&D organizations with expertise in materials, electrochemistry, thermal systems, controls, modeling, hardware and software development, and systems integration. Battelle has worked across the full range of TRL levels, ranging from development of new materials to small-scale manufacturing of deployed power systems. Battelle also has experience with developing and deploying power systems ranging from microwatts to megawatts. |
| **Beckett Energy Systems, a division of RW Beckett Corporation** | SENSOR ENHANCED AND MODEL VALIDATED LIFE EXTENSION OF BATTERIES FOR ENERGY STORAGE | **Brad Moore** | 38251 Center Ridge Road North Ridgeville, OH 44039 | bmoore@beckettcorp.com | 440-353-6257 | Private Corporation – Systems Integrator, Manufacturer | Sub-recipient to DNV | Providing distributed energy storage system and operating expertise with second use batteries to test sensor and validate life extension model | Beckett 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 1 kWh Li-ion battery modules, energy management controller board (serves as master controller to coordinate equipment and battery management system), and fully integrated, modular distributed energy storage systems of 25 kW – 100 kW with storage capacity of 1 – 4 hours. |
| **DNV** | Sensor Enhanced and Model Validated Life Extension of Batteries for Energy Storage | **Davion M Hill, PhD** | 5777 Frantz Rd, Dublin OH 43017 | Davion.M.Hill@dnv.com | 614 761 1214 | Engineering consulting, testing, and research | Principal Organization | DNV is involved in the testing and qualification of an off gas 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 DNV-KEMA service offerings include high power testing, certification of power electronics, and cycling and field testing of energy storage systems up to 2MW. Drawing upon the expertise within DNV corporate research, we expand upon certification and testing services into R&D and system development. We also compliment these testing services with modeling and technoeconomic analysis. Our goal is to enable new energy storage technologies with validation and R&D projects with a balanced analysis and testing approach. |
| **DNV KEMA** | Sensor Enhanced and Model Validated Batteries for Energy Storage | **Ali Nourai** | 8212 Shannon Glen blvd | Ali.nourai@dnvkema.com | 614 940 7847 | Engineering consulting, testing, and research | Principal Organization | Energy Storage - safety | Applications of Energy storage for grid |
| **Eaton Corp** | Predictive Battery Management System for Commercial Hybrid Electric Vehicles | **Bryan Farrens** | 7945 Wallace Rd, Eden Prairie, MN 55344 | BryanFarrens@Eaton.com | 952-937-7241 | Large Business | Principal Organization | ·Accurate and real-time pack-level battery prognostics.<br>·System-level optimal control strategy to dynamically maximize performance with minimum impact on battery life.<br>·Load prediction to ensure robustness of approach to varying application and environment conditions.<br>·Modular framework scalable to multiple source-load configurations. | Eaton Corp. core capabilities focus on advanced algorithms and design of automatic controls, diagnostics, prognostics, and system modeling and optimization, data mining, signal processing, communications, safety and systems engineering, power systems architecture, micro-grids design and prototyping, power distribution control. Test facilities include hardware-in-loop testing, bench testing and rapid prototyping of power systems. |
| **Gayle Technologies, Inc.** | SUMMIT Project | **Jimmy Gayle** | 10 Quality Way Nashville, TN 37207 | Jimmygayle@gayletech.com | (615)262-0626 | Small Business | Principal Organization | Develop an ultrasonic nondestructive testing system that reports the state of health of a battery with real-time output. | Gayle Technologies, Incorporated ("GTI" referred to as "the Company"), is an *acoustical mechanical ultrasound company* based out of Nashville, Tennessee, providing cutting edge technologies to manufacturing and industrial customers. The Company manufactures and distributes several specialized products, including, but not limited to: Ultraphonics® 111Rs, Microphonics® A07s, and CarScan© and the patented (#7,387,026) CarGate® Ultrasound Leak Check System. Mr. Gayle, the CEO of GTI, has also been issued a patent (7,987,720) Ultrasonic sensing array system and method that will cover the use and method of detecting leaks in substantially closed objects, such as automobiles, airplanes, tanks and other vehicles, using ultrasonic transmitter and one or more ultrasonic sensors or receivers.<br><br>GTI's management has led the acoustical ultrasound technology marketplace for over 20 years. The corporate offices house a research and development facility that provides new ground breaking solutions at a global level. GTI has designed, built and tested solutions for its clients via the use of acoustic ultrasound. These "sound solutions" provided to customers, help improve clients' value in the marketplace and meet a critical need to increase profitability while improving quality. |
