Topic: N152-099

Paragon Space Development Corporation

Cooled BusWork for Shipboard Distribution and Energy Storage

Paragon’s Buswork Integrated Cooling System (BICS) is a low-profile TRL 5 solution for battery module cooling that implements our proven Low-profile Hybrid-Manufactured (LPHM) Coldplate technology. BICS is uniquely suited to high-power energy storage cooling with its combination of high electrical isolation, >7kV, and low thermal resistance, <0.02°C/W. This technology is a drop-in replacement for conventional copper busbars. BICS moves heat more effectively by acquiring heat from batteries through the cell terminals, taking advantage of anisotropic cell construction. This produces better temperature uniformity without any cell-to-liquid contact, addressing the complexity of conventional liquid cooling approaches. BICS also permits use of any common thermal working fluid. Intended for future electronic ships systems and high-power weapons, for commercial ships, and applications for power distribution and storage, BICS reduces system size, weight, and power, and reduces lifetime cost.

Technology Category Alignment:

Aircraft Propulsion, Power and Thermal
Energy storage
Thermal Transport and Control
High Energy Lasers (HEL)
Power and Energy

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SYSCOM: NAVSEA
Contract: N00178-17-C-0016
Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N00178-17-C-0016

Department of the Navy SBIR/STTR Transition Program

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WHO

SYSCOM: NAVSEA

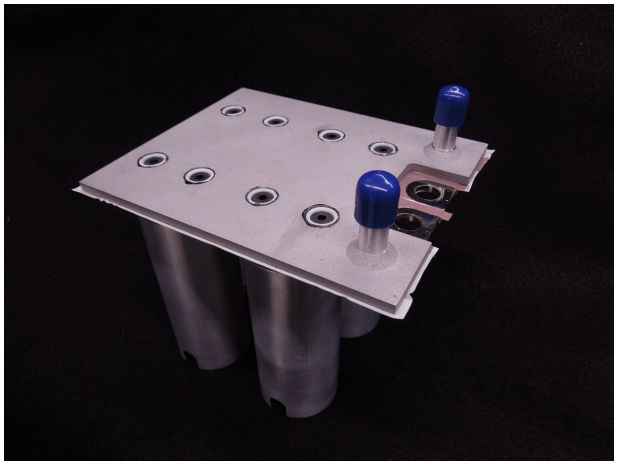
Sponsoring Program: PMS 320 – Electric Ships Office (ESO)

Transition Target: Integrated Power & Energy Systems (IPES)

TPOC:
(215)897-7593

Other transition opportunities: Commercial opportunities in: all-electric ferries and in high-current busbars for power transmission.

Notes: Image shows Paragon's Subscale Busbar Integrated Cooling System (BICS) attached to mock cells that simulate the interface and heat generated by Saft's VL30AFe cells.



WHAT

Operational Need and Improvement: The Naval Power and Energy Systems (NPES) technology development roadmap identifies an Integrated Power & Energy System (IPES) architecture that shares power, energy storage, and advanced controls ship wide for improved flexibility and adaptability. IPES will support evolving mission requirements, for improved endurance and efficiency to improve ship range and capability, and for greater system survivability by providing for a whole ship system backup, limiting the impact of damage, and providing a battery backup for maneuvers. The Navy is seeking to foster the development of common, affordable electrical components and systems that could have broad application to ships. Electrochemical storage (battery) cells have designs which do not lend themselves to effective thermal management.Therefore, there is a need to develop an innovative modular bus bar cooling system for energy storage with high rate heat removal that leverages the thermal mass and conductivity of bussing systems.

Specifications Required: Maintain cell terminal temperature at or below 60°C while maintaining charge and discharge rates equivalent to full discharge in 4 minutes (a 15C-rate). A 15C-rate is defined as "15 times the charge and discharge C-rate". (e.g. a 30Ah battery discharging at 15C discharges at 450A)

Technology Developed: Paragon's Buswork Integrated Cooling System (BICS) addresses the issue of thermal management in high power storage systems. BICS enables high rate charge and discharge of the energy storage magazine, while maintaining safe cell and conductor temperatures.This permits size and weight savings by enabling an energy storage magazine having fewer storage modules capable of meeting the high frequency and high power demands of integrated shipboard power. BICS is a low-profile solution for high power battery module cooling that implements our Paragon's Coldplate technology. BICS is uniquely suited to high power energy storage cooling with its combination of high electrical isolation, temperature uniformity, >7kV, and low thermal resistance, <0.02°C/W. This technology is a drop-in replacement for conventional copper busbars. BICS moves heat more effectively by acquiring heat from batteries through the cell terminals, taking advantage of anisotropic cell construction.

Warfighter Value: Intended for future electronic ships systems and high-power weapons, for commercial ships, and applications for power distribution and storage, BICS reduces system size, weight, and power, and reduces lifetime cost.

WHEN

Contract Number: N00178-17-C-0016 **Ending on:** July 15, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Sub-scale demonstration with Simulated Heat Load	N/A	Demonstrates manufacturing and performance that meets targeted heat flux.	TRL3	November 2016
Demonstration at Scale with Simulated Heat Load	N/A	Demonstrates hybrid-manufacturing design, performance that meets worst case heat generation for 48V module.	TRL4	January 2018
Demonstration at Scale with live energy storage cells	N/A	Demonstrates thermal and electrical performance when tested with batteries similar to target cell design.	TRL5	February 2018
Low-cost prototype demonstration with Simulated Heat Load	Med	Demonstrates low-cost, high volume production of hybrid-manufacturing design, thermal performance given worst case heat generation for 48V module.	TRL 5	May 2019
Low-cost BICS prototype demonstration with live energy storage cells	Med	Demonstrates BICS prototype thermal and electrical performance when tested with target cell design.	TRL6	July 2019

HOW

Projected Business Model: Paragon will manage the manufacture and assembly of the BICS hardware. Paragon has established relationships for additive manufacturing of key components and has demonstrated the capability for low volume production. Paragon's demonstrated capabilities are competitive in cost at volumes up to 100 units, and Paragon is capable of producing an estimated 1,000 units on an annual basis. Paragon is presently demonstrating the capability for cost competitive production at high volumes of 1,000 or more units annually through relationships with traditional manufacturing vendors. Paragon plans to retain this technology as a commercial product of a spin-off subsidiary focused on the development and hybrid production of coldplates and heat-exchangers with in-house low-volume manufacturing capabilities and contracted high-volume manufacturing capabilities.

Company Objectives: Paragon is seeking DoD and commercial integration opportunities with primes in the energy storage, high-current power transmission, and directed energy arena. Paragon also intends to commercialize the technology at the core of BICS as a low-cost, highly customizable, print-to-order coldplate and heat exchanger product for the aerospace, extreme environments, and prototyping market. It will be an integral component of Paragon's Thermal Control Systems capabilities to address the unique integration needs and quantities demanded by our current customer base, which includes NASA, Boeing, Lockheed Martin, and Sierra Nevada Corporation.

Potential Commercial Applications: The flexibility of Paragon's hybrid manufacturing process allows us to respond quickly with functional prototypes for a wide range of applications.
Paragon intends to commercialize this technology and its components as:
a) A battery module cooling solution for electric ships, ferries, and vehicles.
b) A highly customizable, print-to-order general purpose coldplate and heat exchanger product
c) A low profile, high performance electronics cooling product for integration with laser diodes,
d) A space rated component for Thermal Control Systems to support NASA, Boeing, Sierra Nevada, and other Paragon customers.

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