Active Project (2016 - 2016)

High Efficiency Hybrid Energy Storage Utilizing High Power Density Ultracapacitors For Long Duration Balloon Flights, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

FastCAP proposes to develop an ultra-high power density and high frequency ultracapacitor capable of surviving over the wide temperature range of -60C to 130C and exhibiting peak gravimetric and volumetric power density of 120kW/kg and 150kW/L respectively. FastCAP is planning to design and prototype a hybrid system comprised of the proposed ultracapacitor in parallel with a high energy density, rechargeable, lithium ion battery showing at least 50% volume reduction and 100% lifetime increase compared to stand-alone lithium batteries, meeting long duration research balloon requirements. During Phase I, FastCAP will evaluate both novel under-development and off-the-shelf lithium chemistries utilized in aerospace applications. The resulting hybrid battery-ultracapacitor (HBU) system combines the benefits of both technologies and will meet NASA's scientific balloon requirements of energy density, power density, shelf life, temperature, reliability and cycle life. This ultracapacitor can also be coupled to a piezoelectric generator, thanks to a high cut off frequency greater than 500Hz. The proposed HBU system will enable significant improvements in the design of power storage for terrestrial and planetary balloons, reducing their weight, volume, and complexity, while improving performance and relaxing design constraints on scarce candidate battery technologies. Compared to today's high-rate reserve and rechargeable battery technologies, the proposed hybrid system will provide much higher power and higher energy density, show tremendous improvement in cycle lifetime, and show reduced risk of explosion and thermal runaway associated with high-rate discharge, thanks to the power buffering role of the ultracapacitor within the HBU system. In applications where batteries are currently oversized for power handling, dramatic reductions in total energy storage system weight will be achieved by complementing those batteries with ultracapacitors.

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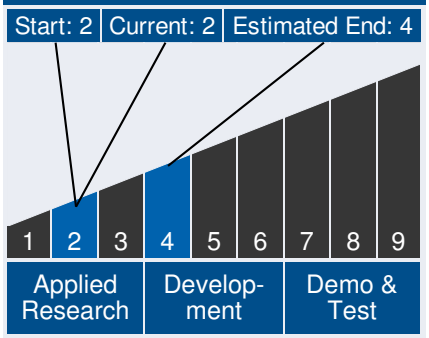
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Continued on following page.

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ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The proposed 28 VDC hybrid aerospace graded ultracapacitor/battery module will be designed to power critical components needed for long duration terrestrial and planetary balloons. This innovative design will ensure available energy for more than 12 continuous hours using a lithium ion high energy density rechargeable battery (>200Wh/kg), and guaranteeing power delivery in the range of 100-1000 watts with the ultracapacitor pack. Phase II will focus on collaboration with an aerospace rated battery supplier (i.e. EaglePicher/Yardney) that has designed and produced high energy density batteries for previous space missions. We have received a letter of support from EaglePicher indicating a possible partnership leading to customized design work and testing validations specific to NASA requirements. Inclusion of a high power density ultracapacitor module working in parallel with a high energy battery pack will provide a considerable overall weight and volume reduction for the energy storage system with improved performance. NASA Potential applications include: Terrestrial and Planetary Balloons, specifically: * Long Duration Ballon/Ultra Long Duration Balloon Missions (LDB/ULDB) * Extra-terrestrial Balloon Missions (Venus In-Situ Explorer (VISE) and Titan Exploration) * Gamma-Ray Imager/Polarimeter for Solar flares (GRIPS) * Balloon Observation Platform for Planetary Science (BOPPS) * Super Pressure Balloon (SPB)

To the commercial space industry:

Potential Non-NASA Commercial Applications: FastCAP has been engaged in business discussions over the past two years with several aerospace companies that design and manufacture flight systems, satellites, launch vehicles and spacecraft that use advanced information and communication systems. All of these applications require energy management systems. The Boeing Company and EaglePicher have submitted letters of