| **General Electric Global Research** | Control Enabling Solutions with Ultrathin Strain and Temperature Sensor System for Reduced Battery Life Cycle Cost | **Aaron Knobloch** | 1 Research Circle Niskayuna, NY 12309 | knobloch@research.ge.com | 518-387-7355 | Industry | Principal Organization | GE is developing low-cost, thin-film sensors that would enable realtime mapping of temperature and surface pressure for each cell within in a battery pack, which could help predict how and when batteries fail. | We could develop custom prototypes of at least the temperature sensors in the near term for interested parties and custom strain sensors could be prototyped in 2014. |

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| **National Renewable Energy Laboratory (NREL)** | 1. Power Management of Large Battery Packs - Utah State University<br>2. Battery Management System Design - Washington University<br>3. Predictive Battery Management for Hybrid Vehicles -Eaton Corp. | **Ahmad Pesaran** | 15013 Denver West Parkway, Mail Stop:1633, Golden, CO 80401-3305 | Ahmad.pesaran@nrel.gov | 303-275-4441 | Federally Funded Research and Development Center | Sub-recipient on 3 awards | 1. Researchers at NREL will work with the Utah State University team to develop electronic hardware and control software for an advanced plug-in hybrid electric vehicle battery management system to maximize the lifetime of each cell in a battery pack.<br>2. WashU/NREL team will develop a predictive battery management system with innovative control hardware that uses advanced mathematical models to optimize battery performance.<br>3. Eaton Corporation will collaborate with NREL to develop a power control system to optimize the operation of commercial-scale hybrid electric vehicles, integrating NREL battery life predictive models with Eaton HEV control algorithms. | 1. Physics-based battery and energy storage modeling toolset –NREL computational models span material- to system-scale analysis of battery life, performance and safety, and range from empirical to 3D multi-physics models. Suitable for embedded control applications, NREL has developed fast-running models based on vector fitting, fractional derivative and other order-reduction techniques.<br>2. Experimental and Matlab-based analytical tools to evaluate hybrid energy storage systems such as battery-ultracapacitor, battery-battery, asymmetric electrochemical capacitors fuel cell-battery, fuel cell-ultraccapacitor,<br>3. Estimation algorithms – Kalman, Extended Kalman, and Particle Filter algorithms enabling real-time tuning of performance & life models on embedded controllers<br>4. Business decision models – Techno-economic models to quantify the value energy storage devices in vehicle, grid and other applications<br>5. Robust fault detection – Fail-safe pack-level design architecture for cell fault detection and isolation (NREL IP)<br>6. Safety testing and thermal abuse modeling– On-demand internal short trigger for simulation of field failure in test articles (NREL IP). Also thermal abuse and internal short circuit modeling<br>7. Thermal monitoring and management – Unique test laboratory capabilities for thermal characterization as it relates to battery performance, life, safety & balance of plant systems<br>8. Electric vehicle simulation, testing, and evaluation - Simulation and testing based evaluation of advanced vehicle technologies to determine their impact on fuel economy, vehicle performance, exhaust emissions, vehicle component cost, and market potential<br>9. Electric Vehicle Grid Integration – Unique capabilities in the development and implementation of electrified transportation systems, particularly those that integrate renewable-based vehicle charging systems.<br>10. Power Electronics - Developing management systems for advanced power electronics and looking at technologies to improve reliability, efficiency, and ruggedness. |
