ARPA-E PROJECT SELECTIONS –
ADVANCED MANAGEMENT AND PROTECTION OF ENERGY-STORAGE DEVICES (AMPED)
PROJECT DESCRIPTIONS

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These projects have been selected for negotiation of awards; final award amounts may vary.

** Two projects were added to ARPA-E's AMPED Program, bringing the total number of projects from 12 to 14. The two new projects are Lawrence Livermore National Laboratory's (LLNL) Battery Management System with Distributed Wireless Sensors and Gayle Technologies' Ultrasonic Battery Management System.*

Lead Research Organization	Amount	Lead Organization Location (City, State)	Project Title Project Description
Palo Alto Research Center	$4,018,960	Palo Alto, CA	**Smart Embedded Network of Sensors with Optical Readout (SENSOR)** Palo Alto Research Center will develop new fiber optic sensors that are inserted into battery packs to monitor and measure batteries during charge and discharge cycles. These compact fiber optical sensors will measure the battery's health while in use to avoid degradation and failure.
Ford Motor Company	$3,128,000	Dearborn, MI	**High Precision Life Testing of Automotive and Grid Storage Batteries** Ford Motor Company and Arbin Instruments will develop a high-precision battery testing device to improve battery-life forecasting and validation. Extremely precise measurements sampled by the device will reduce the time and expense required in the research, development, and qualification testing of new automotive and stationary batteries.
GE Global Research	$3,128,285	Niskayuna, NY	**Ultrathin Strain and Temperature Sensor System** GE Global Research will develop thin-film sensors that enable real-time, two-dimensional mapping of temperature and surface pressure for each cell within a battery pack. These new sensors will provide higher resolution compared to today's thermal sensors, improving internal battery measurement capabilities and lowering the cost of electric vehicles.

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Oak Ridge National Laboratory	$1,000,000	Oak Ridge, TN	**Temperature Regulation for Lithium-Ion Cells** Oak Ridge National Laboratory is developing an innovative battery design to more effectively regulate destructive hot-spots that develop during use. This improvement in transporting heat away from active materials in the battery is expected to increase the battery's life and reduce the system cost associated with thermal management.
Utah State University	$3,070,051	Logan, UT	**Cell-level Power Management of Large Battery Packs** Utah State University will develop electronic hardware and control software to create an advanced battery management system that actively maximizes the performance of each cell in a battery pack. This cell-level battery management system could reduce electric vehicle battery pack cost by 25% or more.
Battelle Memorial Institute	$600,054	Columbus, OH	**Battery Fault Sensing in Operating Batteries** Battelle will develop an optical sensor to monitor the internal environment of a lithium-ion battery in real-time. This internal sensor will detect the magnitude and location of internal battery faults and other hazardous conditions that current battery sensor technologies fail to identify.
Pennsylvania State University	$1,000,000	University Park, PA	**Health Management System for Reconfigurable Battery Packs** Pennsylvania State University is developing an innovative design for electric vehicle battery packs that can reroute power in real-time between cells. Compared to today's electric vehicle battery packs, this reconfigurable battery architecture will enhance battery safety and performance.
Washington University in St. Louis	$2,000,000	St. Louis, MO	**Optimal Operation and Management of Batteries Based on Real Time Predictive Modeling and Adaptive Battery Management Techniques** Washington University in St. Louis will develop a predictive battery management system that uses innovative modeling software to optimize battery use. The system will predict optimal charge and discharge of the battery in real-time, enhancing battery performance and improving battery safety, charge-rate, and usable capacity.

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Det Norske Veritas	$2,030,962	Dublin, OH	**Sensor Enhanced and Model Validated Batteries for Energy Storage** Det Norske Veritas will develop a gas monitoring system to provide early warning signals that a battery is operating in stressful conditions and at risk of premature failure. As batteries degrade, they emit measureable quantities of gas that can be mapped over the battery's life time. This detection method will optimize performance and help repurpose batteries for other applications.
Southwest Research Institute	$712,500	San Antonio, TX	**Strain Estimation Technology for Lithium-Ion Batteries** Southwest Research Institute will explore the potential of tracking physical expansion and contraction of lithium-ion batteries during charge and discharge cycles as a new method for analyzing battery capacity and health.
Robert Bosch LLC	$3,100,000	Palo Alto, CA	**Advanced Battery Management System** Bosch will develop battery monitoring and control software to improve the energy utilization, reliability, and charge rate of electric vehicle batteries. Bosch's advanced battery management system will leverage breakthroughs in real-time modeling of the battery's internal environment.
Eaton Corporation	$2,481,588	Southfield, MI	**Predictive Battery Management for Hybrid Vehicles** Eaton Corporation is developing a power control system to optimize the operation of commercial-scale hybrid electric vehicles. Eaton's innovative approach reduces the size of the battery needed for operating large hybrid electric vehicles with no loss in battery life or vehicle performance, enabling a more cost-effective solution for commercial vehicles.

