Funding Opportunity Description

Purpose

The purpose of this Johnson Controls Request for Proposals (RFP) “Advancements in Battery Energy Storage Systems” is to solicit Applications from the University of Wisconsin (Madison and Milwaukee) for funding of research and development of transformational advancements in Systems technology, Materials technology, and Manufacturing processes related to battery energy storage systems.

Johnson Controls encourages faculty and academic staff to initiate projects that will lead to productive intercampus interactions and promote partnerships in many areas between the two campuses, including Chemistry, Physics, Materials Science, Computer Science, Biology, Engineering and others.

Proposal Evaluation Criteria:

Decisions on the selection of project awards will be made jointly by committee consisting of Johnson Controls and the University of Wisconsin (Milwaukee and Madison). The primary criteria for selection of the projects will include:

- Technical strength of the proposal, including its originality
- Level of intercampus interactions: Demonstrable synergistic interactions between the two academic institutions
- Level of interdisciplinary interactions between multiple research disciplines
- Value to member industries and potential for technology transfer
    - Potential for high economic value and/or job creation
    - Potential for generating new intellectual property
- Likelihood of generating follow-up funding
- It should be clear in the proposal that without this funding the work would not be performed.

Proposal Preparation Details:

Investigators are asked to submit proposals using the templates provided. Each proposal submitted must contain the following components*:

1. Project Narrative - Five pages maximum (template provided)
2. Budget (template provided)
3. Budget Justification (template provided) including plan and sources for future funding
4. Intellectual Property Rights Requirement – As a condition of Application hereunder, Johnson Controls requires a minimum of a paid-up, nonexclusive license to any technology and patents that result from the Project, and the Proposal must confirm such minimum license to be granted.
5. Two Page CVs of key project participants (no template)
6. Letters of Collaboration with partners (no template)

*Note: All documents must be single spaced and use only Arial 10 point or Times New Roman 11 point font.

Templates can be found on the UWM Research Foundation website at: www.uwmresearchfoundation.org.

Project Budget: Proposals are invited in the range of $50k to $100k and should be for no more than one year duration. The total funds awarded for this cycle are expected to be $500,000.00. The budget should be used for equipment and graduate students or post-docs. PI support including summer salary is not allowed.

The proposals are targeted to provide support to fellowship-quality graduate students engaged in current research topics that are directly relevant to the Johnson Controls strategic research objectives as well as support of associated time and materials that support the proposed research. Since the funding opportunity is for a one-year duration, the students and projects awarded this support will be immediately eligible for a second and third year of support from continuing Johnson Controls RFP funds assuming acceptable progress has been made in their research objectives.

PI's should receive acknowledgement of their application within one business day, and if they do not, they should contact their intake point – For UW-Milwaukee PI's contact Andrea Bishop, abishop@uwmfdn.org if you do not receive confirmation.

Project Reporting Requirements

Each project must incorporate the following reporting requirements:

- Quarterly Project Reviews ***Oral Presentation of Research Progress***
- Project Must Include ***Mid-Term Status Presentation***
- Project Final Presentation Must Include ***Oral Presentation of work performed from the funding along with written report.***
- Research Seminar at the end of the year which will include Johnson Controls, University of Wisconsin Milwaukee and University of Wisconsin Madison (Time and LocationTBD). ***Project Final Oral Presentation will be given at the Research Seminar.***
- Project Final Report, ***Project Evaluation from the Industry Sponsors and any Provisional Patent Application(s) and Publications.*** Due Within 60 days of Presentation

Application Process: E-mail the completed proposal applications in a single PDF document to: jcienergygrants@lists.uwmfdn.org no later than 5:00 PM CDT on November 17, 2011. Late proposals will not be considered.