| **NexTech Materials** | Sensor Enhanced and Model Validated Batteries for Energy Storage | **Lora Thrun** | 404 Enterprise Dr., Lewis Center, OH 43035 | l.thrun@nextechmaterials.com | 614 842-6606 | Manufacturing | Sub-recipient to DNV | Sensors for monitoring battery health, providing diagnostics, and providing feedback for action or alarm | NexTech has developed patented sensor technologies for detecting gas species associated with leaking or decomposition of Li-ion battery components. Coupled with electronics, these sensors can potentially be used to detect early signs of battery failure, alarm of any impending failure, and execute a shut down under extreme conditions. Working with DNV, we are also investigating the use of sensor technology to better understand degradation mechanisms in batteries. NexTech can custom develop and manufacture sensors for challenging applications. |
| **NexTech Materials, Ltd.** | Sensor Enhanced and Model Validated Life Extension of Batteries for Energy Storage | **Scott L. Swartz, Ph.D.** | 404 Enterprise Drive<br>Lewis Center, OH 43035 | s.swartz@nextechmaterials.com | (614) 842-6606, x103 | Engineering and Manufacturing | Sub-recipient to DNV | As a subcontractor to DNV, NexTech is involved in the development and testing of an off gas sensor to monitor off-gas species from degraded lithium ion batteries, with the aim of using this sensor as a state of health indicator. NexTech will provide prototype sensors to DNV for demonstration within an energy storage system. | NexTech Materials is a developer and manufacturer of ceramic electrochemical systems, including solid oxide fuel cells and ceramic gas sensors. NexTech has demonstrated gas sensors with the capability for detecting minute quantities (e.g., less than 50 parts per billion) of common lithium ion battery electrolyte materials, such as dimethyl carbonate and dimethyl carbonate. The ability to detect these species at such low concentrations offers potential for either prediction of imminent battery failure so that failure can be prevented. Alternatively, the sensor technology can be used as an alarm for safety purposes. NexTech also manufacturers hydrogen safety sensors and is developing gas sensor technology for a number of gas species, including carbon monoxide, hydrocarbons, VOCs, and hydrogen sulfide. |
| **Oak Ridge National Laboratory** | Temperature Self-regulation of Large Format Li-ion Cells | **Hsin Wang** | MS-6064, Bldg 4515, 1 Bethel Valley Road, Oak Ridge, TN 37831 | Wangh2@ornl.gov | 865-576-5074 | Federally Funded Research and Development Center | Principal Organization | Cell temperature control via alternative cooling paths. Modeling of cell temperature during operation and under various cooling, temperature regulation conditions, especially on the benefits of side-cooling. | Our project will demonstrate the benefit of cooling the large format cell utilizing the high thermal conductivity of the current collectors inside the cells. Temperature control from the side of the cell instead of the top and bottom surfaces are expected to show benefits for high capacity cells with certain form factors (e.g. thicker cells). The electrochemical based modeling will provide realistic heat generation for given cell chemistry and designs and the thermal modeling will allow us to select the type of cells that will show the maximum cost and performance benefits from side cooling. Other capabilities related to this project include: cell manufacturing capability at Farasis Energy, cycling, IR imaging and testing facilities at ORNL. Another relevant capability is an UL backed pinch test for internal short circuit and thermal runaway of pouch cells, currently in collaboration between Naval Surface Warfare Center and DOE VTP. |
| **Palo Alto Research Center (PARC)** | Smart Embedded Network of Sensors with Optical Readout (SENSOR) | **Rob McHenry** | 3333 Coyote Hill Rd, Palo Alto CA 94304 | Rob.McHenry@parc.com | 650-812-4730 | Large Business | Principal Organization | PARC and LG Chem Power are developing a fiber optic smart monitoring system targeting battery management systems for electric vehicles. The system will use PARC's low-cost, compact wavelength-shift detection technology and machine learning/sensor network expertise to enable accurate state estimation, effective real-time performance management, and optimized battery design; and will undergo industry-standard validation. | PARC believes that the greatest opportunity to improve the performance of batteries lies in the ability to extract more power from the batteries already on the market. PARC has developed a portfolio of technologies that change how batteries are manufactured, monitored, and controlled in order to dramatically improve their performance for various challenging applications such as electric vehicles, grid storage, defense and aerospace systems. In addition to the AMPED SENSOR project, PARC is actively working on:<br><br>* Adaptive model-based controls for battery management that optimize the operational value of battery assets: complex wear and cost functions are balanced in realtime against performance requirements (e.g. in EVs) or revenue opportunities (e.g. for grid storage).