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*Gayle Technologies, Inc.	$729,600	Nashville, TN	**Ultrasonic Battery Monitoring** Gayle Technologies, Inc. is developing a diagnostic inspection system using ultrasound technology to detect flaws within vehicle battery packs. Gayle Technologies' innovative approach will enable the examination of internal battery structures without any disassembly of the battery packs, as opposed to current methods which require complete disassembly and destruction of the battery.
*Lawrence Livermore National Laboratory	$2,000,000	Livermore, CA	**Battery Management System with Distributed Wireless Sensors** Lawrence Livermore National Laboratory (LLNL) is developing a wireless sensor network for large lithium-ion battery packs that can operate reliably in the full range of electrified grid and vehicle environments. This wireless sensor network can dramatically reduce system cost, improve operational performance, and detect pack failures in real time, enabling a path to cheaper, better, and safer large-scale batteries.

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ENERGY STORAGE SBIR/STTR PROJECT DESCRIPTIONS

Lead Research Organization	Amount	Lead Organization Location (City, State)	*Project Title* Project Description
ITN Energy Systems, Inc.	$ 1,725,000 (SBIR)	Littleton, CO	**Advanced Vanadium Redox Flow Battery** ITN will dramatically improve current state-of-the-art Vanadium flow batteries for grid-scale energy storage. This project integrates a unique, low-cost membrane with a new flow battery chemistry to develop an efficient and affordable energy storage system for renewable energy generation sources like solar and wind for small commercial and residential consumers.
Energy Storage Systems, Inc.	$ 1,725,000 (SBIR)	Portland, OR	**Iron Flow Battery** Energy Storage Systems, Inc. will construct a flow battery for grid scale storage using an advanced cell design and electrolyte materials composed of low cost iron. The flow battery will have a target storage cost of less than $100/kWh, which could enable deployment of renewable energy technologies throughout the grid.
TVN Systems, Inc.	$ 1,724,000 (STTR)	Lawrence, KS	**Hydrogen-Bromine Electrical Energy Storage System** TVN Systems, Inc., the University of Kansas, and Vanderbilt University will develop an advanced flow battery with a low-cost, durable membrane and unique catalyst. The success of this project could enable deployment of renewable energy technologies throughout the grid.
Materials & Systems Research, Inc.	$ 1,725,000 (SBIR)	Salt Lake City, UT	**Advanced Sodium Battery** MSRI will design advanced sodium battery membranes that are stronger and cost less than existing membrane technologies. This manufacturing process will make high-strength membranes for grid-scale batteries that increase cycle life and improve safety in a single step.
Pellion Technologies, Inc.	$ 2,500,000 (SBIR)	Cambridge, MA	**Rechargeable Multivalent Batteries from Common Metals** Pellion will develop a rechargeable battery for electric vehicles that has the potential to travel three times the distance of today's Li-ion car batteries. The batteries will be fabricated from abundant, low-cost metals that can be domestically sourced. If successful, this technology could revolutionize the distance electric vehicles can travel on a single charge.

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Sila Nanotechnologies, Inc.	$ 1,725,000 (SBIR)	Atlanta, GA	**Doubling the Energy Density of Lithium-ion Batteries for Transportation** Sila will develop an electric vehicle battery that doubles the capacity of today's Li-ion batteries. This technology uses low cost nano-composite materials that could cut energy storage cost in half or more. This cost reduction could accelerate electric vehicle adoption and decrease range anxiety associated with current electric vehicles.
Xilectric, Inc.	$ 1,725,000 (SBIR)	Auburndale, MA	**Reinvention of the Edison Battery** Xielectric will reinvent Thomas Edison's battery chemistries for today's electric vehicles. This reinvented battery will cost less than the battery that starts today's gas powered cars. This battery uses an innovative chemistry based on domestically available aluminum and magnesium and simple construction to increase performance and lower cost.