Management Team *(cont.)*

Program Manager:
- Carlos Torrez

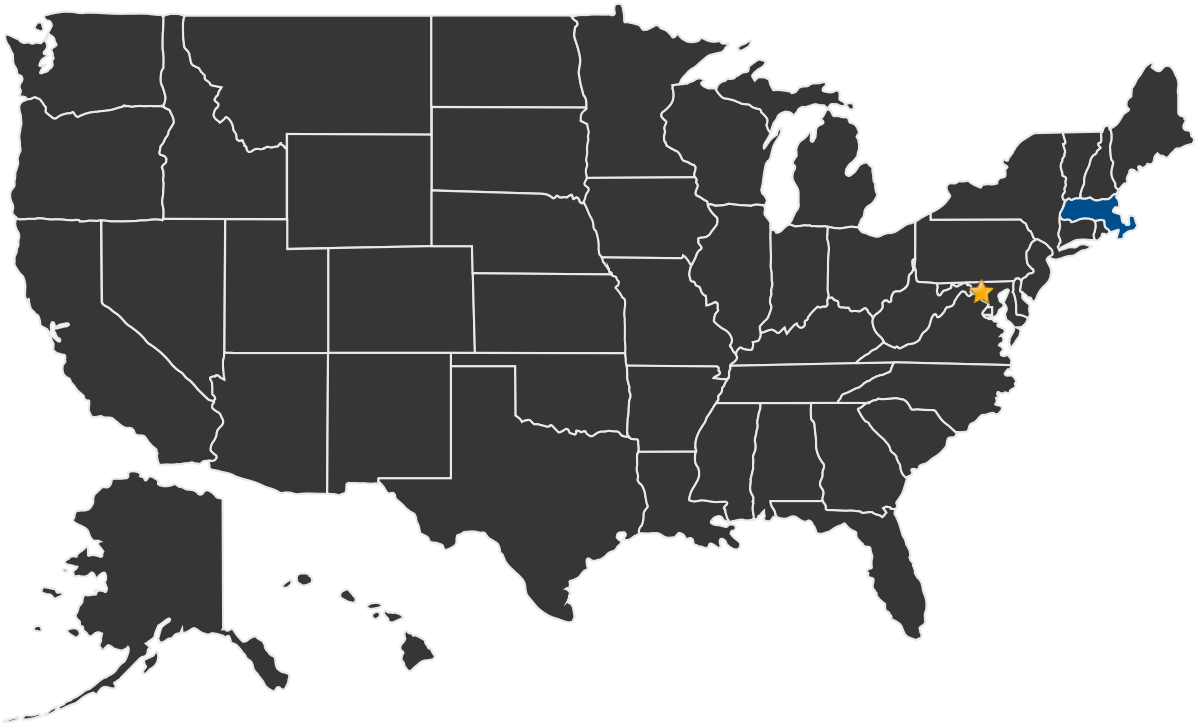
Principal Investigator:
- Fabrizio Martini

Technology Areas

Primary Technology Area:
Space Power and Energy Storage (TA 3)
└ Power Generation (TA 3.1)
  └ Chemical (TA 3.1.2)

support in conjunction with FastCAP's proposal, which we have attached in supporting documentation. Other relevant aerospace companies that showed interest to the proposed high power high energy power storage are Aerojet Rocketdyne, Lockheed Martin, and Raytheon. From this list, EaglePicher is the preferred partner during Phase II and III of FastCAP's proposal since they currently offer advance aerospace graded batteries. Other possible commercial applications are related to pulsed power, point of load power buffering, and load conditioning, including: satellites, planetary/asteroids missions, launch vehicles, high altitude UAVs, peak power harvester for solar arrays, electric propulsion systems, landers and rovers, and deep space mission.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Goddard Space Flight Center

Other Organizations Performing Work:

- FastCAP Systems Corporation (Boston, MA)

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PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23414)

IMAGE GALLERY

High Efficiency Hybrid Energy Storage Utilizing High Power Density Ultracapacitors For Long Duration Balloon Flights, Phase I

DETAILS FOR TECHNOLOGY 1

Technology Title

High Efficiency Hybrid Energy Storage Utilizing High Power Density Ultracapacitors For Long Duration Balloon Flights, Phase I

Potential Applications

The proposed 28 VDC hybrid aerospace graded ultracapacitor/battery module will be designed to power critical components needed for long duration terrestrial and planetary balloons. This innovative design will ensure available energy for more than 12 continuous hours using a lithium ion high energy density rechargeable battery (>200Wh/kg), and guaranteeing power delivery in the range of 100-1000 watts with the ultracapacitor pack. Phase II will focus on collaboration with an aerospace rated battery supplier (i.e. EaglePicher/Yardney) that has designed and produced high energy density batteries for previous space missions. We have received a letter of support from EaglePicher indicating a possible partnership leading to customized design work and testing validations specific to NASA requirements. Inclusion of a high power density ultracapacitor module working in parallel with a high energy battery pack will provide a considerable overall weight and

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