<br>* Co-extrusion printing of battery electrodes that introduces a revolutionary structural design element for battery optimization. Performance of existing chemistries is improved by depositing enhanced energy storage and enhanced ionic transport regions. |
| **PolyStor Energy Corporation** | Battery Management System with Distributed Wireless Sensors | **James Kaschmitter** | 470 Lindbergh Ave. Livermore, CA 94551 | jkaschm@yahoo.com | (925) 570-7251 | Small Business | Sub-recipient | PolyStor is building novel custom cells for AMPED. These high energy cells have sensors incorporated internally and externally to monitor cell performance and safety. The sensors communicate wirelessly with the pack's BMS. | PolyStor has expertise in all aspects of lithium-ion and supercapacitor cell and pack technology. PolyStor's team has more than 50 years of cumulative experience in cell and pack design, for both lithium-ion and supercapacitors, including introduction of the world's first NiCo cell and the carbon aerogel supercapacitor. PolyStor has substantial experience with new electrode technologies such as silicon anode and HE NCM cathode. Operational capabilities for battery and supercapacitor development includes complete pouch cell fabrication and test equipment: 1) powder prep; 2) slurry mix; 3) electrode coating; 4) electrode prep and tabbing; 5) cell assembly and electrolyte fill; 6) cell packaging/tab weld; 7) formation; 8) performance and cycle testing under different environmental conditions; 9) pack design and assembly, including BMS; 10) battery/supercapacitor hybrid design and build.. The cell assembly line is fixtured for lightweight, hermetic cell packaging allowing cells to be packaged in a highly repeatable process. PolyStor also performs contract design and manufacture of electrode tapes. |

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| **Robert Bosch LLC** | Advanced Battery Management Systems | **Dr. Nalin Chaturvedi** | 4005 Miranda Avenue, Palo Alto CA 94086 | Nalin.Chaturvedi@us.bosch.com | (650) 320-2967 | Large Business | Principal Organization | Design of battery management systems for optimal utilization and improved performance of energy storage systems for automotive and grid application. | 1) Design of optimal utilization strategies and SCADA for hybrid energy systems (diesel, battery, PV, etc.), Battery / energy management systems, online energy storage state and parameter estimation development, optimal charge/discharge strategies, and hardware-in-the-loop validation. 2) Physical and empirical modeling, testing, characterization, of lithium ion batteries, flow-batteries and other energy storage systems, aging mechanism modeling & diagnosis. 3) Lab-scale cell design for analysis and in-situ reference electrode measurements. |
| **Sandia National Laboratories** | High-precision Tester for Automotive and Stationary Batteries | **Summer Ferreira** | P.O. Box 5800 MS 0614; Albuquerque NM 87155-0614 | srferre@sandia.gov | 505-844-4864 | Federally Funded Research and Development Center | Sub-recipient | Development of a commercially viable battery tester with measurement precision that is significantly better than today's best battery testers. Improvements in the predictive ability of battery testers would enable significant reductions in the time and expense involved in battery technology validation. | Sandia National Laboratories is a DOE/NNSA National Lab that carries out research and development in Nuclear Weapons, Defense Systems & Assessments, Energy, Climate & Infrastructure Security, and International, Homeland, & Nuclear Security.<br><br>Capabilities include sensors, microsystems, controls, power electronics, battery safety/abuse capabilities, storage, and grid integration.<br><br>Battery Safety and Controls: Battery material synthesis, prototyping, modeling, diagnostics, safety research and abuse testing, life cycle testing, materials analysis, sensors and controls Engineered sensors and controls for battery systems in abnormal environments (e.g. post-accident); in-situ battery diagnostics and modeling for end-of-life prediction.<br><br>Grid-Scale Energy Storage: Experience in grid analytics, power electronics development and controls for energy storage and the development and refinement of battery chemistries and materials, including lithium based systems, sodium based systems, flow batteries. Sandia also has extensive test facilities to accommodate cell and strings of batteries, as well as a 1MW test pad for complete energy storage systems. |