Tentative Timeline

- RFP Release: October 6, 2011
- Proposals Due: November 28, 2011
- E-mail the completed proposal applications in a single PDF document to jcienergygrants@lists.uwmfdn.org
- Project Selections: January 1, 2012
- Project Kick-Off: January 23, 2012
- Mid-term Review: June 25, 2012
- Research Seminar and Final Oral Report (Time and Location TBD):
- Project Completion: January 23, 2013

Topic Area 1: ***Impact of Contaminants on Li-Ion Chemistry using Materials Characterization and Molecular Modeling.***

Performance of Lithium Ion batteries is strongly affected by metal contaminants. Concentrations at the parts per billion levels can adversely impact the performance of the cell in multiple pathways. Redox shuttling of metal impurities can lead to dendrite formation on the electrodes eventually resulting in cell failure.

Applications are invited that seek the following:

- Impact of metal impurities at the molecular level on the anode, cathode, and separator by using molecular modeling and experimental verification.
- Mechanism of dendrite formation of metal impurities on the electrodes.
- Methods to inhibit the growth of dendrite formation using molecular modeling and experimental chemistry.
- Correlation of dendrite formation versus charge discharge cycles

Topic Area 2: ***In-Situ Sensor Communications and Transduction***

The development of advanced sensors has led to improved monitoring and control of many systems. In many cases, however, the sensor may not be co-located with the equipment used to power and analyze the sensor. Additionally, many applications do not allow for a physical connection, such as a wire, to be used for connecting the sensor to the analytical hardware. An example is a battery – a sensor placed in the interior of a lithium battery cannot be easily connected to the outside environment without compromising the integrity of the battery.

To address these challenges, Johnson Controls solicits innovative solutions for sensors that:

- Can be placed *in situ* into an environment to which physical connections cannot be made
- Provide a means of communication from the sensor to the outside environment
- Provide a means of performing measurements without external power sources

Other favorable criteria include:

- Devices that do not require welds, due to fragility
- Platforms that can be used for multiple types of sensors, including (but not limited to) temperature, voltage, current, chemical identity

- Robustness to hostile chemical environment (such as that found in lead acid or lithium batteries)
- Self-powered or passive sensing
- Communication protocols that optimize over multiple sensors (peer-to-peer, self-healing, etc)

Topic 3: ***Battery Management Algorithms and Applications***

Billions of dollars are spent annually on research to improve the performance of vehicles. Because of the high cost of making more efficient systems, it becomes increasingly important to get the maximum benefit from existing components. One approach is to use "smart" systems, since algorithmic improvements add little cost or weight to a vehicle while potentially providing significant gains in fuel economy.

Johnson Controls solicits innovative algorithms that utilize any available information to optimize the performance of the vehicle's energy storage system (ESS). The ESS can consist of multiple devices, including potentially multiple batteries, or batteries and other devices such as ultracapacitors.

These algorithms should:

- Change the behavior of the ESS based on information available to the algorithms.
- Optimize ESS behavior against specified metrics
- Be reducible to small microchips that do not require large amounts of memory, power, or computational overhead
- Adapt to changes in operating conditions in real-time or near real-time.

Other favorable criteria include:

- Use of multiple data sources over which to optimize ESS behavior
- Predictive models that can optimize ESS behavior against anticipated conditions in addition to present conditions.
- Communication with other vehicle components via CAN bus for vehicle-level optimization
- Performing multiple functions, for instance improvement of fuel economy and state of health monitoring

Topic 4: ***Vehicle System Analysis and Optimization***

Modern vehicles have become sufficiently complicated that minor changes to a single component can have significant effects on the vehicle – and *vice versa*. As a manufacturer of energy storage devices, Johnson Controls seeks to better understand how changes to ESS design and vehicle design affect each other.

Johnson Controls solicits proposals for optimization of ESS design based upon variable specification and vehicle configuration. This effort would be funded by Johnson Controls, with potential collaboration from a major automotive OEM.

