Topic: N151-073

K2 Energy Solutions, Inc.

Enhanced Cell Designs for Improved Internal Heat Transfer for High Rate and Power Capable, Large-Format Batteries

The anticipated deployment of electric-powered weapons systems on Navy ships and increasing power demands of radar and electronic warfare systems will place a highly variable and unpredictable demand on shipboard power systems. Issues associated with this can be greatly mitigated by integrating energy storage into the power system. However, this energy storage system must be capable of very high charge and discharge rates without excessive internal heating that can reduce both performance and battery life. The technology being developed will enable such an energy storage device, by combining proven high power, long-life electrode and cell designs with internal and external thermal management technology that prevents excessive temperature rise without degrading battery performance.

Technology Category Alignment:

Energy storage
High Energy Lasers (HEL)
Radio Frequency Weapons (RFW)
Power and Energy

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SYSCOM: ONR
Contract: N68335-17-C-0051

Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-17-C-0051

Department of the Navy SBIR/STTR Transition Program

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WHO

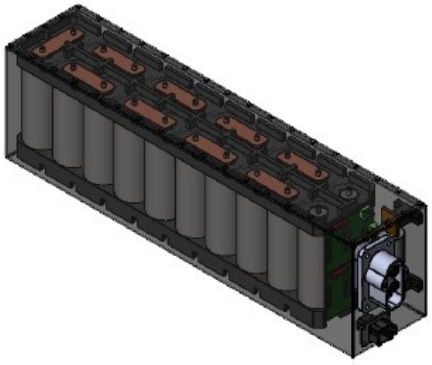
SYSCOM: ONR

Sponsoring Program:

Transition Target: Multi-Mission Energy Storage FNC, Railgun INP

TPOC:
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Other transition opportunities:



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WHAT

Operational Need and Improvement: Energy storage is a key enabling subsystem for supporting future shipboard electrical loads. However, the capability of legacy high energy cells need to be increased to meet the needs of envisioned future shipboard applications. Improved internal cell-level thermal management of large-format, high power batteries will facilitate the development of simplified, more manageable large-scale battery systems.

Specifications Required: Develop, fabricate and demonstrate a 20Ah, 1000V cell and battery design and Battery Management System (BMS):
- suitable for operation at 1000V and 10C (threshold) to 30C (objective), using 40°C liquid cooling only.
- suitable -for compact racking and operation in tight applications and in spaces with ambient temperatures up to 60°C.
- able to transfer heat to the cooling media in such a manner that upon completion of a full discharge (=80% DOD) at rated conditions, the cells can immediately undergo charge at a 2C rate (threshold) or higher (15C, objective), repeatedly.

Technology Developed: 1) Electrode designs that both minimize cell internal resistance to reduce heat generated during high power operation and maximize heat conduction away from active materials that generate heat during that same high power operation; 2) Cell terminal designs that maximize both thermal and electrical conduction to minimize cell temperature rise during high power operation; and 3) Passive thermal management technologies that rapidly dissipate heat away from individual cells and cell casing and internal jellyroll interfaces that efficiently transfer heat to the external thermal management structure.

Warfighter Value: Batteries fabricated with the cells being developed under this project will be capable of continuous, high power operation on both charge and discharge, which will enable their use as shipboard energy buffers. This will be critical in the increasingly electrified warships of the future, where electric weapon systems and more powerful radar and communications systems will place high demands on the ship's power system. The presence of an "energy buffer" in the form of a high-power energy storage system will enable to operation of these advanced systems without compromising the performance of other critical ship systems.

WHEN

Contract Number: N68335-17-C-0051 **Ending on:** June 25, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Preliminary cell design review	Med	Cell performance validation testing	4	1st QTR FY19
Preliminary battery module design review	Med	Module performance validation testing	4	2nd QTR FY19
Final cell design reivew	Med	Cell performance validation testing	5	3rd QTR FY19
Final battery module design review	Med	Module performance validation testing	6	3rd QTR FY19

HOW

Projected Business Model: As a developer and manufacturer of lithium iron phosphate cells and batteries, it is K2's intent to manufacture the cells and batteries developed under this project. This will require that the company set of a dedicated facility within the US to manufacture these cells (presently, K2 manufacturers small format cylindrical cells at our facility in China). To this end, we have already begun to purchase equipment for this projected manufacturing line and are targeting an initial manufacturing volume of ~500 large-format cylindrical cells per day.

Company Objectives: K2's overall goal is to be the premier domestic supplier of lithium-ion cells and batteries and we see supplying both COTS and custom batteries to the U.S, military as critical to meeting that goal. K2 was selected as the sole source supplier of batteries to the Navy for its electromagnetic railgun development program, is the sole source supplier of batteries to the Marines GREENS program, and and is a significant supplier of cells and modules to a number of OEM's making UPS systems for the U.S. military. We see the cells and batteries being developed under our Phase II project as a key pathway for keeping the company competitive in the energy storage arena, which is rapidly evolving in both military and commercial sectors.

Potential Commercial Applications: The electric utility industry uses large battery bank installations in lieu of "peaker plants" in order to level load the power generation requirements during peak time of day. The automotive and marine industries are transitioning to electric drive. These large-format high-power batteries would be directly relevant for these applications and would furthermore reduce Department of Defense (DoD) procurement costs with the economy of scale of manufacturing for multiple industrial sectors.

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