| **Southwest Research Institute** | Novel SOC and SOH Estimation through Sensor Technology | **Cheuk Ng** | 6220 Culebra Road, San Antonio, TX 78238 | Cheuk.Ng@swri.org | (210)522-3311 | Private – Non Profit | Seedling project – single-company project | SwRI is developing a sensing technology to track the performance of lithium-ion batteries during operation. In SwRI's design, strain gages would be strategically placed on the cells to monitor their state of charges and overall health. SwRI is working to develop complex algorithms and advanced circuitry to demonstrate the potential of these sensing technologies at the pack level. | 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/discharge 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 maximize 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 runaways (using rate calorimetry). Furthermore, SwRI is developing SOC and SOH sensors under ARPA-E to improve the survivability of electrochemical-battery-powered equipment. |
| **University of California, San Diego** | Advanced Battery Management Systems | **Miroslav Krstic** | UCSD, Dept. MAE, MC 0411, La Jolla, CA 92093-0411 | krstic@ucsd.edu | 858-822-1374 | Academic Institution | Sub-recipient (Bosch is principal) | Estimation of the state of charge and state of health based on 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). | GENERAL: Control and real-time non-model-based optimization. Adaptive control and estimation techniques for electrochemistry and thermal (battery pack/thermal runaway) dynamics.<br>HESM-SPECIFIC: Static and dynamic modeling (physics-based and data-based) of components of hybrid storage systems. Control and optimization methods (extremum seeking, reference governor, model predictive control) for the management of battery-ultracapacitor and other hybrid storage systems. Energy management to adapt to stochastically fluctuating loading conditions or batteries degrading at unequal rates. Low/high-frequency power splits between battery and capacitor using two-time-scale model approximations and two-stage-actuator allocation methods. |
| **University of Colorado, Colorado Springs (UCCS)** | Robust cell-level modeling and control of large battery packs | **Dr. Scott Trimboli**<br>**Dr. Gregory Plett** | 1420 Austin Bluffs Pkwy., Colorado Springs, CO 80918 | gplett@uccs.edu<br>scott.trimboli@uccs.edu | (719) 255-3490<br>(719) 255-3468 | Academic Institution | Sub-recipient to Utah State University (USU) | Development of advanced physics-based electrochemical cell-level battery models; generation of linear reduced-order models; and application of model predictive control to improve battery performance and extend useful lifetime. Models include battery degradation mechanisms for solid electrolyte interphase (SEI) film growth and lithium deposition plating. | Battery modeling (equivalent circuit, physics-based, reduced-order)<br>Reduced-order battery degradation modeling<br>Optimized controls for charging and power limits<br>Battery testing (cell/module/pack) |
| **Utah State University** | Robust Cell-level Modeling and Control of Large Battery Packs | **Dr. Regan Zane** | 4120 Old Main Hill Logan, UT 84322-4120 | regan.zane@usu.edu | (435) 797-9118 | Academic Institution | Principal Organization | Advanced BMS with cell-level control and physics based modeling to improve battery pack lifetime, reduce pack size, improve charge rate, and provide system with cell-level state of health and charge monitoring. | Power electronics and management, advanced BMS, integrated power circuit design, physics based cell modeling (through partners) and control. |
| **Washington University in St. Louis** | 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 | vsubramanian@wustl.edu | 314-935-5676 | Academic Institution | Principal Organization | Battery Management System based on thermal-electrochemical model | BMS based on fastest physics based models.<br>Enabling real-time simulation, optimization and control of most detailed physics based model |