Department of the Navy SBIR/STTR Transition Program

STATEMENT A. Approved for public release; distribution is unlimited.
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Topic # N13A-T028

Hybrid, Ultra-High-Speed, High Efficiency, Power Dense, Electronically Controlled Energy Conversion Unit for Ship Systems, Unmanned Vehicles, and Robotics Applications

Electric Drivetrain Technologies, LLC

WHO

SYSCOM: ONR

Sponsoring Program: Navy's power and energy management program and a next generation integrated power system architecture (NGIPS) for application on shore based facilities, future surface ships, and underwater vehicles.

Transition Target: Applications within PMS 320; potential fit for PMS 405 with a focus on railguns and directed energy weapons

TPOC:
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Other transition opportunities: The DoD has engaged in the High Speed Mechanical Energy Storage Initiative (HMES) throughout the various system components and this technology may enhance the results from this initiative.

Images courtesy of the U.S. Navy, 140708-N-ZK869-003 SAN (July 2014), 140708-N-ZK869-010 (July 2014), 160324-N-DM751-003 (March 2016)

Notes: Opportunities in commercial grid power applications and high density energy storage (mechanical battery). The passive magnetic bearing system has significant other opportunities both for military and commercial applications.

WHAT

Operational Need and Improvement: The Navy requires compact power sources for pulsed power applications. The very high speed energy storage can reduce the space and weight required for these power conditioning system. This is an important factor as the Navy's need for pulse power sources will continue to increase in the foreseeable future. A smaller, lighter energy storage and power conditioning system saves cargo space and fuel while enhancing system portability. This motor/generator will have a wide range of applications, i.e. it can be used as the core building block of a very lightweight electrical energy storage system for unmanned aerial vehicles (UAV) or to maintain power quality in micro-grids that experience high pulse loads such as airframes and Navy ships.

Specifications Required: The Navy seeks to develop new, innovative motor/generator technologies that can effectively operate at speeds up to 1,000 kRPM at power densities of 40 kW/kg (excluding heat exchanger) with an overall system efficiency of 95 percent or better. Based on our initial design we will be able to achieve a power density of 60 KW/Kg well above the Navy's targets.

Technology Developed: We have developed new and novel motor technologies that allow us to manufacture efficient motors for very high speed operation. Two of the main features of this motor are a passive magnetic bearing technology that is a key component to achieve these extremely high speeds, and a pulse width modulated inverter that switches at 1 MHz and greater PWM carrier frequency. The dynamic bandwidth of the current loop system is > 100 KHz to minimize motor losses, control the bearing stabilization and improve the system's dynamic performance and the power quality of the output voltage.

Warfighter Value: The system addresses the Navy's need for its power and energy management program and a next generation integrated power system architecture (NGIPS). The combined system is a very power dense, lightweight mechanical energy storage system that is competitive with current battery technology and which can be rapidly discharged and recharged. This system is virtually maintenance free and has no cycle limitations which yield a near unlimited (greater 10 years) life.

WHEN

Contract Number: N00014-15-C-0150 **Ending on:** November 30, 2016

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Bearing Test Model	Low	stable bearing operation	TRL 3	August 2016
Medium Speed Test Model (300 KRPM capable, 50 KW peak)	Med	successful pulse power operation at > 20 KW	TRL 4	November 2016
Design high speed/full size evaluation unit	High	complete design documentation	TRL 4	July 2017
Build high speed/full size evaluation unit	High	unit running at 500 KW pulse load	TRL 5	March 2018
Complete full testing of high speed/full size evaluation unit	High	complete all testing at full power (thermal etc.)	TRL 6	July 2018

HOW

Projected Business Model: We will team with a partner (TBD) to transition the technology for DoD applications. We have had very preliminary discussions with Honeywell and UTC.

Our sister company will develop industrial power products for manufacture and sale to the industrial market. We plan to also work with a suitable partner and we are having initial discussions with potential industrial partners.

Company Objectives: We will continue to develop different aspects of the technology:
- high speed motors: new technologies are needed for machine tool spindles, high performance energy efficient compressors
- magnetic bearing: are sought for many industrial and HVAC applications to increase operating speed, reduce maintenance costs and quite, more reliable, more energy efficient operation
- high bandwidth inverter: we are already implementing this technology for use in TELECOM power systems and we pan to expand on these developments
- high speed flywheel system: we plan to continue the development of mechanical batteries for utility power management, solar power plants and we have discussed a 100 MWh modular storage system with a potential customer

Potential Commercial Applications: Bearing: low cost, high RPM machines, i.e. turbo/super chargers. No contact - no wear bearings for machine tools and aerospace applications
Motor technology: very low cost motor system made from solid materials (non-laminated) or soft magnetic composites (SMC) for appliances and automotive
High speed motor: turbo/super chargers, efficient generators, spindle drives
Mechanical energy storage: alternative to batteries with no memory and maintenance free unlimited life (charge/discharge) cycles

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