Proposed approaches should:

- Characterize metrics against which ESS designs can be measured (performance, cost, size, etc)
- Establish variables against which to optimize (12V, 48V, 120V, 360V,battery size, shape, placement, multiple batteries, etc)
- Operating Voltage
- Identify other vehicle systems that can affect, or be affected by, the ESS
- Define method for performing optimization of ESS design

Other Favorable Criteria Include:

- Propose resources sought from the OEM and Johnson Controls
- Define schedule for performing research

Topic 5: ***Vehicle Pack Safety Analysis***

Batteries contain a large amount of inherently energetic material. Safe operation of a hybrid electric vehicle (HEV) or other electric vehicle (EV) requires that the passengers of the vehicle be kept safe from those materials in the event that the battery is damaged. Continued battery research has the potential to exacerbate the problem, as more power and energy is packed into an ever smaller space.

Johnson Controls solicits proposals to investigate the safety of battery packs under a variety of conditions, with a focus on:

- Prediction of battery pack characteristics and performance envelope based on analysis of individual materials and components
- Understanding and prediction of failure modes of battery packs
- Characterization of different failure causes as appropriate to battery type – including overcharging, shorting, or vehicle crashes, among others
- Connection of theoretical and experimental analysis

Other favorable characteristics include:

- Demonstrate a connection between material characterization and battery pack modeling
- Multi-disciplinary analysis, including thermal, physical, mechanical, and chemical analysis

Topic Area 6: ***Advanced Materials for High Energy Density Li-ion batteries and beyond.***

The state-of-the-art Li-ion cells for electrical vehicle applications have an energy density around 150Wh/kg. The capacities of cathode and anode materials in the cells are around 150mAh/g and 300mAh/g, respectively. It is important and necessary for the industry to double the energy density of Li-ion cells to around 300Wh/kg in order to have a drive range of approximately 200mi per charge for electrical vehicles. This requires the high energy density of active materials and novel cell chemistry to be developed.

Applications are invited that seek the following:

- High capacity of Li-ion cathode (>180mAh/g) and anode materials (>600mAh/g).
- High energy density cell design.
- Advanced cell chemistry beyond Li-ion cells, such as Li-S (Lithium-Sulfur), Li-O (Lithium-air) with high energy density beyond 300Wh/kg.
- Safety improvement at material and cell levels for high energy density cell system.

Topic 7: ***Signal Processing and Communications***

A battery pack could contain large number of sensors and cells. Therefore, it’s a challenge to communicate the current state of the battery pack reliably and timely manner in an abusive environment – extreme temperature swing, noisy, corrosive, and others.

Johnson Controls solicits proposals to investigate the communication of a battery pack to either vehicle communication system and/or human interface under a variety of conditions, with a focus on:

- Secured communication methods
- High level self correction
- Low power or self-power over extended life
- Simple communication protocol
- Wireless
- Scalable over large number of nodes

Other favorable characteristics include:

- Integration with In-Situ Sensor
- Integration with future vehicle network
- Integration with future wireless infrastructure
- Self-managed network
- Potential integration with biometrics for added security

Topic Area 8: ***Advanced Pb-acid battery development.***

Today Pb-acid is one of the main energy storage systems for the SLI (startling/lighting/igniting) applications in vehicles. This is mainly due to the high cranking power of Pb-acid even at low temperature, around -20°C, and low cost. The excellent high discharge power of Pb-acid batteries allows starting the vehicles at a wide temperature window from -30°C to nearly 60°C. Recently, one type of Pb-acid batteries, AGM (Absorbed Glass Mat) has become a key energy storage system for micro-hybrid vehicles ("start-stop vehicles"). This requires the high charge and discharge power density of advanced Pb-acid battery.

Applications are invited that seek the following:

- High charge acceptance of Pb-acid battery (targeting 200% improvement of current Pb-acid battery system)
- Novel Pb-acid battery development with high discharge power and charge acceptance, such as asymmetric ultra-capacitor designs including Pb/C (carbon) design, Pb-acid and ultra-capacitor combination design, etc.
- High energy density Pb-acid battery and material development (>50Wh/kg).
- Pb-acid additive developments to allow stable performance during the life time of battery.